# Hypnotic Mindcontrol Workshop ®

Composite Strategy

*Presented*

*by*

*Mr. Augusto Mel*

**II**

This worlds **world** is *worldly*.
Learning as we dream finding ourselves there,
**here…** and *everywhere*.

# Journal

II

***"A neurological effect of external electric fields has been mentioned by Wiener (1958), in a discussion of the bunching of brain waves through nonlinear interactions. The electric field was arranged to provide "a direct electrical driving of the brain". Wiener describes the field as set up by a 10 Hz alternating voltage of 400 V applied in a room between ceiling and ground."***

***Norber Wiener – 1958*** **-** Nonlinear problems in random theory

***Henricus G. Loos – 2001*** **-** United States Patent 6,506,148 Nervous system manipulation by electromagnetic fields from monitors.

Anything is possible. Hypnotic Mindcontrol Workshop® proved that. It began with a warning coming from a speech given in the summer of 1985. You may remember it urging people to *gain back control* of their own unconscious. That we should skillfully program our own mind…

… or that the world would automatically program it for us.

It's now the year 2006 and **the "Threshold of Consciousness"** was already crossed. Trance induced **"Thought streams"** are simple to produce. Controlling the public mind with technology is now easier than ever before. By using Composite Strategy (C.S.) like *US Patent 6,238,333 Remote Magnetic Manipulation of Nervous Systems,* it's easy to understand how. That's just one "Known" source. How about the possibilities of US Patent 6889085? It was assigned to the Sony Corporation on May 20, 2005. It's a "Method and system for forming an acoustic signal from neural timing difference data". Yes, …very nice.

What about the unknown? **Our imagination and abiliy to invent is beyond phenomenal.** What's next and why?

As always, if you'e been able to keep up with technical aspects of the workshop you'll also understand the implications of each invention. You'll also figure out that not *All* patents are available for review because of national security concerns.

Today you'll get a chance to discover **Composite Strategy**. *It's probably as close as you'll ever get to the actual truth of what's taken place, so good luck!*

Now get going,
Mr. Augusto Mel

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**United States Patent 3951134 Apparatus and method for remotely monitoring and altering brain waves**

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**United States Patent 5,356,368 Method of and apparatus for inducing desired states of consciousness**

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**The range of gauge fields Hendricus G. Loos - 1965 Published by Elsevier Science B. V.**

**The r operator. Enabling Querying for Semantic Associations - Budapest, Hungary. Anyanwu, Kemafor and Sheth, Amit (2003)**

**Spin connection in general relativity*1 by Hendricus G. Loos Giannini Scientific Corporation, 1963.**

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**United States Patent 6,506,148 Nervous system manipulation by electromagnetic fields from monitors**

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**United States Patent 5,450,859 Protection of living systems from adverse effects of electric, magnetic and electromagnetic fields**

**TACTICAL INFRASOUND Study Leader: Christopher Stubbs**

# Appendix

## *R*ecommended reading list of additional patents, threads and leads to check out…

***US1749090 Apparatus for obtaining criminal confessions***
***US2227902 Carrier Frequency Signal System***
***US2304095 Method and apparatus for inducing and sustaining sleep***
***US2409033 Electro encephalograph device***
***US2498242 Control System – Bell Labs – Westinghouse Electric Corporation – John R. Boykin***
***US2703344 Cutaneous Signaling -1949***
***US2721316 Method and Means for Aiding the Blind- 1953***
***US2860627 Pattern Photic Stimulator***
***US2902030 Alertness indicator***
***US2968302 Multibeam Focusing Irradiator (Sound) 1956***
***US3032029 System controlling apparatus and method -reduce hum***
***US3060795 Apparatus for producing visual stimulation***
***US3081376 Subscription Television System - B.D. Loughlin***
***US3147437 Single Sideband Radio Carrier Retrieval System***
***US3182259 Submodulation Systems for Carrier Re-Creation***
***US3278676 Apparatus for producing visual and auditory stimulation***
***US3389382 Electron Beam Readout of Stored Information***
***US3393279 Nervous System Excitation Device***
***US3398810 Ultrasonic Sound Beam***
***US3499437 Method and Apparatus for treament of organic structure***
***US3557899 Security apparatus with audible alarm of enhanced urgency***
***US3568347 Psycho-Acoustic Projector***
***US3576185 Sleep inducing method and arrangement using modulated sound and light***
***US3612061 Flexible Cutaneous Electrode Matrix 1969***
***US3612211 Method of producing locally occurring infrasound***
***US3613069 Sonar System***
***US3628193 Tactile Image Projection System 1969***
***US3629521 Hearing Systems***
***US3647970 Method and system for simplifying speech wave forms-Neurophone***
***US3712292 Method and apparatus for producing swept FM Audio signal patterns for inducing sleep***
***US3773049 Apparatus for treatment of neuropsychic & somatic diseases with heat light sound & VHF electromagnetic radiation***
***US3782006 Means & methods to assist people in building up aversion to undesirable habits***
***US3848608 Subject Integument Spatial Stimulator- July 1973***
***US3852519 Video and Audio encoding-decoding system employing***
***US3884218 Method of inducing and maintaining various stages of sleep in the human being***
***US3967616 Multi channel system for & multi factorial method of controlling the nervous system of a living organism***
***US4006291 Three dimensional television system***
***US4141344 Sound Recording System***
***US4227516 Apparatus for Electro-Physiological Stimulation***
***US4315501 Learning Relaxation Device***
***US4315502 Frequency Stimulation Device***
***US4349898 Sonic Weapon System***
***US4388918 Mental Harmonization Process***
***US4395600 Auditory subliminal message system and method***
***US4572449 Method for Stimulating the falling asleep and/or relaxing behavior in a person***
***US4616261 Method and apparatus for generating subliminal visual messages***
***US4686605 Method and apparatus for altering a region in the earth's atmosphere, ionosphere, and/or magnetosphere***
***US4692118 Video Subconscious Display Attachment***
***US4699153 System for accessing verbal psycho-biological conditions of a subject***
***US4712155 Method and apparatus for creating an artificial electron cyclotron heating region of plasma***
***US4717343 Method of changing a person's behavior***
***US4734037 Message Screen (Subliminal)***
***US4777529 Auditory subliminal programming system***
***US4821326 Non-Audible Speech Generation Method & Apparatus***
***US4834701 Apparatus for inducing frequency reduction in brain wave***

# Hypnotics

II

# <u>H y p n o t i c s</u>

## · **Trance Mind trancing** - "<u>Brain Driver</u>"

“Sub-natural strategy began long ago, even before Norbert Weiner with “ Nonlinear problems in random theory” and before Henricus G. Loos with US Patent # 6506148. It influences everything. It’s all about the story, as it unfolds and weaves in metaphor. It’s about the groove actively being worn into the mental fabric of time. Long before American Marconi was bought by GE and spawned RCA, long before Sarnoff had patent battles with Farnsworth…. long before Tesla was robbed and long before Edison’s patent lab mill days, the Laws of Hypnosis contolled the unconscious mind and *society obeyed*. Yes it did and yes it does.

Sub-natural strategy generates realities and shapes behavior to desired outcomes using the laws of the unconscious mind and the body of which it controls. Put yourself in the shoes of the most powerful for a moment. Just pretend a minute and you’d agree that beside having power to run world affairs, self preservation would be of the utmost importance to you. Survival, while holding the most power sounds impossible…. Yet it’s not. The point is to be able to keep things secret. Hide truth, cover it with deception.

What if **<u>you found out??</u>**

Still, all this research has to be used by somebody for something somewhere. Somehow, in some way, scientific experimentation has always had funding, direction and purpose. The problem begins when research becomes classified. A lack of knowledge only compounds programming. We classify information as secret and it helps keep people in power. Securtiy, protection and invisibility are possible. No way back.

This is a world of citizens, a world full of sheep that are shepherded by many forces. Each like a strand of grass living in dirt. What would be the strategy of survival for those with the most power right now? How can people have power without letting other people know that they have it? How can the world be run powerfully while letting it think it runs itself? The individual man vs. the worlds programming. Be alive.

**Mind Control applications are practically endless.**
See “Brain Driver” - United States Patent 4,335,710 - Williamson on June 22, 1982.

*Now here is the situation:* In the following pages you will begin a review of patents and technology within the ministry of mindcontrol science. Below, I’ve quoted the background section from US Patent 6,238,333 *Remote magnetic manipulation of nervous systems*. The inventor, Hendricus G. Loos also wrote in 1965: *The range of gauge fields*. This is no average inventor. His list of patents now include United States Patent 6,506,148 *Nervous system manipulation by electromagnetic fields from monitors.* Yes, computer monitors used to manipulate your unconscious response…. Yes, again very nice. So what if people don’t know?

Again, what if **<u>you found out??</u>**

### *U.S. Pat. No. 6238333*

*“The human nervous system exhibits a sensitivity to certain low-frequency stimuli,as is evident from rocking a baby or relaxing in a rocking chair. In both cases, the maximum soothing effect is obtained for a periodic motion with a frequency near 1/2 Hz. The effect is here called "the 1/2 Hz sensory resonance". In the rocking response, the sensory resonance is excited principally by frequency-coded signals from the vestibular end organ. However, the rocking motion also induces body strains, and these are detected by stretch receptors residing in the skin and elsewhere in the body. In addition, relevant signals may originate from thermal receptors which report skin temperature fluctuations caused by air currents that are induced by the rocking motion. All these receptors employ frequency coding in their sensory function, and it must be that their signals are combined and compared in the brain with the vestibular nerve signals in an assessment of the somatic state.*
*One may thus expect that the sensory resonance can be excited not only through the vestibular nerve, but also separately through the other sensory modalities mentioned. This notion is supported by the observation that gently stroking of a child with a frequency near 1/2 Hz has a soothing effect.*

*Further support derives from the successful excitation of the 1/2 Hz sensory resonance by weak external electric fields, as discussed in "Method and Apparatus for Manipulating Nervous Systems", U.S. Pat. No.5782874. The 1/2 Hz sensory resonance involves the autonomic nervous system, and it can be used to induce relaxation, sleepiness, or sexual excitement, depending on the precise stimulation frequency and the affected afferent nerves. Another sensory resonance has been found at about 2.4 Hz; it involves the cortex since it can slow the speed of silently counting from 100 to 60, with the eyes closed, as discussed in the '874 patent and in U.S. Pat. No. 5,800,481. For both electric field and thermal stimulation, prolonged exposure to fluctuating electric fields near 2.4 Hz has been found to have a sleep-inducing and dizzying effect. The same physiological effect is expected for pulsative magnetic stimulation, since electric fields are induced in the tissue by the changing magnetic field. When using the nerve modulation method, reliance on resonance mechanisms further reduces the stimulation strength required for manipulating the nervous system."*

## U.S. Pat. No. 5,561,689

*Method and apparatus for digital carrier detection in a wireless lan by Arthur E. Fleek; October 1996.*

**Abstract**

*The oscillator at the sending node of a wireless digital network, generates a carrier signal, starting at a first instant. A modulator coupled to the oscillator performs phase shift modulating of the carrier signal with an input signal. A spoiler signal generator is coupled to the modulator, for providing a spoiler signal as the input signal, starting at the first instant and continuing for a first duration which is longer than a period needed for the oscillator to achieve stable characteristics. A transmitter is coupled to the modulator at the sending node, for transmitting a wireless radio signal representation of the carrier signal phase shift modulated with the spoiler signal to a receiver at a receiving node. The spoiler signal in the modulated carrier signal interrupts the periodic characteristic of the pulses, and thereby prevents the carrier sensor from detecting the carrier signal. Further, the spoiler signal ceases to modulate the carrier signal after the first duration when the oscillator has achieved stable characteristics, thereby enabling the carrier sensor to detect the carrier signal.*

Assignee: **International Business Machines Corporation** (Armonk, NY)

**References Cited [Referenced By]**

**U.S. Patent Documents**

| | | | |
|---|---|---|---|
| 3999005 | Dec., 1976 | Dickinson | 455/42. |
| **5159703** | **Oct., 1992** | **Lowery** | **455/42.** |
| 5355523 | Oct., 1994 | Ogawa et al. | 455/71. |

**5159703…. Silent Subliminal Communication System? IBM? What's silently communicating to you from inside your computer??? Yeah…Remember this next time you LOG ON.**

**EKG's, emotional signature clustering, patented technology and beyond:**
**US4335710 Device for the induction of specific brain wave patterns - white noise**
**US4395600 Auditory subliminal message system and method - Anti-shoplifting device**
**US4717343 Method of changing a person's behavior**
**US4777529 Auditory subliminal programming system**
**US4834701 Apparatus for inducing frequency reduction in brain wave**
**US5151080 Method and Apparatus for inducing and establishing a changed state of consciousness**
**US5159703 Silent subliminal presentation system**
**US6024700 System and Method for Detecting a thought and generating a control instruction in response thereto**
**US6219657 Device and Method for Creation of Emotions**
**US6258022 Behavior Modification**
**US6358201 Method and apparatus for facilitating physiological coherence and autonomic balance**
**LICKLIDER, J.C.R. (1949). The intelligibility and information content of quantized speech. Amer. Psychologist. 4, 234.**
**LICKLIDER, J.C.R. (1950). The manner in which and extent to which speech can be distorted and remain intelligible. In H. Von Foerster, (Ed), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the seventh conference. New York: Josiah Macy, Jr. Foundation.**
**LICKLIDER, J.C.R. (1951). A duplex theory of pitch perception. Experientia (Basel) 7, 4, 128-134**
**LICKLIDER, J.C.R. (1955). Auditory frequency analysis. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.**
**LICKLIDER, J.C.R. and MILLER, G.A. (1951). The perception of speech. In S.S. Stevens (Ed.), Handbook of experimental psychology. New York: Wiley.**

**from Hypnotic Mindcontrol Workshop® I ??? Ok then… now we're all caught up.**

**United States Patent 3,678,337**

**Grauvogel July 18, 1972**

# ENVIRONMENTAL CONTROL APPARATUS


## Abstract

The apparatus re-creates indoors electric and magnetic fields which occur naturally out-of-doors. A direct current field is created in an enclosure, such as a building, and low-frequency recurring disturbances or pulses are created in the field. The disturbances and/or the direct current field can be varied in time duration and frequency, either in a random manner or a pre-determined pattern, in order to avoid unresponsiveness of the persons in the building to the beneficial effects of the fields.



Inventors: **Grauvogel; Kurt** (Ottweiler, Saar, **DT**)



Appl. No.: **840444**

Filed: **July 9, 1969**


## Foreign Application Priority Data

| | |
|---|---|
| Jul 11, 1968 [CH] | 10432/68 |

**Current U.S. Class:** **361/231** ; 361/235; 422/291

**Field of Search:** 317/262,262AE,2,3,4,123 21/74.1 128/190,419,421 323/7,9,63

**References Cited [Referenced By]**
**U.S. Patent Documents**

| | | |
|---|---|---|
| 3175129 | March 1965 | Brown et al. |
| 3411045 | November 1968 | Reyner |
| 3311108 | March 1967 | Cristofv et al. |
| 3531150 | September 1970 | Jahnke |
| 3534530 | October 1970 | Hornig |
| 3541390 | November 1970 | Jahnke |
| 849653 | April 1907 | Bachelet |
| 3311108 | March 1967 | Cristofv et al. |
| 3433948 | March 1969 | Gallo |
| 3483672 | December 1969 | Jahnke |

**Foreign Patent Documents**

| | | |
|---|---|---|
| 1,063,293 | December | DT |
| 1,063,294 | December | DT |
| 919,338 | December | GB |

*Primary Examiner:* Myers; Lewis H.
*Assistant Examiner:* Weldon; U.

***Parent Case Text***

This application is a continuation-in-part of U. S. Pat. application Ser. No. 765,605, filed on Oct. 7, 1968.

## *Claims*

What is claimed is:

1. Environmental control apparatus comprising at least one electrode mounted in an habitable enclosure, a direct current source connected to said electrode for producing a direct current electric field in said enclosure, said direct current source having one output connected to ground, the flux lines in said field extending generally between a position adjacent the floor and another position adjacent the ceiling of said enclosure, a pulse generator connected to said direct current source for adding its pulses to the direct current output of said source, said pulses having a relatively low frequence, said pulse generator including means for limiting the increments in field strength created by said pulses to 15 percent of the direct current field strength.

2. Apparatus according to claim 1 including means for setting the frequency of said pulses at from one to twenty pulses per second.

3. Apparatus according to claim 1 including additional means coupled to said direct current source for producing time-dependent, abrupt alterations of the characteristic of said electric field in said enclosure.

4. Apparatus according to claim 3 in which the time interval between successive ones of said alterations is at least 1 minute.

5. Apparatus according to claim 3 including means coupled to said pulse generator for temporarily disabling said pulse generator to create pulse bursts of a pre-determined time duration.

6. Apparatus according to claim 4 in which said time interval is a least 60 times longer than the time duration of one cycle of said pulses.

7. Apparatus according to claim 3 in which said additional means includes a timer.

8. Apparatus according to claim 7 in which said direct current source includes a means for gradually adjusting the direct current potential.

9. Apparatus according to claim 8 comprising a timer for producing time-dependent signals, and means responsive to said signals for controlling said direct current potential adjusting means.

10. Apparatus according to claim 3 including means for adjusting the magnitude of said electric field with respect to time, comprising a means for storing data, producing control signals, and delivering said control signals to said adjusting means to control the adjustments thereof in accordance with time.

11. Environmental control apparatus comprising at least one electrode mounted in an habitable enclosure, a direct current source connected to said electrode for producing a direct current electric field in said enclose, said direct current source having one output connected to ground, the flux lines in said field extending generally between a position adjacent the floor and another position adjacent the ceiling of said enclosure, and pulse generator means connected to said electrode for causing the strength of said field to vary periodically with respect to time at a relatively low frequency, said electrode having a linear configuration to produce a magnetic field component in said enclosure when current flows through said electrode, said linear electrode having two terminals, one receiving the pulses imposed on the direct current voltage by said pulse generator, and the other being connected to said grounded output of said direct current source via a current-limiting circuit, said current-limiting circuit comprising a resistor and a condenser connected in parallel with the resistor, the time constant of said circuit being adapted to the frequency of the pulses delivered by said pulse generator.

12. Apparatus according to claim 11 in which said electrode has a coiled shape.

13. Apparatus according to claim 11 in which said electrode consists of a wire coiled to form a plane spiral.

14. Environmental control apparatus comprising at least one electrode mounted in an habitable enclosure, a direct current source connected to said electrode for producing a direct current electric field in said enclosure, said direct current source having one output connected to ground, the flux lines in said field extending generally between a position adjacent the floor and another position adjacent the ceiling of said enclosure, and pulse generator means connected to said electrode for causing the strength of said field to vary periodically with respect to time at a relatively low frequency, said electrode having a linear configuration to produce a magnetic field component in said enclosure when current flows through said electrode, said linear electrode having two terminals, one receiving the pulses imposed on the direct current voltage by said pulse generator, and the other being connected to said grounded output of said direct current source via a current-limiting circuit, said current-limiting circuit comprising a gas discharge tube connected in series with a current-limiting resistor, the time constant of said circuit being adapted to the frequency of the pulses delivered by said pulse generator.

## *Description*

This invention relates to apparatus for indoor environmental control. More particularly, this invention relates to devices for re-creating indoors electric fields which exist naturally out-of-doors. This application is a continuation-in-part of U. S. Pat. application Ser. No. 765,605, filed on Oct. 7, 1968.

It is believed that naturally-occurring electric fields which exist near the earth affect the physical and mental well-being of living organisms, and especially human beings. It also is believed that when human beings are deprived of such fields, such as when they are working in buildings which shield them from the fields, their well-being is affected adversely. For example, research workers have reported a loss of "internal synchronization"; i.e., changes in physiological parameters of the body, loss of a sense of time, and a corresponding slowing of work efficiency in human test subjects who lived for a length of time in underground bunkers which shielded the subjects from the natural fields outside the bunkers.

It has been proposed to alleviate the foregoing adverse affects of working indoors by creating indoors electric fields which simulate those occurring naturally out-of-doors. The results of tests in which 10 Hz alternating fields were used are reported in the articles entitled: "Principles of Circadian Rhythms in Man, Studied by the Effects of a Weak Alternating Electric Field," Pflugers Archives 302, 97-122 (1968) and "The Influence of Weak Electromagnetic fields on the Circadian Rhythm in Man", Zeitschrift fur Vergleichende Physiologie 56, 111-128 (1967), both by Rutger Wever. Additionally, the use of direct current fields with superimposed pulses is suggested in German Pat. No. 1,217,576.

It is believed that when a living organism such as a man moves in the earth's electric field, currents are induced in the man's body: Specifically, it is believed that current pulses are induced in a man's body when he walks in the earth's field. These pulses will be named "displacement currents" in this description.

One of the objects of the present invention is to provide environmental control equipment which will simulate natural displacement currents in living organisms such as humans not only when the persons are moving, but also when they are at rest inside buildings.

Certain prior art teachings indicate that the electric field in buildings should be uniform in space and constant with respect to time in order to achieve the best therapeutic effect. However, in accordance with the present invention, it is believed that an organism such as man becomes unresponsive to such fields after long periods of exposure to them. Therefore, it is another object of the present invention to provide environmental control apparatus of the aforementioned type, in which the fields are not likely to cause unresponsiveness after long periods of exposure.

In accordance with the present invention, the foregoing objects are met by the provision of environmental control apparatus which produces constant electric fields with low frequency disturbances. The frequency of the disturbances is close to the frequency of naturally-occurring field components so as to closely simulate natural fields in the rooms of buildings. Also, the field strength is changed at different time intervals of the order of hours or minutes in order to prevent long-term unresponsiveness of the organism to the fields.

Other objects, features and many of the attendant advantages of this invention will be appreciated more readily by reference to the following detailed description, when considered in connection with the accompanying drawings, wherein:

FIGS. 1(a) - 1(c) are diagrammatic representations of one embodiment of the environmental control apparatus of the present invention;

FIG. 2 is n electrical circuit diagram of a portion of the apparatus shown in FIG. 1;

FIG. 3 is an electrical circuit diagram of another embodiment similar to that of FIG. 2;

FIG. 4 is a perspective view of an alternative embodiment of a portion of the system shown in FIG. 1;

FIG. 5 is an electrical circuit diagram of a power supply unit for the system of the invention; and

FIGS. 6(a) through 6(e) are waveforms of voltages to be used in creating electric fields by means of the present invention.

The environmental control apparatus shown in FIG. 1 includes an electrode 1 which preferably is of planar shape and is located in a room near an organism such as a person 2 so that it does not make contact with the person. The electrode 1 is secured to the ceiling 4 of the room by means of supporting insulators 3. The room floor serves as the second electrode and, if necessary, can be provided with a grounded, electrically conductive coating 5.

In movable apparatus of the foregoing type, the first electrode is mounted on a movable support such as a stand formed like a lamp post, and the grounded springs of a chair or a bed, for example, form the other electrode. Such arrangements are well known in the art of conditioning air by the use of electric fields.

Still referring to FIG. 1, the electrode 1 is connected by means of a conductor 6 to one output terminal 7 of a power supply unit 28. Terminal 7 carries d.c. voltage with superimposed voltage pulses. The other output terminal 9 of the unit 28 is connected to ground.

The unit 28 includes a power supply 8, a d-c source 11 and an ungrounded pulse generator 10 with two output terminals 12 and 12'. One terminal, for example, the plus terminal of the d-c source 11, is connected to one output lead 7 of the unit 28 through the secondary winding of a transformer Tr 1 (see FIGS. 2 and 3), whose primary winding is connected between the output leads 12, 12' of the pulse generator 10. The pulses produced by the pulse generator 10 thus are superimposed upon the direct current conducted to the electrode 1. The negative terminal of the d-c source 11 is connected through output lead 9 to ground. Of course, the polarity of the d-c source can be reversed without changing the principles upon which the circuit operates.

The desired frequency range of the pulses produced by the generator 10 is approximately from 1 to 20 Hz, and the preferred frequency is 10 Hz. The strength of the direct current field can be from a very low value (less than one volt per meter) to in the vicinity of 2,500 volts per meter, and the increments in field strength created by the pulses preferably are from 5 to 15 percent of the direct current field strength. The time intervals between changes in the field strength which can be used to prevent unresponsiveness of the organism to the fields preferably are approximately from one half minute to one hour.

In the specific circuit shown in the drawings, the superimposed d-c voltage pulses have a peak voltage of 80 volts. The frequency as well as the time duration of the pulses can be adjusted in the unit 28. The frequency preferably is variable from 1 to 20 Hz.

The roman numerals I, II and III in FIGS. 1(a), 1(b) and 1(c), respectively, indicate the conditions which are believed to exist during three different phases of the voltage applied to the electrode 1.

During phase I, the voltage applied to the electrode 1 is constant, and is, for example, plus 900 volts with respect to ground. In the person 2 standing beneath the electrode 1, displacement currents are believed to occur when the direct voltage first is switched on. However, these currents are believed to diminish rapidly when the person is at rest. For designation of this "built-up" condition, a number of negative signs are drawn in the head of the person 2 represented in FIG. 1, while the electrode carries a positive charge.

During phase II, a direct voltage pulse is supplied to the electrode 1 when pulse generator 10 is turned on. When the positive charge on the electrode 1 increases, the field intensity also increases and this field intensity increase is believed to produce a corresponding displacement current in the person. This condition is indicated in FIG. 1(b) of the drawings by an arrow and a greater number of negative signs in the head of the person 2.

Phase III occurs upon the dissipation of the voltage pulse. The electrode has the same constant potential as it had during phase I. The conditions of phases I, II and III are repeated for each successive voltage pulse. In this manner, physiologically favorable displacement currents are believed to be established in living organisms by use of the succession of rhythmic or periodic voltage pulses.

It has been found that the voltage pulses produced in the pulse generator 10 and the corresponding electric field pulses are attenuated under certain conditions. This is believed to result in a corresponding decrease in the currents induced in living organisms, and in the effectiveness of the system.

It is, therefore, a further object of the invention to provide environmental control apparatus for producing in living organisms rhythmic or periodic displacement currents, in which the above-mentioned shortcomings of known devices of this type are avoided.

In view of the fact that magnetic fields also are believed to have a beneficial effect on living organisms, it is another object of this invention to provide apparatus which produces an electrical field having a magnetic field component. Such apparatus is shown schematically in FIGS. 2 and 3. To this end, instead of the planar surface electrode 1 shown in FIG. 1(a), "linear" electrodes, i.e. electrodes made of elongated conductors, are used. Such electrodes have a shape which is adapted to the particular application. For example, they are formed as "point" radiators or as "surface" radiators and preferably consist of a wire bent into a spiral or coiled shape. Examples of such electrodes are shown diagrammatically in FIGS. 2 to 4. Each of the electrodes 15 shown diagrammatically in FIGS. 2 and 3 forms a compact cylindrical coil which acts as "point radiator." For amplifying the desired magnetic field strength; a correspondingly-shaped core 16 of ferromagnetic material is inserted coaxially into the cylindrical coil as is shown in FIG. 3.

FIG. 4 shows an electrode 17 forming a "surface radiator" having substantially the form of a flat coil. In the preferred example shown in FIG. 4, the electrode 17 consists of a wire coiled to a plane spiral. The wire of the electrode 17 is of sufficient diameter so that each of the spiral turns is self-supporting. Also, the spacing of the turns is such that the turns do not touch one another. A disc 18 serves as a support for a lamp housing 21 and is positioned within the innermost turn of the spiral. The lamp housing contains a signal lamp 19 for indicating the operative condition of the electrode. The supporting disc 18 also can be made of ferromagnetic material, whereby, as in the case of the core 16, a greater magnetic field strength will be produced. Such an arrangement is particularly suitable for controlling the electric and magnetic fields in rooms since the effective surface area of the electrode can be large, and the electrode can have a pleasing appearance.

The two terminals 66 and 68 of electrodes 15 and 17 both are connected to the unit 28 in order to produce the magnetic field component. Specifically, the input terminal 66 is connected to the output lead 7 by means of lead 6, and the output terminal 68 is connected to the grounded output lead 9 of the unit 28 through a current-limiting circuit.

In the example shown in FIG. 2, the current-limiting circuit is formed by a resistor 13 and a condenser 14 connected in parallel with the resistor. The resistor 13 has a relatively large resistance, for example 1,000 megohms, so that the electrode 15 holds the desired high potential during operation. The capacitance of the condenser 14 preferably is so chosen that the time constant of the RC circuit formed by the resistor 13 and the condenser 14 is adapted to the frequency of the direct voltage pulses delivered by the pulse generator 10.

In the example of FIG. 3, the current limiting circuit connected in series with the electride 15 consists of a gas discharge tube 19 connected in series with a current-limiting resistor 20. The discharge tube 19 can be a commercial grade glow-lamp, and can be used both in the current limiting circuit, and at the same time as a signal lamp to indicate the operating condition of the system.

Referring to FIG. 4, the series circuit consisting of the electrode 17 and one of the current-limiting circuits can be connected to the terminal 7 of the unit 28, while its other end can be connected to ground. In this example, as mentioned already, the lamp casing secured to the support 18 contains a signal lamp which is connected in series with the electrode 17. Due to the design of the electrode as a "linear" electrode and its connection between the output lead 7 and ground, current flows through the electrode 17 so that a pulsed electric field with a magnetic component is formed in the room.

FIG. 5 illustrates a preferred circuit for a power supply unit 28 for producing a d-c potential with superimposed pulses, and including means for time-dependent, abrupt change of the electromagnetic fields.

The circuit shown in FIG. 5 includes a supply transformer Tr2 whose primary winding is connected to a conventional a-c power supply 80, and which has two separate secondary windings S1 and S2. The secondary winding S1 supplies a direct voltage of 5 volts together with a rectifier circuit GL 1, to the transistorized pulse generator 10. The pulse generator 10 is designed for producing direct voltage pulses, preferably having a peak voltage of about 80 to 100 volts and a pulse repetition frequency of 1 to 20 Hz. The generator 10 includes three transistors I, II, III, and a differentiator in a conventional circuit arrangement, so that the output signals at the output terminals 12, 12' of the generator are steep, peaked voltage pulses. The total circuit of the pulse generator has no ground connection. A conventional voltage multiplying circuit 24 comprising rectifier elements and condensers is connected to the secondary windings S2 of the transformer Tr2 through a potentiometer 23. The voltage multiplying circuit supplies a variable direct voltage of e.g. up to 1,000 volts to its output terminals 22, 22'. The output terminal 22' is connected to ground. The ungrounded pulse circuit 10 and the grounded direct voltage circuit 11 are inductively coupled together by the transformer Tr 1. The primary winding P of the coupling transformer Tr1 is connected to the output terminals 12, 12' of the pulse circuit 10. One end terminal of the secondary winding S of the coupling transformer Tr1 is connected through a blocking rectifier GL 2 with the ungrounded output terminal 22 of the direct voltage circuit 11, and the other end terminal of the transformer Tr1 is connected to the output terminal 7 which supplies the direct voltage with superimposed pulses. The blocking rectifier GL 2 has the function of preventing a return flow of current from the pulse circuit 10 to the d-c source 11. The source 11 also can be a battery instead of the a-c to d-c converter shown in the drawing.

The other terminal 9 of the power unit 28 is connected to the grounded output lead 22' of the direct voltage circuit 11. In the circuit shown in FIG. 5, the live terminal 7 is connected to the grounded terminal 9 through a large (e.g. 1,000 megohms) resistor 13 and a parallel-connected condenser 14. This resistor and condenser comprise the current limitation circuit shown in FIG. 2; therefore, both components are designated by the same reference numerals. The time constant of this resistor-condenser circuit is adapted to the frequency of the direct voltage pulses delivered by the pulse generator so as not to distort the pulses.

The electrode 1 shown in FIG. 1 is a single member connected to the live terminal 7. In this type of circuit the electrode produces a direct current field with superimposed pulses without a magnetic component. However, the above-mentioned reduction of displacement current does not occur.

When the connection between the terminals 7 and 9 is interrupted, for example, by opening a switch 26, and the end terminals of the electrode are connected between the terminal 7 and a further terminal 25 connected to the junction between resistor 13 and condenser 14, by means of the switch 26, a connection of the electrode as shown in FIG. 2 is obtained, and a pulse-superimposed direct current field having a magnetic field component is produced by the electrode. Alternatively, an electrode having a series-connected discharge tube 19 and limiting resistor 20 can be connected to the live terminal 7 when the switch 26 is open, as is shown in FIG. 3. The power unit 28 accordingly permits many different modes of operation.

As mentioned above, one feature of the invention is that the danger of acclimatization of the organism to the fields is avoided by an additional device for the time-dependent abrupt variation of the fields in such a way that a state of stimulation is produced constantly in the organism. The time intervals between disturbances of the continuity of the steady field should be the order of hours or minutes, and the time intervals should be adjustable.

The low-frequency disturbance of the continuity of the steady field can be effected in various ways, for example, by a low-frequency device for the temporary interruption of the direct current, so that rectangular pulses with a minimum voltage of 0 volts, as shown in FIG. 6(a), are produced. In order to produce rectangular pulses with a minimum voltage level differing from zero as shown in FIG. 6 (b), a low-frequency device for varying the d-c potential is provided.

It is preferred, however, to use a pulse generator for the production of low-frequency pulses as shown in FIG. 6(c), or low-frequency pulse sequences as shown in FIGS. 6(d) and 6(e), and superimpose such pulses upon a direct current signal. With a pulse generator it is also possible to adjust and vary the pulse sequence frequency and the amplitude of the pulses. device

The circuit shown in FIG. 5 includes devices for producing low-frequency disturbances of the steady field, independently of the pulse generator 10. As mentioned above, a potentiometer 23 is connected to the secondary coil S2 of the main transformer Tr 2. This potentiometer 23 can be regulated in the embodiment shown in FIG. 5 not only by hand but also mechanically. For example, the wiper arm of the potentiometer can be moved by means of a solenoid 34 and a magnetic member 36 which is moved longitudinally by the solenoid in accordance with the voltage the solenoid receives from a control device 38. The control device 38 converts line voltage into two different control voltages whose values can be controlled by means of two adjusting devices 40 and 42. A timer 43 delivers signals in adjustable time intervals to the control device 38 and the device 38 switches the voltage delivered to the solenoid 34 between the limiting values preset by means of devices 40 and 42.

If the limiting value of zero is set by means of one of the devices 40, 42, there is developed at the output terminal 22 of the d-c source 11 a rectangular pulse with a minimum level of zero, as is shown in FIG. 6(a). If the minimum level is greater than zero, the field potential alternates between two positive voltage values, as is shown in FIG. 6(b). Thus, it is possible to eliminate the pulse-generator 10 if the adjustable timer 43 gives off its reversing signals at the desired frequency.

If the unit 28 contains the pulse generator 10, however, the above described devices shown in the upper portion of FIG. 5 for the rhythmic variation of the steady field potential should be used for the automatic time-dependent abrupt and essential variation of the fields in order to change the degree of stimulation of the organism so as to prevent "acclimatization." The timer 43 then does not give off low-frequency signals, but very low frequency signals whose time duration is of the order of minutes or hours. This abrupt variation of the characteristic of the fields is shown in FIG. 6(e) by the change of the pulse-superimposed d-c voltage from potential A1 to potential A2.

It should be mentioned that the movement of the potentiometer arm is shown herein only as an example of an electromechanical solution of the problem. Of course, purely electrical, contact-free and low-inertia means for performing the same function are also within the scope of the invention.

A time-dependent abrupt variation of the disturbance of the continuity of the steady field in a room also can be achieved, by variation of the rectangular pulse frequency (e.g. by control of the reversal rate of the timer or interval transmitter 43), of the pulse duration, of the pulse sequence frequency, or of the amplitude of the pulses.

To this end is provided a control circuit with elements, shown in the lower portion of FIG. 5, which correspond, respectively, to the elements in the upper portion of FIG. 5 having reference numerals each of which is smaller than its counterpart by 10. The lever 46 moves the wiper arm of a potentiometer 54 for the gradual adjustment of the amplitude of the pulses which are transmitted through the transformer Tr 1 and added to the d-c potential applied to the output terminal 22. The potentiometer 54 is connected in parallel with the secondary winding S of the transformer Tr 1.

If the minimum value of zero is set by means of one of the adjusting devices 50, 52, the secondary winding S is short-circuited, and pulses are not added to the direct field current in the time intervals dictated by the timer 53. Such a time interval is indicated in FIG. 6d by the letter I. Thus, a pulse sequence or burst is obtained whose repetition rate can be adjusted by means of the timer or interval transmitter 53. With reference to FIG. 6d, the pulse frequency (equal to 1/IF) from the pulse generator 10 can be relatively high. In this example, the interval I determined by the timer 53 is the low-frequency disturbance of the continuity of the field in the sense of the present invention.

If limiting values differing from zero are preset on both adjusting devices 50, 52, the amplitude of the pulses is varied from A1 to A2, as shown in FIG. 6e. This variation of the amplitude can be accompanied by an abrupt variation of the steady field potential from P1 to P2 in order to produce a new state of stimulation in the organism and to avoid "acclimatization" of the organism. A similar effect can also be achieved if the switch 26 is switched back and forth automatically in intervals of minutes or hours between the contact 30 and the central neutral position. In this manner, a pulsating field with and without magnetic field component is produced.

Instead of the adjusting devices 40, 42, 50, 52, and the timers 43, 53, a storage device 58 can be used. Into the device 58 is stored all data for the time-dependent or gradual programmed movement of the arm of potentiometer 54 and/or of the potentiometer 23 and, if necessary, other switching elements of the pulse generator 10. The instructions to the storage device can be input by means of punch cards or magnetic tape, for example. In the latter case, the control signals are transmitted over the lines 60, 61, 62, 63 to the control devices 38, 48.

**United States Patent 4,335,710**
**Williamson June 22, 1982**

Device for the induction of specific brain wave patterns


## Abstract

Brain wave patterns associated with relaxed and meditative states in a subject are gradually induced without deleterious chemical or neurological side effects. A white noise generator (11) has the spectral noise density of its output signal modulated in a manner similar to the brain wave patterns by a switching transistor (18) within a spectrum modulator (12). The modulated white noise signal is amplified by output amplifier (13) and converted to an audio signal by acoustic transducer (14). Ramp generator (16) gradually increases the voltage received by and resultant output frequency of voltage controlled oscillator (17) whereby switching transistor (18) periodically shunts the high frequency components of the white noise signal to ground.



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**Field of Search:** 128/1C,1R


### References Cited [Referenced By]

### U.S. Patent Documents

| | | |
|---|---|---|
| 2466054 | April 1949 | Siebel |
| 3160159 | December 1964 | Hoody et al. |
| 3576185 | April 1971 | Schulz et al. |
| **3712292** | **January 1973** | **Zentmeyer, Jr.** |
| 3753433 | August 1973 | Bakerich et al. |
| 3884218 | May 1975 | Monroe |
| 3892957 | January 1975 | Freeman |
| 4034741 | July 1977 | Adams et al. |

#### Foreign Patent Documents

| | | |
|---|---|---|
| 1165541 | July | GB |

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## *Claims*

I claim:

1. A device for the induction of brain wave patterns associated with relaxed and meditative states in a subject comprising:

means for generating a white noise signal having a uniform spectral noise density;

means for receiving said white noise signal and modulating its said spectral noise density in a manner similar to the brain wave patterns associated with relaxed and meditative states; and

means receiving said modulated noise signal for coupling said modulated signal to the subject.

2. A device, as set forth in claim 1, wherein the brain wave patterns associated with relaxed and meditative states occur in a range of freqencies, said means for modulating the spectral noise density including means for modulating said white noise signal beginning at a frequency greater than that of the brain wave patterns.

3. A device, as set forth in claim 2, wherein said means for modulating the spectral noise density further includes means for gradually reducing the frequency at which said spectral noise density is modulated.

4. A device, as set forth in claim 3, wherein said means for modulating the spectral noise density further includes means for terminating all modulation of said white noise signal upon reaching its lowest frequency of modulation.

5. A device, as set forth in claim 3 or 4, wherein said means for modulating the spectral noise density further includes means for reaching a steady state frequency of modulation at a frequency slightly lower than the lowest said brain wave pattern frequency.

6. A device, as set forth in claim 5, wherein said means for modulating said spectral noise density includes switching means for receiving said white noise signal, providing said modulated noise signal, and periodically shunting to ground the high frequency components of said white noise signal.

7. A device, as set forth in claim 6, wherein said means for modulating said spectral noise density further includes oscillator means for controlling the instantaneous frequency at which said switching means periodically shunts to ground said high frequency components of said white noise signal and generator means for controlling the instantaneous frequency of said oscillator means.

8. A device, as set forth in claim 7, wherein said generator means generates an output signal having a variable voltage, which signal is received by said oscillator means and causes said oscillator means to generate a modulation signal having a frequency of from approximately 14 to 15 Hz.

9. A device, as set forth in claim 8, wherein said output signal from said generator means begins operation at its negative most voltage amplitude and continuously gradually increases to a steady-state value at its positive most voltage amplitude, said oscillator means beginning operation at approximately 14 Hz and continuously gradually increasing to a steady-state value at approximately 5 Hz, whereby said switching means modulates the high frequency components of said white noise signal at the instantaneous frequency of said oscillator means.

10. A device, as set forth in claim 9, wherein said means for coupling said modulated signal to the subject is a headphone transducer for converting said modulated signal to an audio signal and having pneumatic tubes adopted to carry said audio signal to the subject in a non-intrusive manner while minimizing extraneous acoustical background distractions.

11. A device, as set forth in claim 10, wherein said switching means includes a switching transistor furnishing said modulated signal, and further including an output amplifier receiving and amplifying said modulated signal, said headphone transducer receiving said amplified modulated signal from said output amplifier.

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## *Description*

TECHNICAL FIELD

The present invention relates generally to a device for effecting deep relaxation in a subject. More particular, the present invention relates to a device for the induction of brain wave patterns associated with relaxed and meditative states in a human subject, commonly known as a "brain driver".

BACKGROUND ART

It has long been recognized that most mammals and in particular humans exhibit distinct recurring electrical frequencies in their brain wave patterns, each of which is related to separately identifiable physiological states. Brain waves having dominant frequencies from approximately 8-13 Hz, inclusive, are known as Alpha frequency brain waves and are associated with relaxed and meditative states as would occur when a subject has his eyes closed but is conscious and not thinking.

Techniques and devices which attempt to promote natural relaxation may be generally classified as passive or active. Passive devices serve merely to mask out irritating external noises with more pleasant sounds or utilize random or "white noise" to psychologically distract the subject from events which inhibit natural relaxation. Active devices seek to intentionally induce Alpha frequency brain waves in the subject, a phenomena known as "brain driving". Irrespective of the manner in which such brain waves are induced, a subject whose brain waves are principally in the Alpha frequency range will become deeply relaxed and exhibit the same beneficial reduced muscular tension and lowered anxiety and adrenalin levels as are associated with a naturally occurring state of relaxation.

Typical of the numerous passive devices are those which vary the output signal from a "white noise" source and convert the same to an accoustical signal, resulting in pleasant masking sounds. In one device, the white noise source output has its amplitude varied by a saw tooth wave form to produce sounds similar to waves repeatedly breaking in a surf. In another device, the output signal from a "white noise" source has its spectral content and amplitude varied in direct response to a subject's instantaneous dominant brain wave frequency and amplitude, respectively, producing a feedback signal to be utilized by the subject to recognize his present physiological state. All passive devices suffer from a fundamental inadequacy in that they cannot actually induce Alpha frequency brain waves with its associated relaxed and meditative condition.

Currently only three basic techniques for forcing a subject into a state exhibiting Alpha frequency brain waves are known to exist. Perhaps the most widely used is chemical tranquilizers, always subject to potentially grave known and unknown negative side effects or contraindications. The other techniques for "brain driving" involve the use of very bright, quickly flashing lights, direct electrical pulse stimulation of the brain through skin electrodes, or some combination thereof. In either instance, the lights or electrical pulses are synchronized to occur at a rate within the Alpha frequency range, i.e., from about 8 to 14 Hz. However, such flashing lights are not only irritating but may likely initiate a seizure in epileptic individuals. Electrical pulses are not only irritating, but also may produce unknown, deleterious side effects upon other parts of the brain or other neurological activity. Moreover, these devices attempt to very abruptly force the subject from an active and possibly highly emotional state to a highly relaxed and meditative state, thereby greatly increasing the likelihood of failure.

DISCLOSURE OF INVENTION

It is, therefore, an object of the invention to provide a device for the induction of brain wave patterns associated with relaxed and meditative states in a subject in a safe manner without deleterious or irritating side effects or contraindications.

It is a further object of the invention to provide a device for the induction of brain wave patterns associated with relaxed and meditative states in a subject, as above, which gradually induces such state in the subject. It is yet a further object of the invention, to provide a device for the induction of brain wave patterns associated with relaxed and meditative states in a subject, as above, which utilizes a pleasing sound that is modulated and programmed in such manner as to induce Alpha frequency brain wave patterns only in those brain structures where it naturally occurs.

It is still a further object of the invention to provide a device for the induction of brain wave patterns associated with relaxed and meditative states in a subject, as above, which ultimately terminates all variations in modulation of the sound thereby freeing and encouraging the subject's brain to assume whatever somnolent brain wave patterns occur naturally to the subject.

It is still a further object of the invention to provide a device for the induction of brain wave patterns associated with relaxed and meditative states in a subject, as above, which includes a source of white noise and a circuit for modulating the spectral noise density of the white noise in a manner similar to the brain wave patterns associated with relaxed and meditative states so as to promote the gradual transition to an Alpha frequency brain wave condition and the continuous maintenance of the subject in that condition.

These and other objects and advantages of the present invention over existing prior art forms will become more apparent and fully understood from the following description in conjunction with the accompanying drawings.

In general, a device for the induction of brain wave patterns associated with relaxed and meditative states in a subject comprises a signal generator for generating a white noise signal having a uniform spectral noise density, a modulation circuit for receiving and modulating the white noise signal, and means for receiving the modulated noise signal and coupling it to the subject. The modulation circuit modulates the white noise signal in a manner similar to the brain wave patterns associated with relaxed and meditative states in the subject, thereby actively gradually inducing such state in the subject.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of an exemplary device according to the concept of the present invention, and depicts the spectral-noise density modulator schematically.

FIG. 2 is a somewhat schematic representation of the voltage waveforms at various points in the device shown in FIG. 1, and although the various waveforms are in approximate time coordination with each other, they are not necessarily to scale.

PREFERRED EMBODIMENT FOR CARRYING OUT THE INVENTION

FIG. 1 illustrates a device, generally indicated by the numeral 10, for the reduction of stress in an individual by the induction of brain wave patterns associated with relaxed and meditative states. Device 10 broadly includes white noise generator 11, spectrum modulator 12, output amplifier 13, and acoustic transducer 14.

White noise generator 11 may be any conventional noise generator, either of the random or impulsive type, that has a level frequency spectrum over the frequency range of interest. One generator found suitable for use herein included an operational amplifier providing a thermal noise signal and an amplification stage.

Spectrum modulator 12 includes transistor shunt gate 15, ramp generator 16, and voltage control oscillator (hereinafter referred to as VCO) 17. Transistor shunt gate 15 includes a conventional NPN switching transistor 18, a by-pass diode 19, two summing resistors 20 and 21, and two capacitors 22 and 23. Ramp generator 16 may be any conventional ramp generator such as an integrator having a period as detailed hereinbelow and having a maximum voltage compatible with VCO 17 and transistor shunt gate 15. A switch 26 may be provided for resetting ramp generator 15 to its zero point, which for an integrator may be its maximum voltage of negative polarity, referred to for convenient reference as -V.

VCO 17 may be any of the multitude of well-known astable multivibrators whose output frequency is a function of the voltage of its input signal. The frequency range of the output signal from VCO 17 should be slightly greater than the frequency range of alpha brain wave patterns and preferably should vary linearly from it highest output frequency when ramp generator 16 is at its maximum voltage of negative polarity (-V) to its lowest output frequency when ramp generator 16 is at its maximum voltage of positive polarity (+V). Where the Alpha brain wave frequency range is taken to be from approximately 8 to 13 Hz, inclusive, it is adequate to provide a VCO 17 output signal frequency range from approximately 5 to 14 Hz, inclusive.

Acoustic transducer 14 may be any conventional device for converting the electrical output signal from transistor shunt gate 15 to an audio signal. In order to increase the likelihood of relaxation in the subject, it is, however, highly desirable to provide the least intrusive coupling between the transducer and the subject while minimizing acoustical background distractions. Therefore, it has been found preferable to utilize a conventional headphone transducer having pneumatic tubes 24, 25 adopted to carry the audio signal to each ear of the subject without applying noticeable pressure to the subject's head.

The interconnection of the various elements described above is straightforward. The collector of switching transistor 18 is connected through capacitors 23 and 22, to noise generator 11 and, through capacitor 23 to output amplifier 13, so that both may receive the output signal from noise generator 11. The output signal from ramp generator 16 is received by both VCO 17, and, through resistor 20, the base of switching transistor 18. The output signal from VCO 17 is also received, through resistor 21, by the base of switching transistor 18. The anode of diode 19 is connected to the base of switching transistor 18, and has its cathode connected to ground along with the emitter of switching transistor 18. The output signal from output amplifier 13 is received by acoustic transducer 14.

To better visualize the operation of device 10, five output signal waveforms emanating from the various elements noted below have been illustrated in FIG. 2. Denoted A through D, inclusive, it should be reiterated at this point that these waveforms are coordinated in time, but not necessarily in amplitude. These waveforms respectively represent the output signals from noise generator 11, ramp generator 16, VCO 17, and transistor shunt gate 15.

Noise generator 11 generates a "white noise" output signal A having a "uniform" spectral noise density. In other words, this means that the ratio of the noise output from noise generator 11 within a specific frequency interval to the frequency interval itself is a constant. As shall become more evident hereinafter, it is of no moment to the present invention precisely what this ratio happens to be, it is significant only that it remains constant.

Spectrum modulator 12 receives white noise signal A from noise generator 11 and modulates its spectral noise density in a manner similar to the brain wave patterns associated with relaxed and meditative states. More particularly, spectrum modulator 12 modulates white noise signal A with a variable frequency in the range of frequencies of Alpha brain wave patterns. It has been found to be most effective in inducing a relaxed and meditative state in a subject to begin modulating white noise signal A at a frequency slightly greater than the frequency associated with the Alpha brain wave pattern occurring when the subject is most active, and gradually over a period (T) of minutes reducing the modulation frequency to a frequency slightly less than the frequency associated with the Alpha brain wave pattern occurring when the subject is least active. Upon reaching this lowest modulation frequency, modulation of white noise signal A is terminated, permitting the subject's natural brain wave patterns to become dominant.

A typical operating cycle would begin by the closing of switch 26, resetting ramp generator output signal B to its "zero" voltage -V volts, and forcing VCO output signal C to its highest frequency of 14 Hz. VCO output signal C is mixed with ramp generator output signal B and received by the base of switching transistor 18, causing switching transistor 18 to alternate at the instantaneous frequency of VCO 17 (then 14 Hz) between saturation and cutoff operational states. Diode 19 sets the maximum base-emitter voltage for switching transistor 18.

When operating in a saturated state, switching transistor 18 shunts to ground the higher frequency components of white noise signal A. When operating in a cutoff state, switching transistor 18 permits the full frequency spectrum of white noise signal A to be received by output amplifier 13. The resultant output from spectrum modulator 12 is output signal D shown in FIG. 2.

As time proceeds, the voltage of ramp generator output signal B increases, proportionally decreasing the frequency of VCO output signal C and the modulation frequency of white noise signal A. When the maximum possible positive voltage (+V) of ramp generator output signal B is reached, the frequency of VCO output signal C remains at a constant 5 Hz, and switching transistor 18 remains in a saturated state, causing all modulation of white noise signal A to terminate, leaving only the low frequency components of white noise signal A to be received by output amplifier 13.

Output amplifier 13 receives transistor shunt gate 15 output signal D and amplifies it to a level compatible with acoustical transducer 14, which converts the signal to an audio format suitable for direct listening by the subject. Output amplifier 13 only need be furnished where further amplification is required.

Several modifications to the depicted embodiment may be noted. Perhaps most significant is the fact that other spectrum modulation patterns could be employed herein, although the illustrated continuously decreasing spectral density modulation is highly advantageous in inducing a relaxed and meditative condition in a subject. For example, rather than ramp generator 16 generating a continuously increasing voltage signal, continuously decreasing the frequency of VCO 17, it would be possible to provide periods of constant voltage output alternated with periods of changing voltage output, resulting in differing patterns of spectral modulation. An essentially unlimited number of possible combinations may be effected by simple adjustment of the generator 16 output signal waveform.

It should also be appreciated that the particular transistor shunt gate 15 shown herewith is merely exemplary of numerous equally suitable circuits for switching the noise generator output signal A. Transistor shunt gate 15 permits modulation of the higher frequencies contained in the source signal at rates which corrolates to natural Alpha brain wave pattern frequencies and, in this manner modifies the spectral noise density of the source signal.

Inasmuch as the present invention is subject to many variations, modifications and changes in detail, a number of which have been expressly stated herein, it is intended that all matter described throughout this entire specification or shown in the accompanying drawings be interpreted as illustrative and not in a limiting sense. It should thus be evident that a device constructed according to the concept of the present invention, and equivalent thereto, will accomplish the objects of the present invention and otherwise substantially improve the art of the induction of specific brain wave patterns in a subject.

**United States Patent** **6,219,657**
**Hatayama** **April 17, 2001**

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# Device and method for creation of emotions


**Abstract**

A device and a method for creation of emotions are provided for an interface of information, such as an artificial agent and a personified agent, intervened between a human being (i.e., user) and an electronic apparatus. For instance, an emotion creating device is configured by a neural network, a behavior determination engine and a feature determination engine. The neural network inputs user information, representing conditions of the user, and apparatus information, representing conditions of the apparatus, so as to produce emotional states. Herein, a present set of emotional states are produced in consideration of a previous set of emotional states. The emotional states represent prescribed emotions such as pleasure, anger, sadness and surprise. The behavior determination engine refers to a behavior determination database using the user information and the emotional states of the neural network so as to determine a behavior of the interface. The feature determination engine refers to a database using the emotional states of the neural network to determine a feature of the interface, which corresponds to a facial feature.


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**Field of Search:** 706/14,18,26,20


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**References Cited [Referenced By]**

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**U.S. Patent Documents**


| | | |
|---|---|---|
| 5497430 | March 1996 | Sadovnik et al. |
| 5724484 | March 1998 | Kagami et al. |
| 5774591 | June 1998 | Black et al. |


**Foreign Patent Documents**

| | | |
|---|---|---|
| 7-72900 | Mar., 1995 | JP |
| 7-104778 | Apr., 1995 | JP |
| 8-339446 | Dec., 1996 | JP |
| 10-49188 | Feb., 1998 | JP |

## Other References

Avent et al, "Machine Vision Recognition of Facial Affect Using Backpropagation Neural Networks", IEEE Proceedings of the 16th Annual International Conference on New Opportunities for Biomedical Engineers, Engineering in Medicine and Biology Society, Nov. 1994.* .
Yamada et al, "Pattern Recognition of Emotion with Neural Network", IEEE International Conference on Industrial Electronics, Control and Instrumentation, Nov. 1995.* .
Sato et al, "Emotion Modeling in Speech Production Using Emotion Space", IEEE 5th International Workshop on Robot and Human Communication, Nov. 1996.* .
Pramadihanto et al, "Face Recognition from a Single View Based on Flexible Neural Network Matching", IEEE 5th International Workshop on Robot and Human Communication, Nov. 1996.* .
Ding et al, "Neural Network Structures for Expression Recognition", Proceeding of IEEE 1993 International Conference on Neural Networks, 1993.* .
Takacs et al, "Locating Facial Features Using SOFM", IEEE Proceedings of the 12th IAPR International Conference on Pattern Recognition, Oct. 1994.* .
Vincent et al, "Precise Location of Facial Features by a Hierarchical Assembly of Neural Nets", IEEE 2nd International Conference of Artificial Neural Networks, 1991.* .
Morishima et al, "Emotion Space for Analysis and Synthesis of Facial Expression", IEEE International Workshop on Robot and Human Communication, 1993.* .
Kawakami et al, "Construction of 3-D Emotion Space Based on Parameterized Faces", IEEE International Workshop on Robot and Human Communication, 1994.* .
Kawakami et al, "An Evaluation of 3-D Emotion Space" IEEE International Workshop on Robot and Human Communication, 1995.* .
Morishima et al, "A Facial Image Synthesis System for Human-Machine Interface", IEEE International Workshop on Robot and Human Communication, 1992.* .
Morishima et al, "Image Synthesis and Editing System for a Multi-Media Human Interface with Speaking Head" IEEE Inter. Conf. on Image Processing and Its Applications, 1992.* .
Morishima et al, "A Media Conversion from Speech to Facial Image for Intelligent Man-Machine Interface", IEEE Journal on Selected Areas in Communications, 1991..

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## ***Claims***

What is claimed is:

1. An emotion creating device, provided for an interface of information between a user and an electronic apparatus, comprising:

a neural network for inputting user information, apparatus information and a present set of emotional states so as to output a next set of emotional states;

a behavior determination engine for inputting the user information and the emotional states of the neural network so as to determine a behavior of an interface; and

a feature determination engine for inputting the emotional states of the neural network to determine a feature of the interface.

2. An emotion creating device as defined in claim 1 wherein the user information corresponds to a number of times of blinking detected by a camera, loudness of voice and a voice interval detected by a mike, a pulse rate detected by a sensor, an intensity of key depression given from a keyboard and a using time given from a mouse, while the apparatus information corresponds to an internal temperature detected by the sensor and a using time measured by a timer, so that the neural network outputs the emotional states which correspond to pleasure, anger, sadness and surprise.

3. An emotion creating device as defined in claim 1 wherein the behavior determination engine comprises

input detection information processing means for detecting the user information, which corresponds to a number of times of blinking detected by a camera, loudness of voice and a voice interval detected by a mike, a pulse rate detected by a sensor, an intensity of key depression given from a keyboard and a using time given from a mouse, to output processed information,

a behavior determination database having a table representing correspondence between the processed information, the emotional states and the behavior of the interface, and

behavior determination means for performing searching on the behavior determination database by inputting the processed information from the input detection information processing means as well as the emotional states of the neural network which correspond to emotions of pleasure, anger, sadness and surprise, thus determining the behavior of the interface.

4. An emotion creating device as defined in claim 1 wherein the feature determination engine comprises

an eye data database for storing eye data,

eye data production means for referring to the eye data database to produce the eye data corresponding to the emotional states of the neural network,

a nose data database for storing nose data,

nose data production means for referring to the nose data database to produce the nose data corresponding to the emotional states of the neural network,

a mouth data database for storing mouth data,

mouth data production means for referring to the mouth data database to produce the mouth data corresponding to the emotional states of the neural network,

a color data database for storing color data, color data production means for referring to the color data database to produce the color data corresponding to the emotional states of the neural network, and

feature data production means for producing the features of the interface based on the eye data, the nose data, the mouth data and the color data which are produced by the eye data production means, the nose data production means, the mouth data production means and the color data production means respectively.

5. A machine-readable recording media storing a program which causes a computer to perform an emotion creating method comprising:

actualizing a neural network for inputting user information, apparatus information and a present set of emotional states to output a next set of emotional states;

actualizing a behavior determination engine for inputting the user information and the emotional states of the neural network to determine a behavior of an interface; and

actualizing a feature determination engine for inputting the emotional states of the neural network to determine features of the interface.

6. An emotion creating device comprising:

a neural network for inputting user information representing conditions of a user and apparatus information representing conditions of an electronic apparatus so as to produce emotional states corresponding to prescribed emotions, wherein the neural network producing a present set of emotional states in consideration of a previous set of emotional states;

a behavior determination engine for referring to a behavior determination database using the user information and the emotional states of the neural network so as to determine a behavior of an interface; and

a feature determination engine for referring to a database using the emotional states of the neural network so as to determine a feature of the interface.

7. An emotion creating device as defined in claim 6 wherein the conditions of the user correspond to a number of times of blinking, loudness of voice, a voice interval, a pulse rate, an intensity of key depression and a first using time that the user accesses the electronic apparatus, while the conditions of the electronic apparatus correspond to an internal temperature and a second using time that the electronic apparatus is used.

8. An emotion creating device as defined in claim 6 wherein the prescribed emotions correspond to pleasure, anger, sadness and surprise respectively.

9. An emotion creating device as defined in claim 6 wherein the interface corresponds to an artificial agent or a personified agent.

10. An emotion creating device as defined in claim 6 wherein the emotional states of the neural network are represented using coordinate values on a four-dimensional coordinate system whose axes respectively correspond to intensities of the prescribed emotions.

11. An emotion creating device as defined in claim 6 wherein the feature of the interface correspond to a facial feature.

## ***Description***

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

This invention relates to devices and methods for creation of motions in electronic apparatuses containing interfaces such as the artificial life and artificial agent. This application is based on patent application No. Hei 9-78918 filed in Japan, the content of which is incorporated herein by reference.

### 2. Prior Art

Recently, electronic apparatuses such as the home electronic apparatuses and office automation apparatuses are designed to have multi functions and complicated configurations. As for the electronic apparatus which is designed to have multi functions, the recent technology realizes a human interface which is capable of increasing an efficiency to handle the apparatus. For example, the recent technology provides the bar code input system and voice input/output system. Conventionally, complicated manual operations are required to input instructions to the apparatus. Those manual operations are replaced by simple button operations. Combinations of the simple button operations are replaced by "collective" bar code inputs. Then, the advanced apparatus is capable of accepting the voice instructions using the natural language which the user is familiar with. Progresses are made on responses from the apparatuses. Previously, the apparatus merely executes the instructions. Nowadays, the apparatus is capable of sending a response showing acceptance of the instruction(s). In the case of the reservation of videotape recording on the videotape recorder, for example, when the user accomplishes the reservation of videotape recording, the videotape recorder automatically indicates a videotape recording reservation mark on a certain section relating to a timer display of a video display screen thereof. At completion of the reservation, a television set connected to the videotape recorder visually displays a string of symbols (or characters) or natural language for declaring acceptance of the reservation on a screen thereof. In addition, the natural language is vocalized so that a speaker of the television set produces human voices representing a short sentence as follows:

"Reservation is completed (or accepted)".

Nowadays, the technology is developed to gradually actualize a simplified interface whose operation is simplified as described above. Now, engineers tend to pay an attention to the method to simulate the operation of the interface as if a personified agent performs the operation. Such personification will make the user to increase his or her expectation to the interface. However, too much increased expectation may cause dissatisfaction of the user against the present level of the interface which the user may not please so much. To eliminate such dissatisfaction of the user against the interface, the paper of Japanese Patent Laid-Open Publication No. 6-12401 provides a new technology which tries to bring (simulated) emotions in the personified agent.

According to the conventional personified agent described above, the emotions are realized by changing one parameter with respect to a single situation or by changing multiple parameters independently with respect to a single situation. For this reason, if the effects given from the external are unchanged, an amount of variations of the emotions should be directly (or univocally) determined, regardless of the present emotional situation. So, as compared with the "actual" biological variations of the emotions, the personified agent is subjected to "unnatural" variations of the emotions.

In addition, the conventional personified agent is designed to accept only the pre-defined situations given from the external. So, the conventional personified agent does not change emotions in response to the non-defined situation(s). For this reason, the conventional personified agent lacks diversity in variations of the emotions.

Another method is provided to control the personified agent using random numbers for variations of the emotions. However, such a method may produce emotions whose variations are unnatural (or strange).

## SUMMARY OF THE INVENTION

It is an object of the invention to provide a device and a method for creation of emotions, which are capable of creating emotions whose variations are natural and biological.

A device and a method for creation of emotions according to this invention are provided for an interface of information, such as an artificial agent and a personified agent, intervened between a human being (i.e., user) and an electronic apparatus.

According to one aspect of the invention, an emotion creating device is configured by a neural network, a behavior determination engine and a feature determination engine. The neural network inputs user information, representing conditions of the user, and apparatus information, representing conditions of the apparatus, so as to produce emotional states. Herein, a present set of emotional states are produced in consideration of a previous set of emotional states. The emotional states represent prescribed emotions such as pleasure, anger, sadness and surprise. The behavior determination engine refers to a behavior determination database using the user information and the emotional states of the neural network so as to determine a behavior of the interface. The feature determination engine refers to a database using the emotional states of the neural network to determine a feature of the interface, which corresponds to a facial feature.

According to another aspect of the invention, an emotion creating method is actualized using programs which are run by a computer to realize functions of the emotion creating device. Herein, the programs and data are stored in a recording media.

## BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects of the subject invention will become more fully apparent as the following description is read in light of the attached drawings wherein:

FIG. 1 is a block diagram showing a configuration of an emotion creating device in accordance with an example of the embodiment of the invention;

FIG. 2 shows an internal configuration of a neural network containing an input layer, an intermediate layer and an output layer;

FIG. 3 shows an example of data used for the learning of the neural network;

FIG. 4 shows an example of an emotion map which is formed in response to emotional states of the neural network;

FIG. 5 is a block diagram showing an internal structure of a behavior determination engine provided inside of the emotion creating device of FIG. 1;

FIG. 6 is a flowchart showing content of processing of an input detection information processing block shown in FIG. 5;

FIG. 7 shows an example of content of a behavior determination database shown in FIG. 5;

FIG. 8 is a flowchart showing content of processing of a behavior determination block shown in FIG. 5;

FIG. 9 is a block diagram showing an outline of a feature determination engine provided inside of the emotion creating device of FIG. 1;

FIG. 10 shows an example of a data storage format for storing data in a database shown in FIG. 9;

FIG. 11 is a flowchart showing a method to produce an emotion value from emotional states in FIG. 9;

FIG. 12 shows an example of a method to determine a facial feature in accordance with the feature determination engine; and

FIG. 13 is a block diagram showing a modified example of the emotion creating device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 is a block diagram showing an example of a configuration of an emotion creating device in accordance with the preferred embodiment of the invention. Herein, the emotion creating device of the present example is mainly configured by a neural network 8, a behavior determination engine 10 and a feature determination engine 11.

The configuration shown in FIG. 1 is designed in consideration of the situation where the emotion creating device is connected to a personal computer. As inputs of data from a user to the emotion creating device, there are provided a camera 1, a microphone (or mike) 2, a sensor 3, a keyboard 4 and a mouse 5. Herein, the camera 1, the mike 2 and the sensor 3 are provided to obtain analog-variation-type information of the user (hereinafter, simply referred to as analog variation information). Concretely speaking, the analog variation information corresponds to the gaze and look picked up by the camera 1, the skin temperature and pulse rate sensed by the sensor 3 as well as the voice and other sound(s) picked up by the mike 2. In addition, information which is variable with stream (hereinafter, simply referred to as streaming information) is defined by programs. The streaming information corresponds to the shout voice and tut of the user against the mistake of the interface as well as the user's response against the output of the apparatus and histroy of the user's response. Two kinds of the information described above are transmitted to the emotion creating device by using any of the camera 1, the mike 2, the keyboard 4 and the mouse 5. Hereinafter, the analog variation information and streaming information are given a general term of "user information". On the other hand, time-series information which is variable in the apparatus (hereinafter, simply referred to as apparatus information) corresponds to an apparatus temperature I.sub.6 detected by an internal sensor 6 and a using time I.sub.7 to use the personal computer, which is measured by a timer 7.

FIG. 2 shows the details of the neural network 8, which is configured by three layers, i.e., an input layer, an intermediate layer and an output layer. As pieces of the user information input to the neural network 8, there are provided "a number of times of blinking" Io detected by the camera 1, "loudness of voice" I.sub.1 and "voice interval" I.sub.2 both detected by the mike 2, "pulse rate" I.sub.3 detected by the sensor 3, "intensity of key depression" I.sub.4 obtained from the keyboard 4 and "using time" I.sub.5 to use the personal computer one time, which is obtained from the mouse 5. As pieces of the apparatus information, there are provided "internal temperature" I.sub.6 detected by the internal sensor 6 and "using time" I.sub.7 measured by the timer 7. Outputs O.sub.0 to O.sub.3 produced on the output layer of the neural network 8 correspond to data representing emotional states. In other words, the four outputs O.sub.0, O.sub.1, O.sub.2 and O.sub.3 respectively correspond to emotions of "pleasure", "anger", "sadness" and "surprise". Incidentally, the outputs O.sub.0 to O.sub.3 are called emotional states. Further, previously outputted emotional states O.sub.0 to O.sub.3 are input to the neural network 8 as present emotional states S.sub.0 to S.sub.3 .

FIG. 3 shows examples of learning data, which are required for the learning of the neural network 8, such as the user information I.sub.0 to I.sub.5, the apparatus information I.sub.6, I.sub.7 and teacher signals T.sub.0 to T.sub.3. The neural network 8 is subjected to learning using the back propagation method and the like. The back propagation method is one kind of learning accompanied with a teacher. According to this method, there is provided a set of data (simply referred to as an input set) representing an input and its appropriate answer (i.e., teacher), so the learning is performed using the set of data. Suppose a situation where the user uses the apparatus for a long time so that the user and the apparatus are both tired. When an input representing such a situation is applied to the neural network 8, the neural network 8 firstly produces emotional states O.sub.0 to O.sub.3 representing a high possibility that the inappropriateness is caused. In that case, it is necessary that the neural network 8 learns to respond to the above situation with ideal emotional states O.sub.0 to O.sub.3 which show an emotion of "rage". In order to do so, teacher signals T.sub.0 to T.sub.3 representing "rage" are applied to the neural network 8. As described above, the learning of the neural network 8 is performed by repeating application of the teacher signals T.sub.0 to T.sub.3 with respect to several kinds of inputs. After completion of the learning, the neural network 8 is capable of producing "appropriate" emotional states O.sub.0 to O.sub.3, which complements the given input sets, with respect to information which is not directly input to the neural network 8 as the input set(s). If the neural network 8 is not taught the emotion of "anger", it is possible to construct emotional property of never being caught in the emotion of "anger". By the way, the actual emotions have continuity and directionality. In addition, the actual biological form has emotions which contain an emotion of strong response and an emotion of not so strong response. For example, it is easily caught in the emotion of "anger" but is not easily caught in the emotion of "pleasure". That is, using the characteristics of the neural network 8, it is possible to express more biological emotions. Incidentally, more detailed explanation of the learning of the neural network is described in a book entitled "Neurocomputer" published by "Gijutsuhyouronsya" of Japan.

The emotional states O.sub.0 to O.sub.3 of the neural network 8 are passed to the behavior determination engine 10 and the feature determination engine 11. They are used as one element of determination for determining a behavior such as a response from the apparatus against an inquiry from the user. Or, they are used to produce features such as expression and color of the personified interface.

FIG. 4 shows an example of a virtual four-dimensional space (hereinafter, referred to as an emotion map) which is formed by the emotional states O.sub.0 to O.sub.3. The emotion map is formed by four dimensions corresponding to the emotional outputs O.sub.0 to O.sub.3 representing the pleasure, anger, sadness and surprise respectively. Each of the emotional outputs O.sub.0 to O.sub.3 is variable within a range between (0, 0, 0, 0) and (1, 1, 1, 1). Herein, the characteristic of the emotional output becomes more intense as the value of the emotional output becomes larger. The intensity of the characteristic of the emotional output is represented by a location on the line connecting between (0, 0, 0, 0) and (1, 1, 1, 1). Herein, if all the values of the emotional outputs O.sub.0 to O.sub.3 are equal to each other, it can be said that emotions are placed in a neutral and stable state.

FIG. 5 is a block diagram showing an example of an internal structure of the behavior determination engine 10. The behavior determination engine 10 is mainly configured by an input detection information processing block 51, a behavior determination database 52 and a behavior determination block 53.

The input detection information processing block 51 analyzes user information I.sub.0 to I.sub.5 given from the external. Herein, the block 51 changes over processing elements in response to the user information so as to process the user information. That is, the block 51 uses a picture recognizer for processing of pictures while using a voice recognizer for processing of voices. Incidentally, the information processed by the block 51 is called processed information.

Processing of the input detection information processing block 51 is performed in accordance with steps shown in FIG. 6. It is constructed by an input type discrimination step S101, an input character string decision step S102, an input button decision and input location decision step S103, an input character string decision and sound quality decision step S104, a picture characteristic decision step S105 and a pulse rate decision step S106.

FIG. 7 shows an example of a part of content of the behavior determination database 52. The behavior determination database 52 describes behaviors of the interface in connection with the processed information input thereto and the emotional states O.sub.0 to O.sub.3 of the neural network 8.

Using the processed information given from the input detection information processing block 51 and the emotional states O.sub.0 to O.sub.3 of the neural network 8, the behavior determination block 53 performs searching on the behavior determination database 52 to determine the behavior of the interface.

The processing of the behavior determination block 53 is performed in accordance with steps shown in FIG. 8. It is constructed by a processed information input step S201, a neural network emotional state input step S202, a behavior determination database search step S203 and a behavior output step S204.

FIG. 9 is a block diagram showing an outline of the feature determination engine 11. Herein, the feature determination engine 11 is configured by an eye data production section 91, an eye data database 92, a nose data production section 93, a nose data database 94, a mouth data production section 95, a mouth data database 96, a color data production section 97, a color data database 98 and a feature data production section 99.

Creation of data for the features is performed with respect to parts such as eyes, nose, mouth and color. Each part has its own database. Based on the emotional states O.sub.0 to O.sub.3, the emotion creating device uses the eye data database 92, the nose data database 94, the mouth data database 96 and the color data database 98 to produce eye data, nose data, mouth data and color data which are suited to the emotional states O.sub.0 to O.sub.3. Based on those data, the device produces data used for formation of features, such as picture data.

FIG. 10 shows an example of a data storage format used for the eye data database 92, the nose data database 94, the mouth data database 96 and the color data database 98. Like the emotional states O.sub.0 to O.sub.3, emotion values denoted by a symbol D.sub.i (where i=0 to 3) correspond to the emotions of "pleasure", "anger", "sadness" and "surprise". Herein, the emotion value D.sub.i is set at any one of three values, i.e., "0", "0.5" and "1". At completion of the emotion value D.sub.i, formation data used for formation of each part is determined. The formation data correspond to picture data such as bit map data and polygon data. When all the formation data are completely produced for all parts, the feature data production section 99 integrates them to produce integrated picture data for representation of the features.

FIG. 11 is a flowchart whose processing is applied to each of the eye data production section 91, the nose data production section 93, the mouth data production section 95 and the color data production section 97, wherein it shows a method to produce the emotion value D.sub.i (where i=0 to 3) from the emotional state O.sub.i (where i=0 to 3) output from the neural network 8. Concretely speaking, the method to produce Di from the emotional state O.sub.i is the method that compares an output O.sub.i of the neural network 8 with emotion values D.sub.i stored in each of the eye data database 92, the nose data database 94, the mouth data database 96 and the color data database 98 to select an emotion value D.sub.i which is the closest to O.sub.i.

The method of FIG. 11 to produce the emotion value D.sub.i (where i=0 to 3) is constructed by steps S301 to S307, as follows:

S301: a decision as to whether i=4;

S302: a decision as to whether the emotional state O.sub.i is less than 0.25:

S303: a decision as to whether the emotional state O.sub.i is 0.25 or more and is less than 0.75;

S304: the emotion value D.sub.i is set at 0;

S305: the emotion value D.sub.i is set at 0.5;

S306: the emotion value D.sub.i is set at 1; and

S307: increase a counter i.

Next, a description will be given with respect to the operation of the emotion creating device, which is configured in accordance with the embodiment of the invention, together with the emotion creating method.

The emotion creating device inputs pieces of user information I.sub.0 to I.sub.5 which correspond to analog variation information given from the camera 1, the mike 2 and the sensor 3 as well as streaming information given from the keyboard 4 and the mouse 5. In addition, the emotion creating device inputs pieces of apparatus information I.sub.6 and I.sub.7 given from the internal sensor 6 and the timer 7. In addition to the above pieces of information, the neural network 8 inputs previous emotional states S.sub.0 to S.sub.3 so as to output present emotional states O.sub.0 to O.sub.3.

The behavior determination engine 10 inputs the user information I.sub.0 to I.sub.5 and the emotional states O.sub.0 to O.sub.3 output from the neural network 8, thus determining the behavior of the interface.

Specifically, the behavior determination engine 10 operates in accordance with the aforementioned steps S101 to S106 shown in FIG. 6. That is, the input detection information processing block 51 inputs the user information I.sub.0 to I.sub.5 to discriminate an input type in step S101. If the input type corresponds to a key input, the block 51 makes a decision with respect to an input character string in step S102. If the input type corresponds to a mouse input, the block 51 makes a decision with respect to an input button and an input position in step S103. If the input type corresponds to a voice input, the block 51 makes a decision with respect to an input character string and sound quality in step S104. If the input type corresponds to a picture input, the block 51 makes a decision with respect to picture characteristics in step S105. If the input type corresponds to a sensor input, the block 51 makes a decision with respect to a pulse rate in step S106. Based on results of the decision, the input detection information processing block 51 outputs processed information.

Next, the behavior determination block 53 inputs the processed information output from the input detection information processing block 51 and the emotional states O.sub.0 to O.sub.3 output from the neural network 8. Using those inputs, the behavior determination block 53 performs searching on the behavior determination database 52 so as to determine the behavior of the interface.

FIG. 7 shows an example of the content of the behavior determination database 52. When the user information I.sub.4 representing a click of the mouse 5 is input to the behavior determination engine 10, the behavior determination block 53 determines to do nothing in a case where the emotional state O.sub.1 output from the neural network 8 is greater than 0.5. In other cases, the behavior determination block 53 makes a decision on an event of a position (x, y), so that the event is processed. When the user information I.sub.1 representing a voice input of the mike 2 is input to the behavior determination engine 10, the behavior determination block 53 lowers a tone (or pitch) to output voices for pronouncing a Japanese word of "O-HA-YO-U" (i.e., "Good Morning" in English) in a case where the emotional state O.sub.2 is greater than 0.5. In another case where the emotional state O.sub.1 is greater than 0.8 or the emotional state O.sub.3 is greater than 0.5, the behavior determination block 53 determines to do nothing. In other cases, the behavior determination block 53 outputs voices for pronouncing a Japanese word of "U-RU-SA-I" (i.e., "Shut Up" in English).

The feature determination engine 11 inputs the emotional states O.sub.0 to O.sub.3 of the neural network 8 to determine features of the interface.

Specifically, the eye data production section 91 performs searching on the eye data database 92 to determine eye data; the nose data production section 93 performs searching on the nose data database 94 to determine nose data; the mouth data production section 95 performs searching on the mouth data database 96 to determine mouth data; the color data production section 97 performs searching on the color data database 98 to determine color data. Then, the feature data production section 99 convolutes those data to provide features of the interface.

In the above, each of the eye data production section 91, the nose data production section 93, the mouth data production section 95 and the color data production section 97 produces the emotion value D.sub.i (where i=0 to

3) from the emotional state O.sub.i (where i=0 to 3). That is, if the emotional state O.sub.i is less than 0.25 (see step S302), the emotion value D.sub.i is set at 0. If the emotional state O.sub.i lies between 0.25 and 0.75 (see step S303), the emotion value D.sub.i is set at 0.5. If the emotional state O.sub.i is greater than 0.75, the emotion value D.sub.i is set at 1. Thus, normalization is performed using the emotion value D.sub.i described above. That is, the emotional state O.sub.i of the neural network 8 is compared with the emotion value D.sub.i stored in the eye data database 92, the nose data database 94, the mouth data database 96 and the color data database 98, so that the device selects the emotion value which is the closest to the emotional state.

FIG. 12 shows an example of a method of determination of features of a face, which is one example of the feature determination method. Specifically, FIG. 12 shows variations of a facial feature of eyes. The emotion value Di corresponds to any one of points on the emotion map, so the device is subjected to learning with respect to major points on the emotion map, i.e., ordinal variations of emotions which can be observed from the user. Herein, feature data of the face are provided in advance with respect to the major points, while intermediate features, which complement the major points, are output with respect to points other than the major points. In the case of the eyes, for example, there are provided three kinds of major points, i.e., "normal" (0, 0, 0, 0), "anger" (0, 0.5, 0, 0) and "rage" (0, 1, 0, 0). At occurrence of an intermediate point, the device creates data suited to an emotion of "slight anger" (0, 0.3, 0, 0), for example.

FIG. 13 is a block diagram showing a configuration of the emotion creating device in accordance with a modified example of the preferred embodiment of the invention, wherein parts equivalent to those shown in FIG. 1 are designated by the same numerals. As compared with the aforementioned example of the emotion creating device shown in FIG. 1, the modified example of the emotion creating device of FIG. 13 is characterized by providing a recording media 20 which stores an emotion creating program (including data) to realize an emotion creating method. As the recording media 20, it is possible to employ a magnetic disk, a semiconductor memory and other types of memories. A computer (not shown) loads the emotion creating program from the recording media 20. So, the operation of the computer is controlled to actualize functions of the emotion creating device. The operation of the emotion creating device actualized by the computer is quite identical to that of the aforementioned example of the emotion creating device; hence, the detailed description thereof will be omitted.

According the emotion creating device and its method in the modified example, the neural network 8 is subjected to learning with respect to a finite number of patterns established between combinations of user information I.sub.0 to I.sub.5 and apparatus information I.sub.6, I.sub.7 and their ideal emotional states O.sub.0 to O.sub.3. Thus, the neural network 8 is designed to have a capability to output the emotional states O.sub.0 to O.sub.3 with respect to every situation. So, it is possible to personify the behavior and features of the interface more naturally like the real biological life form.

As this invention may be embodied in several forms without departing from the spirit of essential characteristics thereof, the examples of the embodiment are therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within metes and bounds of the claims, or equivalence of such metes and bounds are therefore intended to be embraced by the claims.

**United States Patent** **6,238,333**

***Loos*** **May 29, 2001**

Remote magnetic manipulation of nervous systems


## Abstract

Apparatus and method for remote manipulation of nervous systems by the magnetic dipole field of a rotating bar magnet. Reliance on modulation of spontaneous spiking patterns of sensory nerve receptors, and exploitation of a resonance mechanism of certain neural circuits, allows the use of very weak magnetic fields. This, together with the large magnetic moments that can be obtained with a permanent bar magnet, makes it possible to effectively manipulate the nervous system of a subject over a distance of several hundred meters, using a small portable battery-powered device. The method can be used in law enforcement for standoff situations.



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## Related U.S. Patent Documents

| Application Number | Filing Date | Patent Number | Issue Date<TD< TD> |
|---|---|---|---|
| 486918 | Jun., 1995 | 5935054 | <TD< TD> |

**Current U.S. Class:** **600/9** ; 977/950

**Field of Search:** 600/9-15

## References Cited [Referenced By]

## U.S. Patent Documents


| | | |
|---|---|---|
| 3678337 | July 1972 | Grauvogel |
| 4197851 | April 1980 | Fellus |
| 4537181 | August 1985 | Shalhoob et al. |
| 4611599 | September 1986 | Bentall |
| 4727857 | March 1988 | Horl |
| 5667469 | September 1997 | Zhang et al. |
| 6001055 | December 1999 | Souder |

**Other References**

P Lindemann, The Megabrain Report, vol. 1, #2, p. 34-35 (1990). .

P. Limdemann, The Megabrain Report, vol. 1, #1, p. 30-31 (1990)..


*Primary Examiner:* Lacyk; John P. ***Parent Case Text*** Part of application Ser. No. 08/486,918, Jun. 7, 1995, U.S. Pat. No. 5,935,054.

## *Claims*

I claim:

1. Apparatus for manipulating the nervous system in the body of a remote subject, the subject having a location, and the apparatus having a position, a geometric straight line being defined through the position of the apparatus and the location of the subject, the apparatus comprising:

a shaft having an axis, the shaft being adapted to render substantially a ninety degree angle between the axis and the geometric straight line;

a bar magnet mounted on the shaft, the magnet having pole faces that are substantially parallel to the shaft axis, the bar magnet inducing in the body a nearly uniform magnetic field; and

rotation means for spinning the shaft, whereby the nearly uniform magnetic field changes in time, and oscillatory eddy currents are induced in the body.

2. The apparatus of claim 1, further including control means for controlling the rotation means.

3. The apparatus of claim 2, wherein the spinning has an angular speed, and the control means comprise means for controlling the angular speed.

4. The apparatus of claim 1, wherein the bar magnet is composite.

5. The apparatus of claim 1, wherein the rotation means comprise coils for inducing a magnetic field that acts on the bar magnet.

6. A method for manipulating the nervous system in the body of a remote subject, the subject having a location, the method comprising the steps of:

mounting a bar magnet on a shaft, the shaft having a center of gravity and an axis, the axis having a direction, the bar magnet having pole faces that are substantially parallel with the shaft axis, the bar magnet inducing a nearly uniform magnetic field in the body;

defining a geometric straight line through the center of gravity and the location of the subject;

adapting the shaft for said direction to make an angle of substantially ninety degrees with the geometric straight line;

spinning the shaft;

whereby the nearly uniform magnetic field changes in time, and oscillatory eddy currents are induced in the body.

7. The method of claim 6 for exciting in the remote subject a sensory resonance having a resonance frequency, wherein the spinning has a frequency, further including the step of setting the spinning frequency to the resonance frequency.

8. The method of claim 6, wherein the steps of mounting, defining, adapting and spinning are repeated N times, N being a positive integer, resulting in bar magnets denoted by M(i), i=1 to N+1, each with its geometric straight line L(i), and wherein all spinning is done at the same rate, further including the steps of:

assigning, for each bar magnet M(i), a magnet axis A(i); defining, for each bar magnet M(i), a phase which at a fixed time is the angle of the magnet axis A(i) with the geometric straight line L(i); and arranging the phases of the bar magnets for constructive interference of the nearly uniform magnetic fields induced in the body.

***Description***

BACKGROUND OF THE INVENTION

The invention relates to stimulation of nerves by pulsed magnetic fields. Such fields induce in the body of an exposed subject eddy currents that are proportional to their rate of change. The currents may cause classical nerve stimulation wherein the nerve membrane is depolarized enough for the nerve to fire. At low frequencies, such a mechanism requires rather large magnetic fields. Fortunately, low-frequency magnetic manipulation of the nervous system is possible by another mechanism which allows the use of very much weaker fields. Instead of relying on causing the firing of normally quiescent nerves, the method uses modulation of the spiking patterns of spontaneously firing nerves. That this can be done with very small tissue electic fields was discussed more than four decades ago by C. A. Terzuolo and T. H. Bullock in "Measurement of Imposed Voltage Gradient Adequate to Modulate Neuronal Firing", Proceedings of the National Academy of Sciences U.S.A., Physiology, 42, 687 (1956). The effect can be exploited in magnetic as well as in electric stimulation, because the physiological effects of the former are solely due to the electric field that is induced by the rate of change of the magnetic field, and by the electric polarization that occurs as the consequence of the induced eddy currents.

The human nervous system exhibits a sensitivity to certain low-frequency stimuli, as is evident from rocking a baby or relaxing in a rocking chair. In both cases, the maximum soothing effect is obtained for a periodic motion with a frequency near 1/2 Hz. The effect is here called "the 1/2 Hz sensory resonance". In the rocking response, the sensory resonance is excited principally by frequency-coded signals from the vestibular end organ. However, the rocking motion also induces body strains, and these are detected by stretch receptors residing in the skin and elsewhere in the body. In addition, relevant signals may originate from thermal receptors which report skin temperature fluctuations caused by air currents that are induced by the rocking motion. All these receptors employ frequency coding in their sensory function, and it must be that their signals are combined and compared in the brain with the vestibular nerve signals in an assessment of the somatic state. One may thus expect that the sensory resonance can be excited not only through the vestibular nerve, but also separately through the other sensory modalities mentioned. This notion is supported by the observation that gently stroking of a child with a frequency near 1/2 Hz has a soothing effect. Further support derives from the successful excitation of the 1/2 Hz sensory resonance by weak external electric fields, as discussed in "Method and Apparatus for Manipulating Nervous Systems", U.S. Pat. No. 5,782,874. The 1/2 Hz sensory resonance involves the autonomic nervous system, and it can be used to induce relaxation, sleepiness, or sexual excitement, depending on the precise stimulation frequency and the affected afferent nerves. Another sensory resonance has been found at about 2.4 Hz; it involves the cortex since it can slow the speed of silently counting from 100 to 60, with the eyes closed, as discussed in the '874 patent and in U.S. Pat. No. 5,800,481. For both electric field and thermal stimulation, prolonged exposure to fluctuating electric fields near 2.4 Hz has been found to have a sleep-inducing and dizzying effect. The same physiological effect is expected for pulsative magnetic stimulation, since electric fields are induced in the tissue by the changing magnetic field. When using the nerve modulation method, reliance on resonance mechanisms further reduces the stimulation strength required for manipulating the nervous system.

SUMMARY

Oscillatory magnetic fields induce electric fields in exposed biological tissue and can therefore act on nerves. Considerable tissue electric fields are needed to cause firing of otherwise quiescent nerves, but very much smaller fields suffice for modulation of spontaneous nerve spiking. Still weaker fields can be used for exciting resonances in certain neural circuits through evoked signals

from afferent somatosensory nerves which carry the modulated spiking patterns to the brain. It has been found that, in this manner, weak oscillatory magnetic fields with an amplitude between 5 femtotesla and 50 nanotesla can be used for manipulating the human nervous system, when the fields are tuned to certain frequencies near 1/2 Hz that cause excitation of sensory resonances. Observable physiological consequences of the resonance include ptosis of the eyelids, relaxation, sleepiness, and sexual excitement, depending on the precise frequency used, and on the location and duration of the magnetic field application.

Both topical and systemic field administration have been found effective. For the latter case the field can be produced over a considerable distance by a rotating permanent magnet that has a large magnetic moment. This makes it possible to manipulate a subject's nervous system over a range of several hundred meters, such as to cause relaxation and drowsiness. The method can be used in law enforcement for standoff situations.

Simple devices which use a rotating bar magnet are disclosed. Multiple rotating bar magnets can be used, and the phase angles of the magnets may then be arranged to cause constructive interference of the magnetic fields induced in the subject.

DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an embodiment as a non-lethal weapon to be used in law enforcement, showing the dipole magnetic field projected upon a standoff site.

FIG. 2 shows how the dipole field of FIG. 1 has rotated in a a short time.

FIG. 3 illustrates the rotating magnet method of projecting a time-varying dipole field upon a remote subject.

FIG. 4 shows a drive circuit for the rotating magnet of FIG. 3.

FIG. 5 shows the preferred embodiment wherein the bar magnet rotation is caused by coils that induce magnetic fields which act directly on the bar magnet.

FIG. 6 illustrates an embodiment for topical application of an oscillating magnetic field for the excitation of a sensory resonance.

FIG. 7 shows a multipole coil for the generation of a localized magnetic field for topical field administration.

FIG. 8 shows a near-sine wave generator with automatic shutoff, suitable for driving magnetic coils.

DETAILED DESCRIPTION

It has been found in our laboratory that a weak oscillatory magnetic field can be used to excite the 1/2 Hz sensory resonance. Sinusoidal magnetic fields have been observed to induce ptosis of the eyelids, relaxation, sleepiness, a "knot" in the stomach, a soft warm feeling in the stomach, a tonic smile, sudden loose stool, and sexual excitement, depending on the precise frequency used, the part of the body exposed, and the strength and duration of the field application. The frequencies for these effects are all close to 1/2 Hz. The physiological effects are experienced after the subject has been exposed to the field for an extended time, ranging from minutes to hours. Even for optimum frequency, the effects have been observed only for weak fields with amplitudes roughly in the range from 5 femtotesla to 50 nanotesla.

Use of square waves for the time dependence of the magnetic field gives similar results, but there is a peculiar harsh feeling that is absent for sine waves, attributed to the strong higher harmonics in the square wave.

The effects have been obtained with systemic field applications as well as with topical applications of a localized magnetic field, either administered to the head or to body regions away from the head; successful excitation in the latter case shows that the magnetic field can act on somatosensory nerves.

Fixing all experiment parameters but the magnetic field amplitude, the described physiological effects are observed only for field amplitudes in an interval, called "the effective intensity window". This feature of sensory resonances may be understood as due to nuisance-guarding neural circuitry which blocks impertinent repetitive sensory signals from higher processing. For the guarding circuitry to spring in action, the amplitude of the nuisance signals needs to exceed a certain threshold. This explains the upper boundary of the effective intensity window. The lower boundary of the window is simply due to the detection threshold for the sensory signals.

Systemic application of an approximately uniform rotating magnetic field at a frequency of 0.55 Hz and an amplitude of 2.3 nanotesla results in wooziness after about two hours of exposure; sexual excitement sets in about one hour later. The rotating magnetic field for this experiment was obtained by using a 33 rpm phonograph turntable which carries two permanent magnets with a total magnetic moment of 6.5 Am.sup.2 ; the distance to the subject was 10.4 m. Allthough the use of the 33 rpm turntable is convenient, the frequency is not quite optimum for excitation of the 1/2 Hz sensory resonance. This explains the long exposure times needed to obtain a physiological response, accounting for the drift in resonance frequencies described in the '874 patent. Other experiments with systemic application of magnetic fields, albeit with slightly greater nonuniformity, have given results that are similar to those obtained with topical applications of sharply localized fields. The rotating magnet device shown in FIGS. 3-5 is discussed later in the context of law enforcement in standoff situations, but it may be employed for therapeutic purposes as well. The device can be used for collective treatment of a number of subjects in a single building or in a complex of buildings.

The physiological effects induced by the magnetic field over an extended time often linger for as much as an hour after ending the application. This suggests that the endocrine system is affected, either directly or indirectly.

Experiments with magnetic field therapy for mild insomnia have been conducted for over 200 nights, using a variety of voltage generators and coils. Among the various wave forms, sine waves have given the best results when used with very weak fields, of the order of 10 femtotesla, applied to the lower lumbar region of the body. A typical frequency used in these experiments is 0.49 Hz. A virtue of the very weak fields is that habituation to the stimulus is at a minimum, so that the treatment remains effective over many nights. Habituation is further minimized by using multipole magnetic fields. Such fields are sharply localized, and they have strongly nonuniform spatial distributions. As a result, the evoked somatic signals received by the brain from the various parts of the body are strongly nonuniform and localized.

Therefore, changes in sleep position cause a large variety of sensory patterns of limited duration. Another successful approach for controlling habituation is to limit the magnetic field application to half an hour or so; larger field strengths can then be used.

Experiments for inducing sexual excitement by sinusoidal magnetic fields have been performed using topical as well as systemic field application. Topical application of a sinusoidal multipole magnetic field of order six to the lower lumbar region, with maximum field amplitude of about one nanotesla, usually causes after about 13 minutes of exposure an erection that can be maintained as long as an hour. Effective frequencies depend somewhat on physiological conditions, but a typical frequency for obtaining this effect is 0.62 Hz.

The experiments suggest a method and apparatus for manipulating nervous systems by fluctuating magnetic fields. The method has two fundamental features: use of modulation of spontaneous spiking activity of certain types of somatosensory receptors, and the exploitation of sensory resonances. Both these features allow reduction of the magnetic field amplitude, and in combination they make possible small and compact battery-powered devices that can be used by the public for induction of relaxation, sleepiness, or arousal, and clinically for the control and perhaps the treatment of tremors and seizures, and disorders of the autonomic nervous system, such as panic attacks.

A sensory resonance has been found near 2.4 Hz, that can be excited by weak pulsed external electric fields, or by weak heat pulses delivered to the skin, or by subliminal acoustic pulses, as discussed respectively in U.S. Pat. Nos. 5,782,874 and 5,800,481, and U.S. patent application Ser. No. 08/961,907. It is expected that this resonance can also be excited magnetically. Other sensory resonances may perhaps be found, with frequencies below 45 Hz.

An embodiment of the invention is shown in FIG. 6, where a voltage generator 1, labeled "GEN", is connected through a thin coaxial cable 2 to a coil assembly 3; the latter is placed some distance beneath the subject 4 near the body region selected for topical field application. The frequency of the voltage generator 1 can be manually adjusted with the tuning control 5, so that by manual scanning frequencies can be found at which sensory resonances are excited. Upon being energized by the generator 1, the coil assembly 3 induces a magnetic field with field lines 6, which at large distances is a multipole field. The coil 3 can be conveniently placed under the mattress of a bed. The setup of FIG. 6 has been employed in the insomnia therapy experiments and the sexual arousal experiments discussed.

A simple near-sine-wave generator suitable for driving the coil of FIG. 6 is shown in FIG. 8. The battery-powered generator is built around two RC timers 16 and 17, and an operational amplifier 18. Timer 17 (Intersil ICM7555) is hooked up for astable operation; it produces a square wave voltage with a frequency determined by potentiometer 19 and capacitor 20. The square wave voltage at output 21 drives the LED 22, and serves as the inverting input for the amplifier 18 (MAX480), after voltage division by potentiometer 23. The noninverting input of amplifier 18 is connected to an intermediate voltage produced by resistors 24 and 25. Automatic shutoff of the voltage at point 26, that powers the timer and the amplifier, is provided by a second timer 16 (Intersil ICM7555), hooked up for monostable operation. The shutoff occurs after a time interval determined by resistor 27 and capacitor 28. Timer 16 is powered by a three-volt battery 29, controlled by a switch 30. The amplifier 18 is hooked up as an integrator; additional integration is performed by the capacitor 31 and resistor 32. The resistor 33 limits the output current to the terminals 34 that are connected to the coil assembly by the coaxial cable 2.

For topical magnetic field applications, such as illustrated by FIG. 6, it is important to have a sharply localized magnetic field, either to avoid unwanted exposure of body regions away from the region of application, or to decrease habituation, as discussed above. A planar coil assembly suitable for the induction of such sharply localized magnetic field is shown in FIG. 7. The assembly consists of four coils, referred to as 7, 8, 9, and 10, with alternating winding directions. The series assembly of coils is connected to the coaxial feed cable 2. The coils 7-10 are mounted on an adhesive sheet 11 of insulating material, and the assembly is covered with adhesive tape. The coil diameters are proportional to 1, 2, 3, and 2, and the number of windings are respectively proportional to 4, -6, 4, and 1, where positive and negative numbers denote respectively clockwise and counterclockwise windings. For clarity the connecting wires between coils are shown as running at some distance from each other, but these wires should actually be laid very close together, in order that their induced magnetic fields cancel each other as much as possible. With this understanding, the coil assembly of FIG. 7 can be shown to induce at large distances a magnetic field that falls off as the ninth power of distance.

Eddy currents are induced in tissue by time-varying magnetic fields. Time dependence can of course be achieved by rotating an otherwise steady magnetic field. Since large steady fields can be obtained from a permanent magnet without spending energy, it is sensible to produce the rotating field by mechanically rotating a permanent magnet. There are several patents, such as U.S. Pat. Nos. 4,727,857 and 5,667,469, wherein such an approach is used for topically inducing therapeutic low-frequency eddy currents by means of equipment placed closely adjacent to the patient's skin.

As aluded to earlier, rotating magnetic fields can also be used for remote systemic magnetic manipulation of the nervous system of a subject, "remote" meaning at a distance exceeding three meters. The dominant field far away from a magnet is a dipole field, which falls off as the third power of distance. The very small field strengths that suffice for magnetic excitation of sensory resonances, together with the large magnetic moments that can be achieved with permanent magnets, make remote magnetic manipulation of nervous systems with small and compact devices a practical possiblity. For instance, for a device of 20 cm overall diameter the magnetic moment of a fitting bar magnet can easily be as large as 52 Am.sup.2, and such a magnet is capable of inducing a 0.39 pT magnetic field at a distance of 300 m. By tuning the magnet rotation to a sensory resonance frequency near 1/2 Hz, such a field amplitude is sufficient to cause drowsiness. The arrangement is thus suitable for a non-lethal weapon which may be used, for instance, in law enforcement standoff situations. Such an application is illustrated in FIG. 1, where subjects are holding out in a house 52. Shown are squad cars 53, one of which is equiped with a rotating magnet device. The magnetic dipole field emanating from the device is illustrated schematically by field lines 54. The rotation of the permanent magnet causes the magnetic field to rotate, and FIG. 2 shows field lines 54' a short time later, after the magnet has made a quarter turn.

When the magnet rotation is tuned to the appropriate sensory resonance frequency, the oscillatory eddy currents induced in the subject's bodies may cause sleepiness, which would diminish the subject's alertness and clarity of thought. It is noted that the physiological effects of the magnetic excitation of sensory resonances appears to be larger when 60 or 50 Hz power fields are absent, so that there may be merit in turning off the electric power to the house, if this can be done safely and is not contraindicated by other considerations.

A suitable rotating magnet device may be designed along the following lines. The magnetic field projected upon the remote subject must have, at the large range involved, an amplitude in the effective intensity window. Since this field is predominantly of dipole nature, and is therefore approximately proportional to the magnetic moment of the magnet, it is advantageous to maximize the magnetic moment within the imposed constraints. The moment is the product of the distance between the magnetic poles and the strength of the poles, expressed as the emanating magnetic flux. Thus, other things remaining the same, the poles need to be as far away from each other as possible. Clearly, a horse-shoe magnet will not do; rather, the optimum configuration is a bar magnet. A second issue pertains to the orientation of the bar magnet with respect to the rotation axis. This orientation is expressed as the angle .gamma. between the rotation axis and the bar magnet axis, defined as the line connecting the centers of the pole faces (this line is also the direction of the magnetic moment vector). Since the eddy currents induced in the body of the exposed subject are proportional to the rate of change of the magnetic field, the amplitude of the field oscillation needs to be maximized. This is done by choosing the angle .gamma. as ninety degrees. The next question is how to choose the angle .beta. between the rotation axis and the line that connects the magnet with the subject. To answer this question it must be noted that the field along the front direction of the magnet, i.e., along the magnet axis, is twice as large as the field along the side direction, i.e., ninety degrees away from the magnet axis. It follows that the angle .beta. best be chosen as ninety degrees, because the field oscillation amplitude then benefits from the strong field along the front direction of the magnet.

A rotating magnet device designed along the aformentioned lines is illustrated in FIG. 3, which shows a shaft 62 that is free to spin in a bearing 63, and is driven by a stepper motor 78. The spinning motion may be continuous or may proceed in discrete steps. Mounted on the shaft is a bar magnet 55 with pole faces 57 and 58, that have polarities labelled "N" and "S". The bar magnet has an axis 79 that connects the centers of the pole faces. The angle .gamma. between the magnet axis 79 and the axis 59 of the shaft 62 is substantially ninety degrees. A subject 4' is located remote, i.e., at least 3 meters, from the rotating magnet device. The device is oriented such that the angle .beta. between the shaft axis 59 and the geometric straight line 56 that connects the shaft 62 with the subject 4' is substantially ninety degrees. To define the line 56 precisely, it is specified to go through points A and B, where point A is the position of the apparatus, taken as center of gravity of the shaft 62, and point B is the location of the subject, taken as the center of gravity of the body of the subject 4. The angles .beta. and .gamma. are not critical, and "substantially" may be read as "within 20 degrees". With the mentioned angle .gamma., the pole faces of the bar magnet will be substantially parallel to the shaft axis. Further shown are field lines 54 of the magnetic field induced by the bar magnet 55. As the latter is rotated by the stepper motor 78, the nearly uniform magnetic field induced in the body of the subject 4' varies in time, so that eddy currents are induced in the electrically conductive body.

One may use a composite bar magnet that consists of two magnets separated by a ferromagnetic spacer, for the purpose of inexpensively increasing the magnetic moment.

Driving circuitry for the rotating magnet of FIG. 3 is illustrated in FIG. 4, showing a clock 70 which generates a square wave train of clock pulses 71 that are processed by a counter 72 which outputs a pulse 50 at every Nth clock pulse, the integer N being provided by the output of a counter 73, and shown by the display 67. The integer N can be increased or decreased by push buttons 74 and 75, respectively labelled "UP" and "DOWN". The counter 73 together with the buttons 74 and 75 is therefore effectively a tuner for controlling the frequency of the pulses 50. These pulses are processed by the driver 77, connected to the stepper motor 78.

The law-enforcement personnel present at the standoff site will of course also be subjected to the rotating magnetic field, and this constitutes a major drawback of the method. The effective intensity window may relieve this problem to some extent, since the personnel experience large fields that may lie outside the window. Yet, frequent changes of personnel may be required in order to have an alert crew at all times.

Multiple devices may be used; all magnets then should rotate with the same frequency, although interesting beat effects arise when the individual frequencies are somewhat different. Use of multiple devices raises two new issues. Let all devices be located in the ground plane, i.e., a plane through the local ground surface, or, in hilly or mountanous terrain, tangent to the ground at the subject's location. Let devices n=1, 2, . . . m be located at .theta..sub.n, r.sub.n, where (.theta.,r) are polar coordinates in the ground plane, centered at the subject. The angle .phi..sub.n between the shaft axis of the nth device and the ground plane is pertinent and needs to be specified. For the setup depicted in FIGS. 1-3, the angle .phi. is ninety degrees. The second issue concerns phases. For the standard case with both .beta. and .gamma. equal to ninety degrees, the phase .alpha..sub.n of bar magnet n may be taken as the angle, at a fixed time, between the magnet axis and the line that connects the magnet with the subject; in FIG. 3 these lines are respectively shown as 79 and 56. It is advantageous to choose the phase angles .alpha..sub.n such that at the subject the magnetic fields induced by the individual rotating magnet devices interfere constructively, since that results in a larger total field oscillation amplitude. How to achieve this depends on the angles .alpha..sub.n. One choice is to take all .alpha..sub.n zero, so that the magnets rotate in planes that are perpendicular to the ground plane. For m=2, the choice .theta..sub.1 =0, .theta..sub.2 =.pi. is advantageous, and should be used with a phase difference .alpha..sub.2 -.alpha..sub.1 =.pi.. The fields at the subject then interfere constructively and result in a total oscillatory field amplitude that is the sum of the amplitudes for the single devices. For three devices located at about equally spaced angles .theta..sub.n around the circle one can take .alpha..sub.2 -.alpha..sub.1 =.pi. and .alpha..sub.3 -.alpha..sub.1 =.pi., and get considerable constructive interference, but for a larger number of devices placed at about equally spaced angles .theta..sub.n around the circle it is better to choose all .phi..sub.n equal to .pi./2 so that the magnets rotate in planes that are parallel to the ground plane and the field along the side directions of the magnets can contribute to constructive interference. Finding the optimum values for the phases .alpha..sub.n requires some work. To show how this may be done, consider a Cartesian coordinate system (x,y) in the ground plane, centered at the subject, such that the y-axis coincides with the direction .theta.=0, with the the x-axis chosen such that rotation from the y-axis to the x-axis involves an increasing angle .theta.. It can be easily shown that the magnetic field induced at the subject by the nth device has the Cartesian components where M.sub.n is the magnetic moment of the nth magnet, the permeability .mu. should be taken as 4.pi..times.10.sup.-7 henries/m, and t denotes time. The resultant magnetic field vector B is found by calculating the sum B.sub.x of the B.sub.nx for all n, and the sum B.sub.y of the B.sub.ny for all n; the vector B then has the components B.sub.x and B.sub.y. As time proceeds, the end point of the vector B circulates with the radian frequency .omega. along an ellipse with long axis 2B.sub.max. The task at hand is to find the phase angles

.alpha..sub.n that optimize B.sub.max. This problem can be solved numerically with a grid of values .alpha..sub.n ; since the maximum in B.sub.max is rather broad, the grid can be chosen as coarse. Tables of solutions can be prepared once and for all for typical configurations involving a few rotating magnet devices. In practice, device configurations must be chosen such that B.sub.max lies in the effective intensity window for the chosen sensory resonance.

In the best mode no separate stepper motor is used, and the necessary torque on the magnet is supplied by magnetic fields induced by coils placed close to the magnet. This is illustrated in FIG. 5, where the bar magnet is composite, consisting of two permanent magnets 60 mounted on a ferromagnetic spacer 61, which is fastened to the shaft 62 that can rotate freely in bearings 63. Coils 64 are mounted such as to cause the magnet assembly to engage in a spinning motion, when pulsed currents are passed through the coils in properly phased manner. The currents are caused by a driver 65 connected to the coils by wires 66. The period of rotation of the magnet assembly is determined by the pulse frequency of the driver 76, and is shown by the display 67; the period can be changed by operating the up and down buttons 68 and 69. The driver may include a control unit 51 which can be programmed to provide a chosen schedule of activity times and frequencies. The driver and the control unit are standard circuits well known to those skilled in the art.

For military applications the device of FIG. 5, properly designed for compactness and for withstanding shock, can be air dropped or shot by mortar to locations near foes so that the latter can be subjected to magnetic manipulation. It is then suitable to arrange for radio control of the device. Since the rather slow rotation of a well-balanced magnet assembly can be maintained by small coil currents, battery power is viable. A startup circuit needs to be provided to get the magnet rotation going.

Human sensitivity to very weak magnetic fields at sensory resonance frequencies is not understood. U.S. Pat. No. 5,935,054 contains a discussion of several aspects of this problem. In addition, it is noted that cutaneous stretch receptors may be involved in the response to the weak magnetic fields, because the polarization charges that accumulate on surfaces of discontinuity of the electric conductivity as a result of the eddy currents decay slowest on the skin, if the subject is electrically isolated from the surroundings. Thermal smearing of the polarization charges in the epidermis over a layer with thickness of the order of the Debye length then may cause an electric field to act on susceptable stretch receptors that lie close to the epidermis or protrude from the dermis into the epidermis. This electric field oscillates with the frequency of the applied magnetic field and may perhaps cause frequency modulation of the spontaneous spiking of the stretch receptors.

The method is expected to be effective also on certain animals, and application to animal control is therefore envisioned. The nervous system of mammals is similar to that of humans, so that sensory resonances are expected to exist. The disposition towards the 1/2 Hz resonance is thought to have its origin in the fetal state, developed through the rythmical sensations caused by the mother's walk, associatively coupled with hormone concentrations. For mammals, one expects a resonance of this type at about the frequency of the mother's relaxed walk. Accordingly, in the present invention, the subjects are mammals.

The invention is not limited by the embodiments shown in the drawings and described in the specification, which are given by way of example and not of limitation, but only in accordance with the scope of the appended claims.

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| **United States Patent** | **6,536,440** |
| **Dawson** | **March 25, 2003** |

# Method and system for generating sensory data onto the human neural cortex


**Abstract**

A non-invasive system and process for projecting sensory data onto the human neural cortex is provided. The system includes a primary transducer array and a secondary transducer array. The primary transducer array acts as a coherent signal source, and the secondary transducer array acts as a controllable diffraction pattern that focuses energy onto the neural cortex in a desired pattern. In addition, the pattern of energy is constructed such that each portion projected into the neural cortex may be individually pulsed at low frequency. This low frequency pulsing is formed by controlling the phase differences between the emitted energy of the elements of primary and secondary transducer arrays.



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| **Field of Search:** | 128/897,898,24 |

**References Cited [Referenced By]**

**U.S. Patent Documents**


| | | |
|---|---|---|
| 3848608 | November 1974 | Leonard |
| 4343301 | August 1982 | Indech |
| 4611596 | September 1986 | Wasserman |
| 4628933 | December 1986 | Michelson |
| 4664117 | May 1987 | Beck |
| 4883067 | November 1989 | Knispel |
| 4979508 | December 1990 | Beck |
| 5031154 | July 1991 | Watanabe |
| 5097326 | March 1992 | Meijer |
| 5109844 | May 1992 | De Juan, Jr. et al. |
| 5159927 | November 1992 | Schmid |

| | | |
|---|---|---|
| 5179455 | January 1993 | Garlick |
| 5651365 | July 1997 | Hanafy et al.. |
| 5738625 | April 1998 | Gluck |
| 5853370 | December 1998 | Chance |
| 5935155 | August 1999 | Humayun et al. |
| 5956292 | September 1999 | Bernstein |
| 5971925 | October 1999 | Hossack et al. |
| 6017302 | January 2000 | Loos |

## Other References

Department of Electrical and Computer Engineering, University of Colorado, 1990, Richard T. Mihran, Frank S. Barnes, Howard Wachtel. "Transient Modification of Nerve Excitability in Vitro By Single Ultrasound Pulses". .
Ultrasound Med Biol 1990, Department of Electrical and Computer Engineering, University of Colorado. "Temporally-specific modification of myelinated axon excitability in virto following a single ultrasound pulse" (pp. 297-309) Mihran RT; Barnes FS; and Wachtel H. .
The Pennsylvaia State University, Department of Physics. 1984, J.D. Maynard, E.G. Williams, and Y. Lee. Nearfiled acoustic holography:n I. Theory of generalized holography and the development of NAH. .
Department of Molecular and Cell Biology, Division of Neurobiology, University of California. Garrett B. Stanley, Fei F. Li, and Yang Dan. "Reconstruction of Natural Scenes from Ensemble Responses in the Lateral Geniculate Nucleus" The Journal of Neuroscience, pp 8036-8042; 1999. .
Ultrasonics Fundamentals, Technology, Applications. Dale Ensminger, Columbus, Ohio. (pp. 373-376). .
"Human hearing in connection with the action of ultrasound in the megahertz range on the aural labyrinth" 1979. L. R. Gavrilov, G. V. Gershuni, V.I. Pudov, A.S. Rozenblyum, and E.M. Tsirul'nikov. American Institute of Phusics pp. 290-292. .
The Institute of Electrical and Electronics Engineers, Inc. 1996; Richard A. Normann, Edwin M. Maynard, K. Shane Guillory, and David J. Warren. "Cortical Implants for the Blind". .
Computational Neuroscience 13; Eric L. Schwartz, Bjorn Merker, Estarose Wolfson, and Alan Shaw. 1988. "Applications of Computer Graphics and Image Processing to 2D and 3D Modeling of the Functional Architecture of Visual Cortex". .
CMPnet. The Technology Network. Feb. 10, 1997. "Treading fine line between man and machine, researchers pursue silicon prostheses--Chip implants: weird science with a noble purpose--Second of two parts" Larry Lange. .
EETIMESonline, www.cmpnet.com; The Technology Network/ 1999; ;Craig Matsumoto, EE Times; ISSCC: "Papers outline biochips to restore eyesight,

movement". .
JN Online. The Journal of Neurophysiology, vol. 77 No. 6 1997, pp. 2879-2909, The American Physiological Society. "Encoding of Binocular Disparity by Complex Cells in the Cat's Visual Cortex". .
Gttp:www.bionictech.com, Center for Neural Interfaces. Richard A. Normann, Ph.D. .
BBC News Online Science, Dr. David Whithouse, Sci/Tech Computer uses cat's brain to see. .
Kksbio@engr.psu.edu, PennState College of Engineering, The Whitaker Center for Medical Ultrasonic Transducer Engineering. .
Dpmi.tu-graz.ac.at/research/BCI; Brain Computer Interface. .
Ipaustralia.gov.au/fun/patents/02_ear.htm; Bionic Ear Patent; Melbourne University--Australian Patent 519851; filing date 1978. .
Measurement and Projection of Acoustic Fields; Earl G. Williams; Nava Research Laboratory, Code 5137, Washing D.C. 20375. .
Resonance, Newsletter of the Bioelectromagnetics Special Interest Group. pp. 11-13, 15-16. Judy Wall..

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***Parent Case Text***

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CROSS REFERENCE TO RELATED APPLICATIONS

The present Application is related to the U.S. patent application entitled "Method And System For Forming An Acoustic Signal From Neural Timing Difference Data," Ser. No. 09/690,786, co-filed with the present application on even date, and assigned to the Assignee of the present invention, and is hereby incorporated by reference in its entirety.

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***Claims***

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What is claimed is:

1. A non-invasive system for projecting sensory data in a part of a human brain, the system comprising: a primary transducer array configured to emit acoustic energy as a coherent signal source toward the human brain; a secondary transducer array positioned between the primary transducer array and the human brain; and a sensory data processing system coupled to the secondary transducer array, wherein the sensory data processing system sends an acoustical pattern signal to the secondary transducer array, the secondary transducer array producing a diffraction pattern for the emitted energy from the primary

transducer array, the diffraction pattern altering neural firing timing in the brain.

2. The system of claim 1, wherein the primary and secondary transducer arrays are separated by a distance substantially equal to the wavelength of the emitted energy from the primary array.

3. The system of claim 1, wherein the primary and secondary transducer arrays are separated by a distance substantially equal to a multiple of the wavelength of the emissions from the primary array.

4. The system of claim 1, wherein the primary transducer array appears to the secondary transducer array as a coherent signal source.

5. The system of claim 1, wherein emitted energy from the secondary transducer array is amplitude and phase shifted from the emitted energy from the primary array.

6. The system of claim 1, wherein an interaction of emitted energies from the primary and secondary transducer arrays produces an interference pattern, which is projected into the human brain.

7. The system of claim 1, wherein an interaction of emitted energies from the primary and secondary transducer arrays produces a plurality of controllable, low frequency pulses.

8. The system of claim 1, wherein the primary transducer array comprises an array of piezoelectric elements.

9. The system of claim 1, wherein the secondary transducer array comprises an array of piezoelectric elements.

10. The system of claim 1, wherein the primary and secondary arrays comprise a plurality of piezoelectric elements that are held together by a flexible material, wherein the primary and secondary arrays may conform to a shape of the human head.

11. The system of claim 1, wherein the sensory data processing system obtains sensory data from a data source selected from a group consisting of a video camera, a VCR, a DVD player, a cable broadcast, a satellite broadcast, and an Internet connector.

12. The system of claim 1, wherein the sensory data processing system comprises a processing module configured to convert analog data from a data source to digital data for the secondary transducer array.

13. The system of claim 1, wherein the sensory data processing system converts sensory data to a plurality of neural firing time differences, and converts the neural firing time differences to an acoustical pattern signal, which is sent to the secondary transducer array.

14. The system of claim 1, wherein the sensory data processing system comprises: a signal generator coupled to the secondary transducer array, the signal generator generating an acoustical pattern signal to the secondary transducer array, the acoustical pattern signal being based on sensory data from a sensory data source; and a reference signal generator coupled to the primary transducer array, the reference signal generator generating a reference signal to the primary transducer

## *Description*

FIELD OF THE INVENTION

The present invention relates to non-invasive methods and systems for generating sensory experiences within the human neural cortex.

BACKGROUND OF THE INVENTION

A conventional technique for generating neural activity in the human nervous system requires surgical implants. The implants may comprise wires that cause electronic impulses to interact with some portion of the human nervous system, such as the human neural cortex, and thereby cause neural activity in the human neural cortex. Researchers have successfully mapped audio sensory data to the cochlear channel, and visual data to the visual cortex.

Conventional invasive techniques have several drawbacks. First, surgical implants may cause patient trauma and medical complications during and/or after surgery. Second, additional or on-going surgery may be required, particularly if new technology is developed.

SUMMARY

The present invention solves the foregoing drawbacks by providing a non-invasive system and process for generating/projecting sensory data (visual, audio, taste, smell or touch) within/onto the human neural cortex.

One embodiment of the system comprises a primary transducer array and a secondary transducer array. The primary transducer array acts as a coherent or nearly-coherent signal source. The secondary transducer array acts as a controllable, acoustical diffraction pattern that shapes, focuses and modulates energy from the primary transducer onto the neural cortex in a desired pattern. The secondary transducer emits acoustical energy that may be shifted in phase and amplitude relative to the primary array emissions.

The pattern of energy is constructed such that each portion of the pattern projected into the neural cortex may be individually pulsed at low frequency. The system produces low frequency pulsing by controlling the phase differences between the emitted energy of the primary and secondary transducer array elements. The pulsed ultrasonic signal alters the neural firing timing in the cortex. Changes in the neural firing timing induce various sensory experiences depending on the location of the firing timing change in the cortex. The mapping of sensory areas of the cortex is known and used in current surgically invasive techniques. Thus, the system induces recognizable sensory experiences by applying ultrasonic energy pulsed at low frequency in one or more selected patterns on one or more selected locations of the cortex.

One of the advantages of the present system is that no invasive surgery is needed to assist a person, such as a blind person, to view live and/or recorded images or hear sounds.

This brief summary has been provided so that the nature of the invention may be understood quickly. A more complete understanding of the invention can be obtained by reference to the following detailed description of the preferred embodiments thereof in connection with the attached drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates one embodiment of a system in accordance with the present invention.

FIG. 2 illustrates one embodiment of a transducer system within the system of FIG. 1.

FIG. 3 illustrates one embodiment of a process in accordance with the present invention.

Use of the same reference symbols in different figures indicates similar or identical items.

## DETAILED DESCRIPTION

FIG. 1 illustrates one embodiment of a system 120 in accordance with the present invention. FIG. 1 shows a visual portion 100 of the human cortex located in a person's brain 100A, such as for example, a vision-impaired person's brain. The system 120 of FIG. 1 is used with the visual cortex 100 merely as an example and is not intended to limit the scope of the invention. Instead of or in addition to the visual cortex 100, the system 120 may be used to stimulate neural activity in other areas of the nervous system. For example, the system 120 may be used as is or modified to generate audio, taste, smell or touch sensations within the brain 100A.

In FIG. 1, the system 120 comprises a receiving module 110, a processing module 101, a signal generator 102, a reference signal generator 103, a transducer system 106, a first signal line 104 and a second signal line 105. The receiving module 110, processing module 101, signal generator 102, and reference signal generator 103, may be referred to as, alone or in combination, a sensory data processing system. Various configurations of the system 120 may be configured in accordance with the present invention. The system 120 may comprise other modules and components in addition to or instead of the modules and components shown in FIG. 1.

In general, the system 120 receives, analyzes and transfers the sensory data 112 to the human brain 100A. The receiving module 110 receives sensory input data 112. Such data 112 may comprise live video data captured by a video camera (not shown) which a vision-impaired person may not be able to see. The sensory data 112 may be live or recorded. The data 112 may be generated by other sources, such as for example a VCR, a DVD player, a cable broadcast, a satellite broadcast, an Internet connection, etc.

The processing module 101 receives input data 101A from the receiving module 110 and formats or converts the data 101A. For example, analog input data from the receiving module 110 may be digitized and/or converted into a neural firing time difference pattern. In one embodiment, the system 120 uses a technique that is reversed from a technique disclosed in "Reconstruction of Natural Scenes from Ensemble Responses in the Lateral Geniculate Nucleus" by Garrett B. Stanley et al. in the Sep. 15, 1999 issue of the Journal of Neuroscience, which is hereby incorporated by reference in its entirety.

Processed data 101B is transferred to the signal generator 102. Based upon the data 101B, the signal generator 102 generates a first signal 104A on the first line 104. The reference signal generator 103 generates a reference signal 105A on the second line 105. Both signals 104A and 105A are transferred to a transducer system 106.

FIG. 2 illustrates one embodiment of a transducer system 106 within the system 120 of FIG. 1. The transducer system 106 includes a primary (or first) transducer array 200, and a secondary (or second) transducer array 202. An aperture 201 with a distance "d" separates the primary and secondary arrays 200 and 202. The distance 201 may be fixed or adjusted depending on the wavelength of energy emitted by primary array 200. In one embodiment, the distance 201 is equal to the wavelength of sound emitted by the primary transducer 200.

The primary transducer array 200 may comprise one or more columns and rows of individually-controllable piezoelectric elements. The secondary transducer array 202 may also comprise a two-dimensional array of individually-controllable piezoelectric elements.

In one embodiment, the primary and/or secondary transducer array 200, 202 each comprise a thin sheet of metal, glass, plastic or ceramic material covered with a two-dimensional array of individually-controllable piezoelectric elements. Each element in the arrays 200, 202 may emit a unique signal. The arrays 200, 202 may or may not be flat and may be shaped to conform to a portion of the human head over which the transducer system 106 lays to provide better focusing. The layout of individual elements within each array 200, 202 can also be altered to provide better focusing, according to the shape of the area of the human cortex where signal 104A is to be projected.

In one embodiment, the arrays 200, 202 comprise piezoelectric elements that are held together by a flexible material, such as plastic or rubber. This embodiment allows the arrays 200, 202 to further conform to a portion of the human head over which the transducer system 106 lays to provide better focusing.

The primary and secondary transducer arrays 200 and 202 are arranged such that the primary array 200 acts as a source of coherent energy, while the secondary array 202 acts as a programmable diffraction grating. For example, the primary transducer array 200 may comprise a phased array of emitters, whereby the combined output of some or all of the emitters appears to the secondary transducer array 202 as a coherent acoustical signal source. The primary array 200 may emit acoustical energy, thereby providing an acoustical implementation of projective holography. In one embodiment, the phase of one or more array elements in the primary array 200 is controllable to allow shaping of the energy received by the secondary transducer array 202. The primary and secondary arrays 200 and 202 may emit ultrasonic energy at the same wavelength.

The secondary transducer array 202 may comprise an array of emitters, where each emitter can be individually controlled for amplitude and phase relative to the energy emitted by primary transducer 200. Changes in signal amplitude and phase are driven by signal 104A. The secondary array 202 may provide focusing and low frequency modulation of phase differences and/or signal amplitude between the energy emitted by the arrays 200, 202. The modulation of phase differences and/or signal amplitude induces low frequency vibrations in the neurons of the visual cortex 100. The focusing effect is accomplished by the primary array 200 acting as a coherent signal source, and the secondary array 202 acting as a controllable diffraction pattern, based upon signals 104A and 105A.

Ultrasonic frequencies may accurately place signal patterns within the cortex. Interaction of emissions from the primary and secondary arrays 200, 202 projects an interference pattern (e.g., low frequency signals or pulses) in the brain 100A. The projected interference pattern creates a highly defined pattern within the visual cortex 100 or another other part of the human neural cortex. Each point in the pattern may have an individually pulsed low frequency amplitude that is used to modify neural firing times.

Low frequency amplitude modulation combined with wavelength phase interactions from the primary and secondary transducer arrays 200, 202 form a stimulus to activate neurons in the visual cortex area 100 or another other part of the human neural cortex. By controlling the pattern of signal amplitude and phase shifts in secondary array 202, a wide range of patterns can be focused towards visual cortex 100 or any other region of the human cortex. Ultrasonic signals altering neural firings are discussed in "Temporally-specific modification of myelinated axon excitability in vitro following a single ultrasound pulse" by Mihran et al. published by the Ultrasound Med Biol 1990, 16(3), pp. 297-309 and "Transient Modification of Nerve Excitability In Vitro by Single Ultrasound Pulses" by Mihran et al. found in the Department of Electrical and Computer Engineering, University of Colorado, 1990, paper #90-038, which are hereby incorporated by reference in their entirety.

Changes in the neural firing timing induce various sensory experiences depending on the location of the firing timing change in the cortex. The mapping of sensory areas of the cortex is known and used in current surgically invasive techniques.

FIG. 3 illustrates one embodiment of a process in accordance with the present invention. In a process block 301, the receiving module 110 (FIG. 1) receives sensory input data 112 from, for example, a video camera, VCR, DVD player, cable broadcast, satellite broadcast, and/or Internet connection. The receiving module 110 outputs the data 101A to the processing module 101 (FIG. 1).

In a block 302, the processing module 101 processes the input data 101A. As stated above, in one embodiment, the processing module 101 digitizes analog data 101A from the receiving module 110 and/or converts the data 101A into a set of neural firing time differences or a pattern.

In a block 303, the signal generator 102 converts the firing time differences to a first signal 104A. For example, the first signal 104A may comprise an acoustical pattern, which comprises a plurality of amplitude and phase differences. In one embodiment, this conversion is accomplished by using known techniques in generating projective holograms. Acoustic holography is discussed in "Nearfield acoustic holography: I. Theory of generalized holography and the development of NAH" by J. D. Maynard et al. in the October 1985 issue of the Journal of the Acoustical Society of America, which is hereby incorporated by reference in its entirety. In a block 304, the reference generator module 103 generates a reference signal 105A, which provides a coherent signal source, onto the second line 105. In one embodiment, the acts described in blocks 303 and 304 occur substantially simultaneously.

In a block 305, signals 104A and 105A are transferred to transducer system 106. The first signal 104A is transferred to the secondary array 202. The reference signal 105A is transferred to the primary array 200.

In a block 306, the transducer arrays 200 and 202 project a focused interference pattern onto the human cortex. The shape of the interference pattern and the amplitude pulse rate for each portion of the pattern may be controlled through the signals transferred in block 305. Low frequency pulses are derived from the interaction of the emissions from the primary and secondary arrays 200, 202.

In a block 307, low frequency pulsing of different points of the projected ultrasonic energy modifies the firing timing of the neurons in the human nervous system (in this example, the visual cortex 100), thereby giving rise to perceived sensory experiences, such as visual images. Sensory data is mapped in the neural cortex as differences in neural firing times. Thus, altering the firing times in cortical neurons can generate sensory experiences. One advantage of the present system is that no surgery is needed to change neural activity causing a sensory experience. Although the present invention has been described with reference to specific embodiments, these embodiments are illustrative only and not limiting. Many other applications of this present invention will be apparent in light of this disclosure and the following claims.

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| **United States Patent** | **6,587,729** |
| **O'Loughlin , et al.** | **July 1, 2003** |

# Apparatus for audibly communicating speech using the radio frequency hearing effect


### Abstract

A modulation process with a fully suppressed carrier and input preprocessor filtering to produce an encoded output; for amplitude modulation (AM) and audio speech preprocessor filtering, intelligible subjective sound is produced when the encoded signal is demodulated using the RF Hearing Effect. Suitable forms of carrier suppressed modulation include single sideband (SSB) and carrier suppressed amplitude modulation (CSAM), with both sidebands present.



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| Appl. No.: | **10/131,626** |
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### Related U.S. Patent Documents

| Application Number | Filing Date | Patent Number | Issue Date<TD< TD> |
|---|---|---|---|
| 766687 | Dec., 1996 | 6470214 | <TD< TD> |

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|---|---|
| **Current U.S. Class:** | **607/55** ; 128/897; 332/167; 381/151; 600/586 |
| **Current International Class:** | A61N 1/08 (20060101); H03C 001/54 () |
| **Field of Search:** | 332/167 381/151 607/56,55 340/384.1 600/559,23,586 128/897,898 |

### References Cited [Referenced By]


### U.S. Patent Documents

| | | |
|---|---|---|
| 3563246 | February 1971 | Puharich et al. |
| 3629521 | December 1971 | Puharich et al. |
| 4835791 | May 1989 | Daoud |
| 5450044 | September 1995 | Hulick |

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### *Government Interests*

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

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### *Parent Case Text*

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This application is a division of U.S. patent application Ser. No. 08/766,687 filed on Dec. 13, 1996, now U.S. Pat. No. 6,470,214, and claims the benefit of the foregoing filing date.

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### *Claims*

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What is claimed is:

1. An apparatus for communicating an audio signal a(t), comprising: an audio predistortion filter having a filter function As(f) for producing a first output signal a(t)As(t) from the audio signal a(t); means for adding a bias A to the first output signal, to produce a second output signal a(t)As(f)+A; a square root processor for producing a third output signal (a(t)As(f)+A).sup.1/2 responsive to the second output signal; and a modulator for producing a double sideband output signal responsive to the third output signal, having a carrier frequency of .omega..sub.c, and being mathematically described by (a(t)As(f)+A).sup.1/2 sin(.omega..sub.c t); and transmitting the double sideband output signal to a demodulator, whereby the audio signal a(t) is recovered from the double sideband output signal.

2. The communication apparatus defined in claim 1 wherein: the double sideband output signal has RF power; and the demodulator is for converting the RF power into acoustic pressure waves.

3. The communication apparatus defined in claim 2 wherein: the demodulator converts the RF power into the acoustic pressure waves by means of thermal expansion and contraction, whereby the acoustic pressure waves approximate the audio signal a(t).

4. The communication apparatus defined in claim 2 wherein the demodulator includes a mass that expands and contracts responsive to the RE power of the double sideband

output signal.

5. The communication apparatus defined in claim 4 wherein the mass is approximately spherical.

6. The communication apparatus defined in claim 1 wherein: the double sideband output signal is comprised of a first sideband component and a second sideband component; and means for suppressing the second sideband component, whereby the demodulator recovers the audio signal a(t) solely from the first sideband component.

7. The communication apparatus defined in claim 1 wherein the audio predistortion filter is a low-pass filter.

8. The communication apparatus defined in claim 7 wherein the audio predistortion filter is a digital processor.

9. The communication apparatus defined in claim 1 wherein: the square root processor is a diode biased by a voltage source, in series with a resistance, whereby a voltage across the diode is proportional to a square root of the second output signal a(t)As(t)+A.

10. The communication apparatus defined in claim 1 wherein the modulator is a balanced modulator.

11. The communication apparatus defined in claim 1 wherein: the audio signal a(t) includes a high frequency component; and the audio predistortion filter de-emphasizes the high frequency component by approximately 40 dB per decade.

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***Description***

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BACKGROUND OF THE INVENTION

This invention relates to the modulating of signals on carriers, which are transmitted and the signals intelligibly recovered, and more particularly, to the modulation of speech on a carrier and the intelligible recover of the speech by means of the Radio Frequency Hearing Effect.

The Radio Frequency ("RF") Hearing Effect was first noticed during World War II as a subjective "click" produced by a pulsed radar signal when the transmitted power is above a "threshold" level. Below the threshold level, the click cannot be heard.

The discovery of the Radio Frequency Hearing Effect suggested that a pulsed RF carrier could be encoded with an amplitude modulated ("AM") envelope. In one approach to pulsed carrier modulation, it was assumed that the "click" of the pulsed carrier was similar to a data sample and could be used to synthesize both simple and complex tones such as speech. Although pulsed carrier modulation can induce a subjective sensation for simple tones, it severely distorts the complex waveforms of speech, as has been confirmed experimentally.

The presence of this kind of distortion has prevented the click process for the encoding of intelligible speech. An example is provided by AM sampled data modulation

Upon demodulation the perceived speech signal has some of the envelope characteristics of an audio signal. Consequently a message can be recognized as speech when a listener is pre-advised that speech has been sent. However, if the listener does not know the content of the message, the audio signal is unintelligible.

The attempt to use the click process to encode speech has been based on the assumption that if simple tones can be encoded, speech can be encoded as well, but this is not so. A simple tone can contain several distortions and still be perceived as a tone whereas the same degree of distortion applied to speech renders it unintelligible.

SUMMARY OF THE INVENTION

In accomplishing the foregoing and related object the invention uses a modulation process with a fully suppressed carrier and pre-processor filtering of the input to produce an encoded output. Where amplitude modulation (AM) is employed and the pre-processor filtering is of audio speech input, intelligible subjective sound is produced when the encoded signal is demodulated by means of the RF Hearing Effect. Suitable forms of carrier suppressed modulation include single sideband (SSB) and carrier suppressed amplitude modulation (CSAM), with both sidebands present.

The invention further provides for analysis of the RE hearing phenomena based on an RF to acoustic transducer model. Analysis of the model suggests a new modulation process which permits the RF Hearing Effect to be used following the transmission of encoded speech.

In accordance with one aspect of the invention the preprocessing of an input speech signal takes place with a filter that de-emphasizes the high frequency content of the input speech signal. The de-emphasis can provide a signal reduction of about 40 dB (decibels) per decade. Further processing of the speech signal then takes place by adding a bias level and taking a root of the predistorted waveform. The resultant signal is used to modulated an RF carrier in the AM fully suppressed carrier mode, with single or double sidebands.

The modulated RF signal is demodulated by an RF to acoustic demodulator that produces an intelligible acoustic replication of the original input speech.

The RF Hearing Effect is explained and analyzed as a thermal to acoustic demodulating process. Energy absorption in a medium, such as the head, causes mechanical expansion and contraction, and thus an acoustic signal.

When the expansion and contraction take place in the head of an animal, the acoustic signal is passed by conduction to the inner ear where it is further processed as if it were an acoustic signal from the outer ear.

The RF to Acoustic Demodulator thus has characteristics which permit the conversion of the RF energy input to an acoustic output.

Accordingly, it is an object of the invention to provide a novel technique for the intelligible encoding of signals. A related object is to provide for the intelligible encoding of speech.

Another object of the invention is to make use of the Radio Frequency ("RF") Hearing Effect in the intelligible demodulation of encoded signals, including speech.

Still another object of the invention is to suitably encode a pulsed RF carrier with an amplitude modulated ("AM") envelope such that the modulation will be intelligibly demodulated by means of the RF Hearing Effect. A related object is to permit a message to be identified and understood as speech when a listener does not know beforehand that the message is speech.

Other aspects of the invention will be come apparent after considering several illustrative embodiments, taken in conjunction with the drawings.

## DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram model of RF to Acoustic Demodulation Process making use of the Radio Frequency ("RF") Hearing Effect;

FIG. 2 is a spherical demodulator and radiator having a specific acoustic impedance for demodulation using the RF Hearing Effect;

FIG. 3 is a diagram illustrating the overall process and constituents of the invention; and

FIG. 4 is an illustrative circuit and wiring diagram for the components of FIG. 3.

### DETAINED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawings, FIG. 1 illustrates the RF to acoustic demodulation process of the invention. Ordinarily an acoustic signal A reaches the outer ear E of the head H and traverses first to the inner ear I and then to the acoustic receptors of the brain B. A modulated RF signal, however, enters a demodulator D, which is illustratively provided by the mass M of the brain, and is approximated, as shown in FIG. 2, by a sphere S of radius r in the head H. The radius r of the sphere S is about 7 cm to make the sphere S equivalent to about the volume of the brain B. It will be appreciated that where the demodulator D, which can be an external component, is not employed with the acoustic receptors of the brain B, it can have other forms.

The sphere S, or its equivalent ellipsoid or similar solid, absorbs RF power which causes an increase in temperature that in turn causes an expansion and contraction which results in an acoustic wave. As a first approximation, it is assumed that the RF power is absorbed uniformly in the brain. Where the demodulator D is external to the brain B, the medium and/or RF carrier frequency can be selected to assure sufficiently uniform absorption.

For the modulated RF signal of FIG. 1, the power absorbed in the sphere S is proportional to the power waveform of the modulated RF signal. The absorption rate is characterized quantitatively in terms of the SAR (Specific Absorption Rate) in the units of absorbed watts per kilogram per incident watt per square centimeter.

The temperature of the sphere S is taken as following the integrated heat input from the power waveform, i.e. the process is approximated as being adiabatic, at least for short term intervals on the order of a few minutes.

The radial expansion of the sphere follows temperature and is converted to sound pressure, p(t), determined by the radial velocity (U.sub.r) multiplied by the real part of the specific acoustic impedance (Z.sub.s) of the sphere, as indicated in equation (1), below.

Where: .rho..sub.o =density, 1000 kg/m.sup.3 for water c=speed of sound, 1560 m/s, in water @ 37.degree. C. k=wave number, 2.pi./wavelength r=sphere radius, in meters (m) f=audio frequency f.sub.c =lower cutoff break frequency,=c/(2.pi.r) j=the 90 degree phase-shift operator

The specific acoustic impedance for a sphere of 7 cm radius, on the order of the size of the brain, has a lower cut-off break frequency of about 3,547 Hertz (Hz) for the parameters given for equation (1). The essential frequency range of speech is about 300 to 3000 Hz, i.e., below the cut-off frequency. It is therefore the Real part (R.sub.e) of Z.sub.s times the radial particle velocity (U.sub.r) which determines the sound pressure, p(t). The real part of Z.sub.s is given by equation (1a), below:

In the speech spectrum, which is below the brain cut-off frequency, the sphere S is an acoustic filter which "rolls off", i.e. decreases in amplitude at -40 dB per decade with decreasing frequency. In addition to any other demodulation processes to be analyzed below, the filter characteristics of the sphere will modify the acoustic signal with a 40 dB per decade slope in favor of the high frequencies.

Results for an AM Modulated Single Tone

An RF carrier with amplitude A.sub.c at frequency .omega..sub.c is AM modulated 100 percent with a single tone audio signal at frequency .omega..sub.1. The voltage (time) equation of this modulated signal is given by equation (2), below:

The power signal is V(t).sup.2 as given by equation (3), below:

To find the energy absorbed in the sphere, the time integral of equation (3) is taken times absorption coefficient, K. The result is divided by the specific heat, SH to obtain the temperature of the sphere and then multiplied by the volume expansion coefficient, Mv to obtain the change in volume. The change in volume is related to the change in radius by equation (4), below:

To obtain the amplitude of the radius change, there is multiplication by the radius and division by three. The rms radial surface velocity, U.sub.r is determined by multiplying the time derivative by r and dividing by 2.sup.1/2. The result, U.sub.r, is proportional to the power function, P(t) in equation (5), below.

The acoustic pressure, p(t), is given in equation (6), below, as the result of multiplying equation (5) by the Real part of the specific acoustic impedance, R.sub.e (1).

The SPL (Sound Pressure Level), in acoustic dB, is approximated as 20 log[p(t)/2E-5]. The standard acoustic reference level of 2E-5 Newtons per square meter is based on a signal in air; however, the head has a water-like consistency. Therefore, the subjective level in acoustic dB is only approximate, but sufficient for first order accuracy.

In a single tone case the incident RF power, P(t), from equation (3) has two terms as shown in equation (7), below, which are in the hearing range.

This is converted to the acoustic pressure wave, p(t), by multiplying by the specific acoustic impedance calculated at the two frequencies. Therefore, the resulting pressure wave as indicated in equation (8), below, becomes

The result is an audio frequency and a second harmonic at about 1/4 amplitude. Thus using an RF carrier, AM modulated by a single tone, the pressure wave audio signal will consist of the audio tone and a second harmonic at about -6 dB, if the specific acoustic impedances at the two frequencies are the same. However, from equation (1) the break frequency of a model 7 cm sphere is 3.547 Hz. Most of the speech spectrum is below this frequency therefore the specific acoustic impedance is reactive and the real component is given by equation (8a), below:

Below the cutoff frequency the real part of the impedance varies as the square of the frequency or gives a boost of 40 dB per decade. Therefore, if the input modulation signal is 1 kHz, the second harmonic will have a boost of about 4 time in amplitude, or 12 dB, due to the variation of the real part of the specific acoustic impedance with frequency. So the second harmonic pressure term in equation (8) is actually four times the power or 6 dB higher than the fundamental term. If the second harmonic falls above the cutoff frequency then the boost begins to fall back to 0 dB. However, for most of the speech spectrum there is a sever distortion and strong boost of the high frequency distortion components.

Results for Two Tone AM Modulation Analysis

Because of the distortion attending single tone modulation, predistortion of the modulation could be attempted such that the resulting demodulated pressure wave will not contain harmonic distortion. This will not work, however, because of the non-linear cross-products of two-tone modulation are quite different from single tone modulation as shown below.

Nevertheless, two-tone modulation distortion provides an insight for the design of a corrective process for a complex modulation signal such as speech. The nature of the distortion is defined in terms of relative amplitudes and frequencies.

Equation (8b) is that of an AM modulated carrier for the two-tone case where .omega..sub.a1 and .omega..sub.a2 are of equal amplitude and together modulate the carrier to a maximum peak value of 100 percent. The total modulated RF signal is given by equation (8b), below:

The square of (8b) is the power signal, which has the same form as the particle velocity, U.sub.r (t), of equation (9), below.

From the square of (8b) the following frequencies and relative amplitudes are obtained for the particle velocity wave, U.sub.r (t), which are in the audio range;

If the frequencies in equation (9) are below the cut-off frequency, the impedance boost correction will result in a pressure wave with relative amplitudes given in equation (9a), below:

p(t)=C'[sin(.omega..sub.a1 t)+b.sup.2 sin(.omega..sub.a2 t)+(1-b.sup.2)/4 cos((.omega..sub.a1 -.omega..sub.a2)t)+(1+b.sup.2)/4 cos((.omega..sub.a1 +.omega..sub.a2)t)-1/2 cos(2.omega..sub.a1)t)-b.sup.2 /2 cos(2.omega..sub.a2 t) (9a)

where: b=.omega..sub.a2 /.omega..sub.a1 and .omega..sub.a2 >.omega..sub.a1

Equation (9a) contains a correction factor, b, for the specific acoustic impedance variation with frequency. The first two terms of (9a) are the two tones of the input modulation with the relative amplitudes modified by the impedance correction factor. The other terms are the distortion cross products which are quite different from the single tone distortion case. In addition to the second harmonics, there are sum and difference frequencies. From this two-tone analysis it is obvious that more complex multiple tone modulations, such as speech, will be severely distorted with even more complicated cross-product and sum and difference components. This is not unexpected since the process which creates the distortion is nonlinear. This leads to the conclusion that a simple passive predistortion filter will not work on a speech signal modulated on an RF carrier by a conventional AM process, because the distortion is a function of the signal by a nonlinear process.

However, the serious distortion problem can be overcome by means of the invention which exploits the characteristics of a different type of RF modulation process in addition to special signal processing.

AM Modulation With Fully Suppressed Carrier for the Intelligible Encoding of Speech by the Invention for Compatibility With the RF Hearing Phenomena

The equation for AM modulation with a fully suppressed carrier is given by equation (10), below:

This modulation is commonly accomplished in hardware by means of a circuit known as a balanced modulator, as disclosed, for example in "Radio Engineering", Frederick E. Terman, p.481-3, McGraw-Hill, 1947.

The power signal has the same form as the particle velocity signal which is obtained from the square of equation (10) as shown in equation (11), below: From inspection of equations (10) and (11) it is seen that, if the input audio signal, a(t), is pre-processed by taking the square root and then modulating the carrier, the audio term in the particle velocity equation will be an exact, undistorted, replication of the input audio signal. Since the audio signal from a microphone is bipolar, it must be modified by adding a very low frequency (essential d.c.) bias term, A, such that the resultant sum, [a(t)+A]>0.0, is always positive. This is necessary in order to insure a real square root. The use of a custom digital speech processor implements the addition of the term A, i.e. as shown in equation (10*), below:

The pressure wave is given by equation (11*), below:

When the second term of the pressure wave of equation (11*) is processed through the specific acoustic impedance it will result in the replication of the input audio signal but will be modified by the filter characteristics of the Real part of the specific acoustic impedance, R.sub.e {Z.sub.s (f)}, as given in equation (8a). The first term of equation (11*) is the d.c. bias, which is added to obtain a real square root; it will not be audible or cause distortion. The third and fourth terms of (11*) are a.c. terms at twice the carrier frequency and therefore will not distort or interfere with the audio range signal, a(t).

Since the filter characteristic of equation (7) is a linear process in amplitude, the audio input can be predistorted before the modulation is applied to the carrier and then the pressure or wound wave audio signal, which is the result of the velocity wave times the impedance function, R.sub.e {Z.sub.s (f)}, will be the true replication of the original input audio signal. A diagram illustrating the overall system 30 and process of the invention is shown in FIG. 3. Then input signal a(t) is applied to an Audio Predistortion Filter 31 with a filter function As(f) to produce a signal a(t)As(f), which is applied to a Square Root Processor 32, providing an output=(a(t)As(f)+A).sup.1/2, which goes to a balanced modulator 33. The modulation process known as suppressed carrier, produces a double sideband output=(a(t)As(f)+A).sup.1/2 sin(.omega..sub.c t), where .omega..sub.c is the carrier frequency. If one of the sidebands and the carrier are suppressed (not shown) the result is single sideband (SSB) modulation and will function in the same manner discussed above for the purposes of implementing the invention. However, the AM double sideband suppressed carrier as described is more easily implemented.

The output of the balanced modulator is applied to a spherical demodulator 34, which recovers the input signal a(t) that is applied to the inner ear 35 and then to the acoustic receptors in the brain 36.

The various components 31-33 of FIG. 3 are easily implemented as shown, for example by the corresponding components 41-42 in FIG. 4, where the Filter 41 can take the form of a low pass filter, such as a constant-K filter formed by series inductor L and a shunt capacitor C. Other low-pass filters are shown, for example, in the ITT Federal Handbook, 4th Ed., 1949. As a result the filter output is AS(f) a 1/f.sup.2. The Root Processor 42 can be implemented by any square-law device, such as the diode D biased by a battery B and in series with a large impedance (resistance) R, so that the voltage developed across the diode D is proportional to the square root of the input voltage a(t)As(f). The balanced modulator 43, as discussed in Terman, op.cit., has symmetrical diodes A1 and A2 with the modulating voltage M applied in opposite phase to the diodes A1 and A2 through an input transformer T1, with the carrier, O, applied commonly to the diodes in the same phase, while the modulating signal is applied to the diodes in opposite phase so that the carrier cancels in the primary of the output transformer T2 and the secondary output is the desired double side band output. Finally the Spherical Demodulator 45 is the brain as discussed above, or an equivalent mass that provides uniform expansion and contraction due to thermal effects of RF energy.

The invention provides a new and useful encoding for speech on an RF carrier such that the speech will be intelligible to a human subject by means of the RF hearing demodulation phenomena. Features of the invention include the use of AM fully suppressed carrier modulation, the preprocessing of an input speech signal be a compensation filter to de-emphasize the high frequency content by 40 dB per decade and the further processing of the audio signal by adding a bias terms to permit the taking of the square root of the signal before the AM suppressed carrier modulation process.

The invention may also be implemented using the same audio signal processing and Single Sideband (SSB) modulation in place of AM suppressed carrier modulation. The same signal processing may also be used on Conventional AM modulation contains both sideband and the carrier; however, there is a serious disadvantage. The carrier is always present with AM modulation, even when there is no signal. The carrier power does not contain any information but contributes substantially to the heating of the thermal-acoustic demodulator, i.e. the brain, which is undesirable. The degree of this extraneous heating is more than twice the heating caused by the signal or information power in the RF signal. Therefore conventional AM modulation is an inefficient and poor choice compared to the double side-band suppressed carrier and the SSB types of transmissions. The invention further may be implemented using various degrees of speech compression commonly used with all types of AM modulation. Speech compression is implemented by raising the level of the low amplitude portions of the speech waveform and limiting or compressing the high peak amplitudes of the speech waveform. Speech compression increases the average power content of the waveform and thus loudness. Speech compression introduces some distortion, so that a balance must be made between the increase in distortion and the increase in loudness to obtain the optimum result.

Another implementation is by digital signal processing of the input signal through to the modulation of the RF carrier.

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**United States Patent** **6,889,085**
**Dawson** **May 3, 2005**

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# Method and system for forming an acoustic signal from neural timing difference data


## Abstract

A non-invasive system and process for converting sensory data, e.g., visual, audio, taste, smell or touch, to neural firing timing differences in a human brain and using acoustic signals to generate the neural firing time differences. Data related to neural firing time differences, the acoustic signals, and a user's response map may be stored in memory. The user's response map may be used to more accurately map the calculated neural firing time differences to the correct neural locations.


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**Related U.S. Patent Documents**

| Application Number | Filing Date | Patent Number | Issue Date<TD< TD> |
|---|---|---|---|
| 690786 | Oct., 2000 | 6584357 | <TD< TD> |

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**References Cited [Referenced By]**

**U.S. Patent Documents**


| | | |
|---|---|---|
| 3848608 | November 1974 | Leonard |
| 4343301 | August 1982 | Indech |
| 4611596 | September 1986 | Wasserman |
| 4628933 | December 1986 | Michelson |
| 4664117 | May 1987 | Beck |
| 4883067 | November 1989 | Knispel |
| 4905285 | February 1990 | Allen et al. |
| 4979508 | December 1990 | Beck |
| 5031154 | July 1991 | Watanabe |
| 5097326 | March 1992 | Meijer |

| | | |
|---|---|---|
| 5109844 | May 1992 | De Juan, Jr. et al. |
| 5159927 | November 1992 | Schmid |
| 5179455 | January 1993 | Garlick |
| 5526819 | June 1996 | Lonsbury-Martin et al. |
| 5645074 | July 1997 | Shennib et al. |
| 5651365 | July 1997 | Hanafy et al. |
| 5738625 | April 1998 | Gluck |
| 5853370 | December 1998 | Chance |
| 5935155 | August 1999 | Humayun et al. |
| 5956292 | September 1999 | Bernstein |
| 5971925 | October 1999 | Hossack et al. |
| 6584357 | June 2003 | Dawson |

## Other References


Department of Electrical and Computer Engineering, University of Colorado, 1990, Richard T. Mihran et al., "Transient Modification of Nerve Excitability in Vitro by Single Ultrasound Pulses.". .
Ultrasound Med Biol 1990, Department of Electrical and Computer Engineering, University of Colorado, "Temporally-specific modification of myelinated axon excitability in vitro following a single ultrasound pulse" (pp. 297-309), R.T. Mihran et al. .
The Pennsylvania State University, Department of Physics. 1984, J.D. Maynard et al., Nearfield acoustic holography:n I. Theory of generalized holography and the development of NAH. .
Department of Molecular and Cell Biology, Division of Neurobiology, University of California. Garret B. Stanley et al. "Reconstruction of Natural Scenes from Ensemble Responses in the Lateral Geniculate Nucleus, " Journal of Neuroscience, 1999, pp. 8036-8042. .
ULTRASONICS Fundamentals, Technology, Applications, Dale Ensminger, Columbus, Ohio, pp. 373-376. .
"Human hearing in conncetion with the action of ultrasound in the megahertz range on the aural labyrinth," 1979. L.R. Gavrilov et al. American Institute of Physics, pp. 290-292. .
The Institute of Electrical and Electronics Engineers, Inc., 1996. Richard A. Normann et al., "Cortical Implants for the Blind." .
Computational Neuroscience 13; Eric L. Schwartz et al. 1998. "Applications of Computer Graphics and Image Processing to 2D and 3D Modeling of the Functional Architecture of Visual Cortex." .
CMPnet. The Technology Network. Feb. 10, 1997. "Treading fine line beyween man and machine, researchers pursue silicon prostheses--Chip implants; weird science with a noble purpose--Second of two parts," Larry Lange. .
EETIMESonline, www.cmpnet.com; The Technology Network/1999; Craig Matsumoto, EE Times; ISSCC: "Papers outline biochips to restore eyesight, movement." .
JN Online. The Journal of Neurophysiology, vol. 77, No. 6, 1997, pp. 2879-2909, American Physiological Society. "Encoding of Binocular Disparity by Complex Cells in the Cat's Visual Cortex." .
Http:www.bionictech.com, Center for Neural Interfaces. Richard A. Normann. .
BBC News Online Science, Dr. David Whithouse, Sci/Tech Computer uses cat's brain to see. .
Kksbio@engr.psu.edu, Penn State College of Engineering, The Whitaker Center for Medical Ultrasonic Transducer Engineering. .
Dpmi.tu-graz.acat/research/BCI; Brain Computer Interface. .
Ipaustralia.gov.au/fun/patents/02_ear.htm; Bionic Ear Patent; Melbourne University--Australian Patent 519851; filing date 1978. .
Measurement and Projection of Acoustic Fields; Earl G. Williams; Naval Research Laboratory, Code 5137, Washington D.C. 20375. .
Resonance, Newsletter of the Bioelectromagnetics Special Interest Group. pp. 11-13, 15-16, Judy Wall..


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## *Parent Case Text*

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 09/690,786 filed Oct. 17, 2000, now U.S. Pat No. 6,584,357, and entitled "Method and System For Forming An Acoustic Signal From Neural Timing Difference Data." This application is also related to U.S. patent application Ser. No. 09/690,571 filed on Oct. 17, 2000, now U.S. Pat. No. 6,584,357, entitled "Method and System for Generating Sensory Data Onto The Human Neural Cortex, (now U.S. Pat. No. 6,536,440, issued Mar. 25, 2003). assigned to the Assignee of the present invention, and hereby incorporated by reference in its entirety.

## *Claims*

What is claimed is:

1. A method to alter neutral firing times in a brain, the method comprising: non-invasively projecting a first acoustic signal to a neural cortex in the brain; storing a user sensory response and data related to the first acoustic signal in a memory; non-invasively projecting a second acoustic signal to a neural cortex in the brain; and storing a user sensory response and data related to the second acoustic signal in the memory.

2. The method of claim 1, wherein the first acoustic signal varies in amplitude from the second acoustic signal.

3. The method of claim 1, wherein the first acoustic signal varies in frequency from the second acoustic signal.

4. The method of claim 1, wherein the first acoustic signal varies in duration from the second acoustic signal.

5. The method of claim 1, wherein the second acoustic signal is configured to affect the neural firing time of the first neural location.

6. The method of claim 1, wherein the second acoustic signal is configured to affect the neural firing time of a second neural location.

7. The method of claim 6, further comprising: non-invasively projecting additional acoustic signals into the brain; and storing user sensory responses and data related to the additional acoustic signals in a memory; and creating a map of neural locations, user sensory responses and data related to the acoustic signals.

8. The method of claim 6, further comprising: non-invasively projecting additional acoustic signals into the brain, the additional acoustic signals configured to affect neural firing times at a plurality of neural locations in the brain; and storing user sensory responses and data related to the additional acoustic signals in a memory; and creating a map of neural locations, user sensory responses and data related to the acoustic signals.

9. The method of claim 8, further comprising categorizing the data related to the signals by targeted neural locations.

10. The method of claim 1, wherein at least one of the first and second acoustic signals comprise high frequency acoustic signals pulsed at low frequencies.

11. The method of claim 1, wherein the first and second acoustic signals each comprise a pulsed signal generated by a primary transducer array and a secondary transducer array, the primary transducer array generating a reference wave and the secondary transducer array generating a diffraction pattern.

12. The method of claim 1, wherein the first and second acoustic signals are projected into a visual cortex of the brain.

13. The method of claim 10, wherein the first acoustic signal causes the user to perceive a first bright area in a simulated visual field, and the second acoustic signal causes the users to perceive a second bright area in the simulated visual field.

14. The method of claim 1, wherein the first and second acoustic signals are projected into a cochlear channel of the brain.

15. The method of claim 14, wherein the first acoustic signal causes the user to perceive a first sound in a simulated auditory range, and the second acoustic signal causes the user to perceive a second sound in the simulated auditory range.
16. A method to alter neural firing times in a brain, the method comprising: non-invasively projecting a first acoustic signal into the brain, the first acoustic signal configured to affect a neural firing time at a first neural location in the brain; storing a user sensory response and data related to the first acoustic signal in a memory; non-invasivily projection a second acoustic signal into the brain; and storing a user sensory response ane data related to the second acoustic signal in the memory.

17. A method of customizing a library of data related to acoustic signals configured to alter neural firing times in a brain, the method comprising: retrieving data related to a first acoustic signal from a memory; projecting a first acoustic signal into the brain using the data related to a first acoustic signal; storing a user sensory response with the data related to the first acoustic signal in the memory; retrieving data related to a second acoustic signal form the memory; projecting a second acoustic signal in the brain using the data related to the second acoustic signal; and storing a user sensory response with the data related to the second acoustic signal in the memory.

18. A method of customizing a library of data related to acoustic signals configured to alter neural firing times in a brain, the method comprising: retrieving data related to a first acoustic signal from a memory; projecting a first acoustic signal into the brain using the data related to a first acoustic signal, the first acoustic signal configured to affect a neural firing time at a first neural location in the brain; storing a user sensory response with the data related to the first acoustic signal in the memory; retrieving data related to a second acoustic signal from the memory; projecting a second acoustic signal in the brain using the data related to the second acoustic signal; and storing a user sensory response with the data related to the second acoustic signal in the memory, wherein the second acoustic signal is configured to affect the neural firing time of the first neural location.

19. A method of customizing a library of data related to acoustic signals configured to alter neural firing times in a brain, the method comprising: retrieving data related to a first acoustic signal from a memory; projecting a first acoustic signal into the brain using the data related to a first acoustic signal, the first acoustic signal configured to affect a neural firing time at a first neural location in the brain; storing a user sensory response with the data related to the first acoustic signal in the memory; retrieving data related to a second acoustic signal from the memory; projecting a second acoustic signal in the brain using the data related to the second acoustic signal; and storing a user sensory response with the data related to the second acoustic signal in the memory. wherein the second acoustic signal is configured to affect the neural firing time of the second neural location.

20. A method for projecting sensory data in a human brain, the method comprising: calculating neural firing time differences for mapped neural locations in the brain based on received sensory input; selecting data in a memory related to signals configured to generate the neural firing time differences in the brain; and projecting the signals to generate tho neural tiring time differences into the brain.

21. The method of claim 20, wherein the neural firing time differences are configured to cause the brain to experience the sensory input.

22. The method of claim 20, wherein the neural firing time differences are configured to cause the brain to experience a sensation that is similar to the sensory input.

23. The method of claim 20, wherein applying the signals comprises: emitting a first acoustic energy as a coherent signal source toward the brain; and producing a diffraction pattern for the first emitted acoustic energy, the diffraction pattern configured to generate the neural firing time differences.

24. The method of claim 20, further comprising summing the signals configured to generate the neural firing time differences in the brain.

25. The method of claim 20, further comprising: selecting a reference signal based on a type of transducer used to produce the signals configured to generate the neural firing time differences in the brain; and applying the reference signal to the brain, wherein signals configured to generate the neural firing time difference in the brain shape the pulse of the reference signal.

26. The method of claim 20, wherein the sensory input is selected from a group consisting of an image, a sound, a video, a textual piece, and audio piece, a smell, a taste and a tactile sensation.

27. A system to alter neural firing times in a brain, the system comprising: a transducer system configured to non-invasively project a first acoustic signal and a second acoustic signal into the brain; a signal generator coupled to the transducer system; and a memory coupled to the signal generator, the memory configured to store: data related to the first and second acoustic signals; and user sensory responses produced by the first and second acoustic signals, wherein the signal generator is configured to select data in the memory related to signals configured to generate the neural firing time differences in the brain, the transducer system is configured to apply the signals to generate the neural firing time differences in the brain.

28. The system of claim 27, further comprising an input device configured to allow a user to modify the data into the memory.

29. The system of claim 27, further comprising an input device configured to allow a user to enter new data into the memory.

30. The system of claim 27, wherein the data related to the first and second acoustic signals are categorized by targeted neural locations.

31. The system of claim 27, further comprising: a processing module coupled to the signal generator and the memory, the processing module being configured to calculate neural firing time differences for mapped neural locations in the brain based on a sensory input.

32. A method for generating sensory response in a brain comprising: coupling a reference signal to a neural cortex in the brain; and coupling a pulse shaping signal to the neural cortex in the brain to shape energy from the reference signal in a desired pattern onto the neural cortex in the brain.

33. A method for generating sensory data in a brain comprising: projecting an ultrasonic sensory pattern of energy towards a neural cortex, said ultrasonic sensory pattern of energy configured to affect neural firing timing in the neural cortex; and pulsing separately one or more portions of the ultrasonic sensory pattern of energy to create a desired sensory energy pattern.

34. A method for altering neural firing timing in a neural cortex comprising: applying ultrasonic energy to one or more selected locations of the neural cortex; and pulsing the ultrasonic energy at a low frequency in one or more predetermined patterns.

35. A method for generating sensory data in a brain comprising: creating a desired pattern of energy to be applied to one or more locations in a neural cortex of the brain; generating a pulse-shaped ultrasonic energy pattern to match the desired pattern of energy; and directing the pulse-shaped ultrasonic energy pattern towards the one or more locations in the neural cortex of the brain.

36. A non-invasive system for projecting sensory data in a part of a human brain, the system comprising: a primary transducer array configured to emit acoustic energy as a coherent signal source toward the human brain; a secondary transducer array positioned in a predetermined position relative to the primary transducer array and the human brain; and a sensory data processing system coupled to the secondary transducer array, wherein the sensory data processing system sends an acoustical pattern signal to the secondary transducer array, the secondary transducer array producing a diffraction pattern for the emitted energy from the primary transducer array, the diffraction pattern configured to alter neural firing timing in the brain.

37. The system of claim 36, wherein the primary and secondary transducer arrays are separated by a distance substantially equal to the wavelength of the emitted energy from the primary array.

38. The system of claim 36, wherein the primary and secondary transducer arrays are separated by a distance substantially equal to a multiple of the wavelength of the emissions from the primary array.

39. The system of claim 36, wherein the primary transducer array appears to the secondary transducer array as a coherent signal source.

40. The system of claim 36, wherein emitted energy from the secondary transducer array is amplitude and phase shifted from the emitted energy from the primary array.

41. The system of claim 36, wherein an interaction of emitted energies from the primary and secondary transducer arrays produces an interference pattern, which is projected into the human brain.

42. The system of claim 36, wherein an interaction of emitted energies from the primary and secondary transducer arrays produces a plurality of controllable, low frequency pulses.

43. The system of claim 36, wherein the primary transducer array comprises an array of piezoelectric elements.

44. The system of claim 36, wherein the secondary transducer array comprises an array of piezoelectric elements.

45. The system of claim 36, wherein the primary and secondary arrays comprise a plurality of piezoelectric elements that are held together by a flexible material, wherein the primary and secondary arrays may conform to a shape of the human head.

46. The system of claim 36, wherein the sensory data processing system comprises a processing module configured to convert analog data from a data source to digital data for the secondary transducer array.

47. The system of claim 36, wherein the sensory data processing system converts sensory data to a plurality of neural firing time differences, and converts the neural firing time differences to an acoustical pattern signal, which is sent to the secondary transducer array.

48. The system of claim 36, wherein the sensory data processing system comprises: a signal generator coupled to the secondary transducer array, the signal generator generating an acoustical pattern signal to the secondary transducer array, the acoustical pattern signal being based on sensory data from a sensory data source; and a reference signal generator coupled to the primary transducer array, the reference signal generator generating a reference signal to the primary transducer array.

## ***Description***

BACKGROUND OF THE INVENTION

1. Field of the Invention
The present invention relates to a method and system for generating sensory experiences. In particular, the present invention relates to a method and system for forming an acoustic signal from neural timing difference data.

2. Description of Related Art
A conventional technique for generating neural activity in the human nervous system requires surgical implants. The implants may comprise electronic connections and wires that cause electronic impulses to interact with some portion of the human nervous system, such as the human neural cortex, and thereby

cause neural activity in the human neural cortex. Researchers have successfully mapped audio sensory data to the cochlear channel, and visual data to the visual cortex.

Conventional invasive techniques have several drawbacks. First, surgical implants may cause patient trauma and medical complications during and/or after surgery. Second, additional or on-going surgery may be required, particularly if new technology is developed.

## SUMMARY OF THE INVENTION

The present invention solves the foregoing drawbacks by providing a non-invasive system and process that uses acoustic signals to generate sensory data, e.g., visual, audio, taste, smell or touch, within/onto the human neural cortex. The system forms acoustic signals from neural timing difference data.

One advantage of the system is its adaptability to each individual user. Human brains have some similarities, but they may vary in size, shape, number of convolutions, etc. The present system comprises components that may be calibrated and a library of acoustic signals that may be customized for each individual user. The system is advantageously configured to allow vision-impaired and/or hearing-impaired users to experience at least some visual and/or auditory sensations.

Another advantage of the system is that no invasive surgery is needed to assist a person, such as a blind or deaf person, to experience live or recorded images or sounds.

One embodiment of the system comprises a primary transducer array and a secondary transducer array. The primary transducer array acts as a coherent or nearly-coherent signal source. The secondary transducer array acts as a controllable, acoustic diffraction pattern that shapes, focuses and modulates energy from the primary transducer onto the neural cortex in a desired pattern. The secondary transducer emits acoustic energy that may be shifted in phase and amplitude relative to the primary array emissions.

The projected, ultrasonic sensory pattern of energy is configured such that each portion of the pattern projected into the neural cortex may be individually pulsed at low frequencies. The system produces low frequency pulsing by controlling the phase differences between the emitted energy of the primary and secondary transducer array elements. The ultrasonic signal pulsed at low frequencies affects the neural firing timing in the cortex. Even though a person may be blind or have his or her eyes closed, the person's visual cortex neurons are still firing. Changes in the neural firing timing induce various sensory experiences, depending on the altered firing time and the location of the neuron in the cortex. The mapping of some sensory areas of the cortex is known and used in current surgically invasive techniques. The present system induces recognizable sensory experiences by applying ultrasonic energy pulsed at low frequency in one or more selected patterns on one or more selected locations of the cortex. One aspect of the invention relates to a method of storing data related to acoustic signals configured to alter neural firing times in a brain. The method comprises non-invasively projecting a first acoustic signal into the brain. The first acoustic signal affects a neural firing time at a first neural location in the brain. The method stores a user sensory response and data related to the first acoustic signal in a memory. The method non-invasively projects a second acoustic signal into the brain, and stores a user sensory response and data related to the second acoustic signal in the memory.

Another aspect of the invention relates to a method of customizing a library of data related to acoustic signals configured to alter neural firing times in a brain. The method comprises retrieving data related to a first acoustic signal from a memory; projecting a first acoustic signal into the brain using the data related to a first acoustic signal, the first acoustic signal affecting a neural firing time at a first neural location in the brain; storing a user sensory response with the data related to the first acoustic signal in the memory; retrieving data related to a second acoustic signal from the memory; projecting a second acoustic signal into the brain using the data related to the second acoustic signal; and storing a user sensory response with the data related to the second acoustic signal in the memory.

Another aspect of the invention relates to a system of storing data related to acoustic signals configured to alter neural firing times in a brain. The system comprises a transducer system configured to non-invasively project a first acoustic signal and a second acoustic signal into the brain, the first and second acoustic signal affecting one or more neural firing times at one or more neural locations in the brain; a signal generator coupled to the transducer system; and a memory coupled to the signal generator. The memory is configured to store: data related to the first and second acoustic signals; and user sensory responses produced by the first and second acoustic signals. The signal generator is configured to select data in the memory related to signals configured to generate the neural firing time differences in the brain, the transducer system is configured to apply the signals to generate the neural firing time differences in the brain.

The present invention will be more fully understood upon consideration of the detailed description below, taken together with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates one embodiment of a system for generating sensory data onto a human neural cortex.

FIG. 2 illustrates a method for calibrating the system of FIG. 1 which generates sensory data onto a human neural cortex.

FIG. 3 illustrates a method of generating sensory data onto a human neural cortex with the system of FIG. 1.

Use of the same reference symbols in different figures indicates similar or identical items.

## DETAILED DESCRIPTION

FIG. 1 illustrates one embodiment of a system1120 for generating sensory data onto a human neural cortex. The system 120 comprises a receiving module 110, a processing module 101, a signal generator 102, a reference signal generator 103, a transducer system 106, a first signal line 104, a second signal line 105, a memory 140 and an input/output device 144. All of the components, except the memory 140 and the input/output device 144, are described in U.S. Pat. No. 6,536,440, which is assigned to the Assignee of the present invention, and is hereby incorporated by reference in its entirety.

One or more of the components illustrated in FIG. 1, such as the transducer system 106, may be specially configured to generate visual, audio, taste, smell and/or touch within the human neural cortex. In one embodiment, some or all of the components of FIG. 1 may be integrated in a light-weight, compact device that may be strapped to a user, e.g. in a backpack or belt pack.

In FIG. 1, the memory 140 is coupled to at least the signal generator 102 and./or the reference signal generator 103. The memory 140 may comprise any suitable type of memory that is preferably compact and adapted for fast memory access. The input/output device 144 is coupled to at least the memory 140. The input/output device 144 may comprise a keypad, a mouse, a display or other type of suitable input/output device that allows an administrator or user to calibrate the components of the system 120 and/or modify the data stored in the memory 140.

The memory 140 stores a library 142 of neural firing time data and/or neural firing time difference data. The system 120 uses the data in the library 142 to generate an acoustic signal or pattern which alters, e.g. speeds up or slows down, one or more neural firing times of the human brain 100A. The patterns may affect various portions of the brain 100A substantially simultaneously. For example, the transducer system 106 may use signal phase shifts between two ultrasonic sources, such as the primary and secondary transducer arrays 130, 132, to produce specific pulse patterns which modify the firing times of targeted neurons. In one embodiment, the transducer system 106 produces a high frequency pattern that is pulsed at low frequencies. Altering the neural firing times causes a user to perceive sensory experiences.

The resolution, color, accuracy and other characteristics of the generated sensory experiences may vary according to the type of transducers used, the amount of neural firing time data stored in the library 142, and the processing power and speed of the system 120. For example, high resolution may be achieved with a large amount of neural firing time data and transducer arrays configured to focus acoustic signals to very small areas of the brain 100A.

The neural firing time data is obtained by reversing or inverting the acts of a technique described in "Reconstruction of Natural Scenes from Ensemble Responses in the Lateral Geniculate Nucleus" by Garrett B. Stanley et al. in the Sep. 15, 1999 issue of the Journal of Neuroscience, which his hereby incorporated by reference in its entirety. Stanley et al. describes a technique of reconstructing spatiotemporal natural scenes by linearly decoding ensemble responses with the later geniculate nucleus (177 cells) of a cat. The present method and system reverses Stanley's technique in order to convert sensory data to neural firing time data and use a pattern of ultrasound signals based on the neural firing time data to alter neural firing times within the brain 100A. The altered neural firing times, i.e., neural firing time differences, generate sensory experiences for the user.

The use of single ultrasound pulses to modify nerve excitability is described in "Transient Modification of Nerve Excitability In Vitro by Single Ultrasound Pulses" by Mihran et al. found in the Department of Electrical and Computer Engineering, University of Colorado, 1990, paper #90-038, which is hereby incorporated by reference in its entirety. Human hearing and the action of ultrasound are described in "Human Hearing In Connection With The Action of Ultrasound In the Megahertz Range On The Aural Labyrinth" by L. R. Gavrilov in the Sov. Phys. Acoust. 26(4), July-August 1980, pages 290-292, which is hereby incorporated by reference in its entirety.

During the manufacture of the system 120, a manufacturer may configure and store data in the memory 140, as well as calibrate the components of the system 120. The library 142 may comprise pre-determined or tested data related to different signals which are categorized into groups, such as signals generating visual experiences, signals generating auditory experiences, signals generating tactile experiences, etc. The groups may be further sub-categorized based on the size, shape, bright or dark, color, duration, pitch, etc. of the sensory experiences.

The library 142 may be complete, partially incomplete or substantially empty after manufacturing. An administrator at a user site may use the input/output device 144 to modify or add data in the library 142 based on responses from a current user or a previous user of the system 120.

In one embodiment, there is a library of various signals that may be applied to each neural location of the brain 100A or a part of the brain, such as the visual cortex 100. For example, if there are 100 neural locations mapped, then there may be 100 libraries of signals. As used herein, a neural location may comprise a single neuron or a group of neurons.

In one embodiment, there is a library of various signals for each transducer element in the primary and secondary transducer arrays 130, 132. The transducer arrays 130, 132 may be two-dimensional or three-dimensional arrays. A desired ultrasonic pattern in the brain 100A generated by the primary and secondary transducer arrays 130, 132 (e.g. phased arrays) may be calculated by adding the waves generated by each transducer element.

FIG. 2 illustrates a method for calibrating or configuring the system 120 of FIG. 1 which generates sensory data onto a human neural cortex of a particular user's brain 100A. In a start block 200, the administrator attaches the transducer system 106 in FIG. 1 non-invasively to a user's head and powers on the system 120. In one embodiment, the transducer system 106 is positioned near the back of the user's head to be closer to the visual cortex 100. The transducer system 106 may be attached and removed by the administrator or the user.

In a block 202, the administrator causes the transducer system 106 to generate a high frequency acoustic signal(s)/pattern pulsed at low frequencies into the user's brain 100A shown in FIG. 1. An initial signal may be called a `test signal.`

In a block 204, the signal(s) affects, e.g. speeds up or slows down, one or more neural firing times in the user's brain 100A, such as the visual cortex 100.

In a block 206, the user describes a sensory experience to the administrator. For example, if the transducer system 106 is configured to generate sensory experiences in the visual cortex, the user may experience a flashing light, a ramp from a bright area to a dark area, or an object at a particular location of the user's simulated visual field. If the transducer system 106 is configured to generate sensory experiences in the cochlear channel, the user may experience a sound of a particular frequency, amplitude and duration.

In a block 208, the administrator may calibrate the system 120 based on the user's described sensory experience. For example, the administrator may calibrate the processing module 101, the signal generator 102, the reference signal generator 103 and/or the transducer system 106 based on the user's described sensory experience. If the signal was supposed to generate a bright white square in the top left comer of the user's simulated visual field, the administrator may calibrate the system 120 such that the user will perceive a bright white square the next time a signal is sent. The administrator may use the input/output device 144 or some other suitable device to calibrate the system 120.

Instead of or in addition to calibrating the system 120, the administrator may modify the data in the library 142 stored in the memory 140 based on the user's described sensory experience. The administrator may also enter new data associated with the primary and/or secondary transducer arrays 130, 132 into the library 142 with the input/output device 144.

In a block 210, the administrator may repeat the acts in blocks 200-208 a plurality of times to fill a partially incomplete library 142 and/or to achieve a level of sensory accuracy or resolution desired by the administrator or the user. Subsequent signals may vary in frequency, amplitude, duration and location. For example, the administrator may use the system 120 to create a map of various signals with various characteristics applied to various location of the brain 100A or a part of the brain 100A that corresponds to various perceived visual images.

In one embodiment, the administrator uses the system 120 to create a `visual field` of perceived visual `pixels` in memory 140 by testing a plurality of neural locations in the visual cortex 100. The `pixel` may vary from light to dark or from colored to non-colored. The administrator may use the system 120 to map several degrees of light or color intensity for each pixel. The resolution of the visual field depends on (i) the focusing capability of the transducer system 106, (ii) a number of different neural locations tested by the administrator, and (iii) a number of different neural firing time differences applied at each neural location by the administrator slightly altering the amplitude, frequency, etc. of the test signal. Thus, the system components and/or the library 142 may be customized to each individual user.

Data in a library 142 may be transferred from memory 140 to other memories or to a database. Various transfer methods may be used, including wire, cable, and wireless communications systems.

FIG. 3 illustrates a method of generating sensory data onto a human neural cortex. The system 120 may be configured to generate live or recorded images, videos, textual pieces, sounds, audio pieces, smells, taste and tactile sensations. In a block 300, the receiving module 110 of FIG. 1 receives a sensory input from a video camera or other source, such as a VCR, a DVD) player, a cable TV system, an Internet connection, etc. The sensory input may be transmitted by a wire or wireless communication system. For example, for a vision-impaired user, the video camera may be strapped on or near the user's head such that the angle of the camera changes as the user turns his or her head. Alternatively, the video camera may be configured to move according to a hand-controlled device, such as a computer game joy stick. The sensory input may comprise digital data or analog data. If the input data is analog, the proecssing module 101 may digitizc the input data.

In a block 302, the processing module 101 and/or the signal generator 102 calculates neural firing time differences for mapped locations of the visual cortex 100 based on the sensory input.

In a block 304, the signal generator 102 selects data in the library 142 that will be used by the transducer system 106 to generate signals and achieve the desired neural firing time differences in the brain 100A. In one embodiment, the signal generator 102 selects data from the library 142 related to at least one pulse shaping signal, e.g. phase shift, for each targeted location in the visual cortex 100. For example, if there are 900 targeted locations in the visual cortex 100, then the signal generator 102 selects an individual pulse shaping signal from the library 142 for each of the 900 neural locations. The selected signals may vary in amplitude, phase, and/or duration.

In a block 306, the signal generator 102 sums the selected pulse shaping signals into a final applied signal or pattern for the secondary transducer array 132.

In a block 308, the reference signal generator 103 may select a reference signal shaping based one or more factors, such as (1) the size, shape and configuration of the transducer system 106, and (2) the type of signals used by the secondary transducer array. The transducer system 106 may comprise a variety of transducer shapes, sizes, configurations, etc. Data related to various reference signals, including reference signals to generate a planar wave, may be stored in the library 142. The reference signals may be configured and stored by a manufacturer when the system 120 is manufactured and/or modified by an administrator at a user site.

The reference signals generated by the primary transducer array 130 may focus or shape the pattern generated by the secondary transducer array 132. The reference signals may vary in amplitude, phase, and/or duration from the signals selected by the signal generator 102.

In a block 310, the signal generator 102 applies a summed pulse-shaping signal to the secondary transducer array 132, and the reference signal generator 103 applies a reference signal to the primary transducer array 130. The transducer arrays 132, 130 generate a pulsed ultrasound signal(s) or pattern comprised of phase shifts to the brain 100A, and the user experiences a sensory experience based on the sensory input from the video camera or other input source. The generated sensory experience may be may not be exact, but the generated sensory experience at least gives the user an idea of the sensory input. For example, depending on the implementation, a user using the system 120 may be able to only `see` an outline of objects in front of the video camera.

In one embodiment, the ultrasound signals or pattern may be continuous, such that the user perceives a visual image in real-time as the video camera receives the image. In another embodiment, the ultrasound signals or pattern may be almost continuous, such that the user perceives a visual image in almost real-time, i.e., a string of snap shots, as the video camera receives the image.

Various types of memories, input/output devices, caches, controllers, registers and/or processing components may be used in accordance with the present invention. The scope of the present invention is not limited to a particular type of memory, input/output device, cache, controller, register and/or processing component. Various embodiments of the system 160 may comprise other components in addition to or instead of the components shown in FIG. 2 without departing from the scope of the invention. For example, the system 160 may comprise a sensory input device, additional memories, caches, controllers, registers and/or processing components.

The above-described embodiments of the present invention are merely meant to be illustrative and not limiting. *It will thus be obvious to those skilled in the art that various changes and modifications may be made without departing from this invention in its broader aspects.* The appended claims encompass all such changes and modifications as fall within the true spirit and scope of this invention.

# Again...

**"It will thus be obvious to those**
***skilled in the art***
**that various changes and modifications may be made without departing from this invention in its broader aspects."**

# Composite Strategy

II

# <u>C o m p o s i t e   S t r a t e g y</u>

## Natural & Sub Natural Strategy: *we communicate*

> We communicate so well that often I wonder what we're "Not" thinking. Composite Strategy and the meaing of communication is simply explained through a medley of sights, sounds and sensations. It can also mean anything else you want it to mean, or not. Something, nothing and whatever.Yes, no ..yes. No.
>
> *The Double Bind is one specific interpretation*

***Natural Strategies*** *are methods which induce hypnotic behavior and induce waking suggestion "Naturally"- as it would* <u>naturally</u> *occur in regular, everyday experience.* Natural Strategies are also the strategies we use to live our life, the ideas we have in our mental toolbox and which we use to make now a fine time. We can utilize knowledge of naturally occurring hypnotic states to hypnotize ourselves and each other. Natural Strategies are "Machine free" ways of induction. Natural Strategies induce hypnosis through natural means using either verbal and/or nonverbal contexts in communication. Consciously learning these methods require gaining a functional understanding of what governs hypnotic behavior to consciously induce hypnotic modification and test these Ideas. Typically people communicate unconsciously and may employ these strategies "Naturally" without knowing it. Examples are powerful preachers and politicians. **The utilization of naturally occurring mixed states of consciousness make it easy for anyone to develop mastery of hypnotic controls.** We can choose to create our own customized uptime strategy, avoiding downtime/Tranderivational search within ourselves. Utilizing communication at the content level instead of the process level (where analog messages are being marked out by the unconscious) allows us to act beneficially, easily keeping us focused. The whole point is self empowerment, we can do it!

***Sub-Natural Strategies*** *are those methods which induce hypnotic behavior and waking suggestion "Sub-naturally".* These types of strategies use machines and advanced scientific technology to hypnotize a subject. Sub-natural Strategies induce hypnosis by applying the laws of hypnosis, subliminal communication and para-psychophysical manipulation of the human nervous system. All together they form a purposeful " Invisible and Silent " way of modifying behavior and contexts. This type of strategy is usually kept top secret. Some argue that it's best if people were made to believe these strategies don't exist. It's research is old. As far back as the mid 1800's, E.H. Weber measured sensory experience and experimental findings bore a formula with his name. **The subliminal age was born soon after Fechner published Elements of Psychophysics in 1860**

***Composite Strategies*** *are those methods which induce hypnotic behavior and waking suggestion "Through a 6th sense."* This type of strategy uses highly advanced scientific technology to create an "Invisible, Silent and Lethal" force. Information is limited, thus we experience challenges with access and utilization of knowledge that's sensitive in nature to national security.

In 1959 IBM Israel begins operating in Tel Aviv. IBM is assigned Korean War-related projects including bombing-navigational systems for Air Force bombers, and giant high-speed electronic calculators for U.S. air defense. With the beginning of the Korean War, IBM places its U.S. facilities at the government's disposal.

In 2006 the Information Processing Technology Office (IPTO) of the Defense Advanced Research Projects Agency (DARPA) is moving on proposals to develop an ontology-based (sub)system that captures, stores, and makes accessible the flow of one person's experience in and interactions with the world in order to support a broad spectrum of associates/assistants and other system capabilities. The objective of this "LifeLog" concept is to be able to trace the "threads" of an individual's life in terms of events, states, and relationships."

Want to know more? I recommend:

**Necessary Illusions**:
*Thought Control in Democratic Societies*
by Noam Chomsky

The role of the media in a capitalist society is, far from being that of a 'watchdog' for the interests of the people, that of serving the needs of those already in power. This work applies the propaganda model developed by Chomsky and Edward Herman, revealing the crucial function of the media and the educated elite in *limiting* democracy in the US.

**How Real Is Real?:**
*Confusion, Disinformation & Communication*
by Paul Watzlawick

Our everyday traditional ideas of reality are delusions which we spend substantial parts of our daily life shoring up, even if we have to force-fit facts into our definition of reality instead of vice versa. There is no one reality, but many versions of it, some contradictory, but all of which are the result of the interaction of three principles or actions: confusion, disinformation and communication

## **A.I.R. -** *Automatic Instinctive Rapport:* Mastering Strategic Communication

Mastering A.I.R. *and building rapport unconsciously* takes skill, patience and more*. It's a gift…*

We learned that representational systems can be channeled through 4 tuples and that overlap combinations in unconscious processing can lead to hypnotic induction. We also learned that we can enable operatotions to use the Interspersal technique to produce effective "Hypnotic" opportunities to use with maximum operating efficiency. Mixed state communication using The Milton Model and Hypnotic Language Patterning both offer choices to the operator as to how best to manisfest desired behaviors in the subject.

> *"Double Binds, by contrast, offer possibilities of behavior that are outside the patient's usual range of conscious choice and control. Since the original formulation of the double bind (Bateson, Jackson, Haley, and Weakland, 1956) as a hypothesis about the nature and etiology of communication in schizophrenia, a number of authors have sought to utilize the concept of the double bind to understand and facilitate psychotherapy and hypnosis*
> (Haley, 1963; Watzlawick et al., 1967, 1974; Erickson and Rossi, 1975).

## **A.P.C. -** *Acoustic Psycho-Correction –*
Reports and Articles

The Defense News, Jan.11-17, 1993 article U.S. Explores Russian Mind-Control Technology by Barbara Opall stated, “Known as acoustic psycho-correction, the capability to control minds and alter behavior of civilians and soldiers may soon be shared with U.S. military, medical and political officials, according to U.S. and Russian sources. ...Therefore, the Russian authors have proposed a bilateral Center for Psycho-technologies where U.S. and Russian authorities could monitor and restrict the emerging capabilities.” During 1989 CNN aired a program on electromagnetic weapons and showed a U.S. government document that outlined a contingency plan to use EM weapons against "terrorists." Prior to the show a DoD medical engineer sourced a story claiming that in the context of conditioning, microwaves and other modalities had regularly been used against Palestinians.

In 1993, Defense News announced that the Russian government was discussing with American counterparts the transfer of technical information and equipment known as "Acoustic Psycho-correction." The Russians claimed that this device involves "the transmission of specific commands via static or white noise bands into the human subconscious without upsetting other intellectual functions." Experts said that demonstrations of this equipment have shown "encouraging" results "after exposure of less than one minute," and has produced "the ability to alter behavior on willing and unwilling subjects." The article goes on to explain that combined "software and hardware associated with the (sic) psycho-correction program could be procured for as little as U.S. $80,000." The Russians went on to observe that "World opinion is not ready for dealing appropriately with the problems coming from the possibility of direct access to the human mind."

Acoustic psycho-correction dates back to the mid 1970's and can be used to "suppress riots, control dissidents, demoralize or disable opposing forces and enhance the performance of friendly special operations teams." One U.S. concern in relation to this device was aired by Janet Morris of the Global Strategy Council, a Washington-based think tank established by former CIA deputy director Ray Cline. Morris noted that "Ground troops risk exposure to bone-conducting sound that cannot be offset by earplugs or other protective gear."

Dr. Becker was skilled in the art and worked for the CIA on U.S pilots shot down and captured by the Russians in the 1960s. Dr. Becker was asked by the CIA to determine if the pilots were exposed to emr similar to the Moscow Embassy microwave bombardment (from 1953 to 1976). The CIA was looking for an answer to the personality changes in the psychological tests given before and after their capture. Russian UN documents from the 1970s through the 1990s also support the video evidence, which stated that scientific evidence supports the fact that nonthermal effects could be developed for weapons. With the Pentagon's unveiling of the U.S. nonlethal weapons program , Dr. Becker's theory that the U.S. is running a very black and very large emr weapons program in the 1970s is well supported. Dr. Becker discussed the Moscow Embassy microwave bombardment by the Russians from 1953 to at least 1988, (AP, 1988, Reppert), and the Russian Woodpecker signal, used by the Russians to irradiate the U.S. beginning in 1977 and later verified at least to 1988. Dr. Becker and others suspected that the Russians were attempting to create health and psychological effects in the U.S. population from the emr. Check out some patents, start there…I dare you.

## ***More Recommended Reading:***
I recommend reading “The Perception of Speech / Handbook of Experimental Psychology/1951, J.C.R. LICKLIDER and G.A. MILLER” Why? Well because Miller was responsible for determining the limits of human <u>consciouness</u> while licklider is partly responsible for why I can type for you on this <u>computer.</u>

# *Colors of Noise*

- From Wikipedia Encyclopedia

There are many forms of noise with various frequency characteristics that are classified by "color". Some have well-defined technical definitions, while others are colloquial or jokes. Many of these definitions assume a signal with components at all frequencies, with a spectral density per unit of bandwidth proportional to $1/f^{\beta}$. For instance, white noise is flat, with $\beta = 0$,while brown noise is relative to $1/f^2$, with $\beta = 2$.

## *"Technically Defined"*

**White noise**
The most commonly used is white noise, a signal (or process) with a flat frequency spectrum. In other words, the signal has equal power in any band, at any center frequency, having a given bandwidth.

An infinite-bandwidth white noise signal is purely a theoretical construct. By having power at all frequencies, the total power of such a signal would be infinite. In practice, a signal is "white" if it has a flat spectrum over a defined frequency band.

**Pink noise**
The next most commonly used color is pink noise. Its frequency spectrum is not flat, but has equal power in bands that are proportionally wide. (As an example, white noise would have an equal amount of power in the band from 1 to 2 kHz as in the band from 2 to 3 kHz. Pink noise would have equal power in the band from 1 to 2 kHz as in the band from 2 to 4 kHz.) Pink noise is perceptually white. That is, the human auditory system perceives approximately equal magnitude on all frequencies. The power density decreases by 3 dB per octave (density proportional to $1/f$).

**Blue (or azure) noise**
Blue noise's (FS-1037C) power density increases 3 dB per octave with increasing frequency (density proportional to $f$) over a finite frequency range. This can be good noise for dithering.

**Purple (or violet) noise**
Purple noise's power density increases 6 dB per octave with increasing frequency (density proportional to $f^2$) over a finite frequency range. Differentiated white noise. Also known as violet noise.

**Grey noise**
Grey noise is noise subjected to a psychoacoustic equal loudness curve (such as an inverted A-weighting curve) over a given range of frequencies, so that it sounds like it is equally loud at all frequencies. Some say this would be a better definition of "white noise" than the "equal power at all frequencies" definition, since real "white light" has the power spectrum of a 5400 K black body, not an equal power spectrum

Various noise models are employed in analysis, many of which fall under the above categories. AR noise or "autoregressive noise" is such a model, and generates simple examples of the above noise types, and more.

## *"Less official"*

There are also many "less official" colors.

**Red noise**

Red noise has more than one definition:

1. A synonym for brown noise, as above
2. A synonym for pink noise, as above [1]
3. Oceanic ambient noise (i.e., noise distant from the sources) is often described as "red" due to the selective absorption of higher frequencies by the ocean. (Common definition within the oceanographic field, contributed to a newsgroup by P.J. "Josh" Rovero.)

**Orange noise**

Orange noise is quasi-stationary noise with a finite power spectrum with a finite number of small bands of zero energy dispersed throughout a continuous spectrum. These bands of zero energy are centered about the frequencies of musical notes in whatever scale is of interest. Since all in-tune musical notes are eliminated, the remaining spectrum could be said to consist of sour, citrus, or "orange" notes. "Orange noise is most easily generated by a roomful of primary school students equipped with plastic soprano recorders."

**Green noise**

Green noise is supposedly the background noise of the world. A really long term power spectrum averaged over several outdoor sites. Rather like pink noise with a hump added around 500 Hz.

**Black noise**

Black noise, or silent noise, has several different definitions:

1. Silence
2. Noise with a $1/f^{-\beta}$ spectrum, with $\beta > 2$ (Manfred Schroeder, "*Fractals, chaos, power laws*"). Used in modeling various environmental processes. Is said to be a characteristic of "natural and unnatural catastrophes like floods, droughts, bear markets, and various outrageous outages, such as those of electrical power." Further, "because of their black spectra, such disasters often come in clusters."
3. Whatever comes out of an active noise control system and cancels an existing noise, leaving the world noise free. The comic book character Iron Man used to have a "black light beam" that could darken a room like this, and popular sci-fi has a tendency to portray active noise control in this light.
4. As seen in the sales literature for an ultrasonic vermin repeller, black noise with a power density that is constant for a finite frequency range above 20 kHz. More accurately, ultrasonic white noise. This black noise is like the so-called black light with frequencies too high to be sensed, but still capable of affecting the environment.

**Mains hum**

AC-powered appliances can give off a characteristic hum at multiples of the frequency of AC power that they use. This noise is normally an unwanted signal. It has a very specific spectrum: 50/60 Hz (whatever the AC frequency is) plus harmonics.

## **2017**: House Select Committee on Assassinations

*Author Unknown*

In 1975, Frank Church became the chairman of the Select Committee to Study Governmental Operations with Respect to Intelligence Activities. This committee investigated alleged abuses of power by the Central Intelligence Agency and the Federal Bureau of Investigation.

The committee looked at the case of Fred Hampton and discovered that William O'Neal, Hampton's bodyguard, was a FBI agent-provocateur who, days before the raid, had delivered an apartment floor-plan to the Bureau with an "X" marking Hampton's bed. Ballistic evidence showed that most bullets during the raid were aimed at Hampton's bedroom.

Church's committee also discovered that the Central Intelligence Agency and Federal Bureau of Investigation had sent anonymous letters attacking the political beliefs of targets in order to induce their employers to fire them. Similar letters were sent to spouses in an effort to destroy marriages. The committee also documented criminal break-ins, the theft of membership lists and misinformation campaigns aimed at provoking violent attacks against targeted individuals.
One of those people targeted was Martin Luther King. The FBI mailed King a tape recording made from microphones hidden in hotel rooms. The tape was accompanied by a note suggesting that the recording would be released to the public unless King committed suicide.

In September, 1975, a subcommittee under Richard Schweiker was asked to investigate the performance of the intelligence agencies concerning the assassination of John F. Kennedy.

In its final report, issued in April 1976, the Select Committee to Study Governmental Operations with Respect to Intelligence Activities concluded: “Domestic intelligence activity has threatened and undermined the Constitutional rights of Americans to free speech, association and privacy. It has done so primarily because the Constitutional system for checking abuse of power has not been applied.” The committee also revealed details for the first time of what the CIA called Operation Mockingbird.

The committee also reported that the Central Intelligence Agency had withheld from the Warren Commission, during its investigation of the assassination of John F. Kennedy, information about plots by the Government of the United States against Fidel Castro of Cuba; and that the Federal Bureau of Investigation had conducted a counter-intelligence program (COINTELPRO) against Martin Luther King and the Southern Christian Leadership Conference.

In 1976 Thomas N. Downing began campaigning for a new investigation into the assassination of John F. Kennedy. Downing said he was certain that Kennedy had been killed as a result of a conspiracy. He believed that the recent deaths of Sam Giancana and Johnny Roselli were highly significant. He also believed that the Central Intelligence Agency and the Federal Bureau of Investigation had withheld important information from the Warren Commission. Downing was not alone in taking this view. In 1976, a *Detroit News* poll indicated that 87% of the American population did not believe that Lee Harvey Oswald was the lone gunman who killed Kennedy.

Coretta Scott King, was also calling for her husband's murder to be looked at by a Senate Committee. It was suggested that there was more chance of success if these two investigations could be combined. Henry Gonzalez and Walter E. Fauntroy joined Downing in his campaign and in 1976 Congress voted to create a 12-member committee to investigate the deaths of Kennedy and King.

Thomas N. Downing named Richard Sprague as chief counsel of the House Select Committee on Assassinations. Gaeton Fonzi was to later say: "Sprague was known as tough, tenacious and independent. There was absolutely no doubt in my mind when I heard of Sprague's appointment that the Kennedy assassination would finally get what it needed: a no-holds-barred, honest investigation. Which just goes to show how ignorant of the ways of Washington both Sprague and I were".

Sprague quickly assembled a staff of 170 lawyers, investigators and researchers. On 8th December, 1976, Sprague submitted a 1977 budget of $6.5 million. Frank Thompson, Chairman of the House Administration Committee made it clear he opposed the idea of so much money being spent on the investigation.

Smear stories against Sprague began appearing in the press. David B. Burnham of *The New York Times* reported that Sprague had mishandled a homicide case involving the son of a friend. Members of Congress joined in the attacks and Robert E. Bauman of Maryland claimed that Sprague had a "checkered career" and was not to be trusted. Richard Kelly of Florida called the House Select Committee on Assassinations a "multimillion-dollar fishing expedition for the benefit of a bunch of publicity seekers."

Probably the most important criticism came from Eldon J. Rudd of Arizona, a former FBI agent who had worked on the original investigation into the assassination of John F. Kennedy, declared the Committee had "already fanned the flames of rumor, distortion and unwanted distrust of law enforcement agencies." However, Walter E. Fauntroy defended the work of Sprague: "threshold inquiries by a thoroughly professional staff... in the last three months have produced literally a thousand questions unanswered by the investigations of record."

On 2nd February, 1978, Henry Gonzalez replaced Thomas N. Downing as chairman of the House Select Committee on Assassinations. Gonzalez immediately sacked Sprague as chief counsel. Sprague claimed that only the fill committee had the power to dismiss him. Walter E. Fauntroy agreed with Sprague and launched a campaign to keep him as chief counsel. On 1st March, Gonzalez resigned describing Sprague as "an unconscionable scoundrel" Louis Stokes of Ohio was now appointed as the new chairman of the House Select Committee on Assassinations. After a meeting with Stokes on 29th March, Sprague agreed to resign and he was replaced by G. Robert Blakey.

Sprague later told Gaeton Fonzi that the real reason he was removed as chief counsel was because he insisted on asking questions about the CIA operations in Mexico. Fonzi argued that "Sprague... wanted complete information about the CIA's operation in Mexico City and total access to all its employees who may have had anything to do with the photographs, tape recordings and transcripts. The Agency balked. Sprague pushed harder. Finally the Agency agreed that Sprague could have access to the information if he agreed to sign a CIA Secrecy Agreement. Sprague refused.... "How," he asked, "can I possible sign an agreement with an agency I'm supposed to be investigating?"

Two subcommittees were created - a subcommittee on the assassination of President John F. Kennedy, with Richardson Preyer of North Carolina as its chairman, and a subcommittee on the assassination of Martin Luther King, with Walter E. Fauntroy, Delegate of the District of Columbia, as its chairman. The staff was divided into two task forces designated to assist each of the subcommittees.

The House Select Committee of Assassinations set up a panel of forensic pathologists to examine the autopsy materials and other medical evidence. Most of the members concluded that two bullets, both fired from the rear, struck Kennedy. However, one member, Cyril H. Wecht, rejected this theory claiming it was medically impossible, and suggested that at least one bullet had been fired from the right front.

During the investigation the committee discovered that the Dallas Police had a recording of the assassination. A microphone, mounted on one of the motorcycles escorting the motorcade, had picked up sounds in Dealey Plaza at the time of the assassination. Acoustic experts analysed the recording and were able to distinguish four rifle shots. They concluded that there was a 95 per cent probability of the third bullet was fired from the Grassy Knoll.

As a result of this acoustic evidence G. Robert Blakey was able to state that there were "four shots, over a total period of 7.91 seconds were fired at the Presidential limousine. The first, second and fourth came from the Depository; the third from the Grassy Knoll."

The House Select Committee on Assassinations concluded that "scientific acoustical evidence establishes a high probability that two gunmen fired at President John F. Kennedy." It added that "on the basis of the evidence available to it, that President John F. Kennedy was probably assassinated as a result of a conspiracy.

The HSCA was "unable to identify the other gunman or the extent of the conspiracy." However, it did discover evidence to suggest that anti-Castro Cubans were involved in the assassination. For example, an undercover agent heard Nestor Castellanos tell a meeting of anti-Castro Cubans, "We're waiting for Kennedy (on) the 22nd. We're going to see him in one way or another." The committee also obtained evidence that Lee Harvey Oswald met David Ferrie in New Orleans in the summer of 1963. It concluded that "individuals active in anti-Castro activities had the motive, means, and opportunity to assassinate President Kennedy".

The committee claimed that the Warren Commission "failed to investigate adequately the possibility of a conspiracy to assassinate the President." The report was also highly critical of the Secret Service: "The Secret Service was deficient in the performance of its duties. The Secret Service possessed information that was not properly analyzed, investigated or used by the Secret Service in connection with the President's trip to Dallas; in addition, Secret Service agents in the motorcade were inadequately prepared to protect the President from a sniper."

The House Select Committee on Assassinations refused to publish all the documents obtained during the investigation. The CIA forced all members of the committee, all staff members, all consultants to the committee, and several independent researchers involved in the investigation, to sign a Nondisclosure Agreement. As Richard E. Sprague, one of the consultants later explained: "First, it binds the signer, if a consultant, to never reveal that he is working for the committee. Second, it prevents the signer from ever revealing to anyone in perpetuity, any information he has learned about the committee's work as a result of working for the committee. Third, it gives the committee and the House, after the committee terminates the power to take legal action against the signer, in a court named by the committee or the House, in case the committee believes the signer has violated the agreement. Fourth, the signer agrees to pay the court costs for such a suit in the event he loses the suit."

It has been announced that all House Select Committee on Assassinations documents will be published by *2017*.

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A

ABORN, M. and RUBENSTEIN, H. (1952). Information theory and immediate recall. J. exp. Psychol. 44, 260-266.

ADELSON, M. (1955). Some observations on a delayed-feedback self-tracking task. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

ADELSON, M., MUCKLER, F.A. and WILLIAMS, A.C., Jr. (1955). Verbal learning and message variables related to amount of information. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

AHRENDT, W.R. and TAPLIN, J.F. (1947). Automatic regulation - a discussion of fundamentals. (Preliminary edition.) Washington: U.S. Library of Congress.

AHRENDT, W.R. and TAPLIN, J.F. (1951). Automatic feedback control. New York: McGraw-Hill.

ALEXANDER, L.T. and GARNER, W.R. (1952). Information transmission in a tracking task. Amer. Psychologist, 7, 276.

ALLANSON, J.T. (1955). Some properties of a randomly connected neural network. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

ALLANSON, J.T. and WHITFIELD, I.C. (1955). The cochlear nucleus and its relation to theories of hearing. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

ALLUISI, E.A., MULLER, P.F. and FITTS, P.M. (1955). Rate of handling information and the rate of information presentation. USAF WADC Tech. Note No. 55-745, iv

ASHBY, W.R. (1946a). The behavioural properties of systems in equilibrium. Amer. J. Psychol. 59, 682-686.

ASHBY, W.R. (1946b) Principles for the quantitative whole system; with some applications to the nervous system. J. ment. Sci. 92, 319-323.

ASHBY, W.R. (1947a). Dynamics of the cerebral cortex - automatic development of equilibrium in self-organization systems. Psychomet. 12, 135.

ASHBY, W.R. (1947b). Dynamics of the cerebral cortex. XIII - Inter-relations between stabilities of parts within a whole dynamic system. J. comp. physiol. Psychol. 40, 1.

ASHBY, W.R. (1947c). The nervous system as a physical machine, with special reference to the origin of adaptive behaviour. Mind, 56, 44.

ASHBY, W.R. (1947d). Principles of the self-organizing dynamic system. J. gen. Psychol. 37, 125-128.

ASHBY, W.R. (1948). The homeostat. Electron. 20, 380.

ASHBY, W.R. (1950a) The cerebral mechanism of intelligent action. In D. Richter (Ed.), Perspectives in neuropsychiatry .London: H.K. Lewis.

ASHBY, W.R. (1950b). Cybernetics. In G.W.T.H. Fleming (Ed. ), Recent progress in psychiatry-2. J. ment. Sci. Suppl.

ASHBY, W.R. (1950c). The stabilityof a randomly assembled nerve-network. EEG clin. Neurophysiol. 2, 471-482.

ASHBY, W.R. (1952a). Can a mechanical chess-player outplay its designer? Brit. J. Phil. Sci. 3, 44

ASHBY, W.R. (1952b). Design for a brain. London: Chapman and Hall.

ASHBY, W.R. (1953a.). Homeostasis. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

ASHBY, W.R. (1953b). Mechanical chess player. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

ASHBY, W.R. (1954). The application of cybernetics to psychiatry. J. ment. Sci. 100, 114-124.

ASHBY, W.R. (1956a). Design for an intelligence-amplifier. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, NJ.: Princeton Univer. Press.

ASHBY, W.R. (1956b). The effect of experience on a determinate dynamic system. Behav. Sci. 1, 35-42.

ASHBY, W.R. (1956c). An introduction to cybernetics. London: Chapman and Hall.

ATTNEAVE, F. (1954). Some informational aspects of visual perception. Psychol. Rev. 61, 183-193. Also (1954) USAF Pers. Train. Res. Cent. Bull. No.54-59.

ATTNEAVE, F. (1955a). The estimation of transmitted information when conditional probabilities are interdependent. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

ATTNEAVE, F. (1955b). Symmetry, information and memory for patterns. U.S.A.F. Personn. Train. Res. Cent. Rep. No. TN-55-29. Also (1955) Amer. J. Psychol. 68, 209-222.

AUGENSTINE, L. (1953a). Information and thermodynamic entropy. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

AUGENSTINE, L. (1953b). Remarks on Pauling's protein models. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

AUGENSTINE, L. (1953c). Structural interpretations of denaturation data. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

AUGENSTINE, L. (1955a). Evidence of periodicities in human task performance. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

AUGENSTINE, L. (1955b). The use of ILLIAC in determining distributions for information functionals. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

AUGENSTINE, L., BLANK, A.A. and WAYNER, M. (1955). Human performance in information transmission. Technical report No. 69, Control Systems Laboratory, Univer. of Illinois, Urbana.

AUGENSTINE, L., BRANSON, H.R. and CARVER, E.B. (1953). A search for inter- symbol influences in protein structure. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

B

BABBAGE, H.P. (1889). Babbage's calculating engines. London: Spon.

BAER, R.M. (1953a). Biological systems and information dynamics. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

BAER, R.M. (1953b). Some general remarks on information theory and entropy. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

BAKAN, D. (1953). Learning and the principle of inverse probability. Psychol. Rev. 60, 360-370.

BAR-HILLEL, Y. (1952). The present state of research on mechanical translation. Amer. Doc. 2, 4.

BAR-HILLEL, Y. (1953). Some linguistic problems connected with machine translation. Phil. Sci. 20, 217-225.

BAR-HILLEL, Y. (1954). Can translation be mechanized? Amer. Scientist. 42, 248-260.

BAR-HILLEL, Y. (1955a). An examination of information theory. Phil. Sci. 22, 86-105.

BAR-HILLEL, Y. (1955b). Semantic information and its measures. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the tenth conference. New York: Josiah Macy, Jr. Foundation.

BAR-HILLEL, Y. and CARNAP, R. (1953) Semantic information. Technical report No. 247, Research Laboratory of Electronics. M.I.T. Also (1953) Brit. J. Phil. Sci. 4, 147-157. Also (1953) in W. Jackson (Ed), Communication theory, second London symposium. London: Butterworths.

BARNARD, C.I. (1948). Functions of the executive. Cambridge, Mass: Harvard Univer. Press.

BARNARD, G.A. (1951). The theory of information. J. roy. statist. Soc. B 13, 46.

BARNARD, G.A. (1955). Simple proofs of simple cases of the coding theorem. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

BARRETT, E. (1950). Cybernetics as applied to a study of normal and abnormal adjustment mechanisms. J. Psychol. 30, 11-31.

BARRETT, E. and POST, G. (1950). Introduction to some principles of applied cybernetics. J. Psychol. 30, 3-10.

BARRETT, F.D. and SHEPARD, H.A. (1953). A bib1iography of cybernetics. Proc. Amer. Acad. Arts and Sci., 80, 3, 204-222.

BARTLETT, M.S. (1949). Probability in logic, mathematics and science. Dialectica, 3, 104-112.

BARTLETT, M.S. (1950). The statistical approach to the analysis of time-series. In Information theory, first London symposium. London: Ministry of Supply, Mimeographed. 81-102.

BATES, J.A.V. (1950). Significance of information theory to neurophysiology. In Information theory, first London symposium London: Ministry of Supply, mimeographed, 137-143.

BATESON, G. (1949). Bali - the value system of a steady state. In Meyer Fortes (Ed.), Social structure - studies presented to A.R. Radcliffe-Brown. Oxford: Clarendon Press.

BATESON, G. (1953). The position of humor in human communication. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

BAVEIAS, A. (1948). .A. mathematical model for group structures. Appl. Anthrop. 7, 3, 16.

BAVELAS, A. (1950). Communication patterns in task-orientated groups. J. acoust. Soc. Amer. 22, 6, 725-730.

BAVELAS, A. (1952). Communication patterns in problem-solving groups. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

BAVELAS, A. and BARRET, D. (1951). An experimental approach to organizational communication. Personnel (April).

BAVELAS, A. et al. (1950). Human communications systems. Quarterly progress report, Research Laboratory of Electronics, M I T., July, 81-86.

BELL, D.A. (1950). The relevance of entropy to information. Read at U.R.S.I. meeting, Zurich, Sept.

BELL, D.A. (1953a). Information theory and its engineering applications. London: Pitman.

BELL, D.A. (1953b). The 'internal information' of English words. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

BELL, D.A. and ROSS, S.C. (1955). Negative entropy of Welsh words. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

BENDIG, A.W. (1953). Twenty questions - an information analysis. J. exp. Psychol. 46, 345-348.

BENDIG, A.W. (1954). Transmitted information and the length of rating scales. J. exp. Psychol. 47, 303-308.

BENDIG, A.W. and HUGHES, J.B. (1953) Effect of amount of verbal anchoring and number of rating scale categories upon transmitted information. J. Exp. Psychol. 46, 87-90.

BERKELEY, E.C. (1949). Giant brains. New York: Wiley.

BERKELEY, E.C. (1950a). The relations between symbolic logic and large-scale calculating machines. Science, 112, 395-399.

BERKELEY, E.C. (1950b). Simple Simon. Sci. Amer. 183, 5.

BERNE, E. (1953). Concerning the nature of communication. Psychiat. Quart. 27, 185-198.

BERRY, J. (1953). Some statistical aspects of conversational speech. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

BIRCH, H.G. (1952). Communication between animals. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

BIRDSALL, T.G. (1955). The theory of signal detectability. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

BIRMINGHAM, H.P. and TAYLOR, F.V. (1954). A design philosophy for man-machine control systems. Proc. I.R.E 42, 1748-1758.

BLACK, H.S. (1934). Stabilised feedback amplifiers. Elec.Engng, 53, 114.

BLACK, J.W. (1954). The information of sounds and phonetic digrams of one- and two- syllable words. US Naval Sch. Aviat. Med. Res. Rep., Project No. NM 001 064.01.22. Also (1954) J. Speech Hearing Disorders, 19, 397-411.

BLANC-LAPIERRE, A. (1953). Application to optics of certain results and methods of information theory .In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

BLANK, A.A. and QUASTLER, H. (1954). Notes on the estimation of information measures. Technical report No. R-56, Control Systems Laboratory, Univer. of Illinois, Urbana.

BLUNDELL, P.H. (1953). The definition. of rate of information in the presence of noise. In W. Jackson (Ed.), Communication theory, second. London symposium. London: Butterworths.

BODE, H.W. (1945). Network analysis and feedback amplifier design. New York: Van Nostrand.

BODE, H.W. and SHANNON, C.E. (1950). A simplified derivation of linear least square smoothing and prediction theory. Proc. I.RE. 38, 4l7-425.

BODMER, F. (1943). The loom of language. London: Allen and Unwin.

BONNELL, K.E. (1950). 'Feed-back' and 'hunting' as human behaviour. Etc. Rev. gen. Semant. 7, 210-212.

BOOTH, A.D. (1954). Calculating machines and mechanical translation. Discovery, 15, 280-285.

BOOTH, A.D. (1955). Influence of context on translation. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

BOOTH, A.D. and BOOTH, K.H.V. (1953). Automatic digital computers. London: Butterworths.

BOWMAN, J.R. (1953). Reduction of the number of possible Boolean functions. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

BRAGDON, D.E., NAIBANDOV, O. and OSBORNE, J.W. (1953). The control of the blood sugar level. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

BRANSON, H.R. (1953a). A definition of information from the thermodynamics of irreversible processes. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

BRANSON, H.R. (1953b). Information theory and the structure of proteins. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

BRAZIER, M.A.B. (1950a). Neural nets and the integration of behaviour. In D. Richter (Ed.), Perspectives in neuropsychiatry. London: H.K. Lewis.

BRAZIER, M.A.B. (1950b). A neuronal basis for ideas. Dialectica, 4, 237-241.

BRICKER, P.D. (1955). Information measurement and reaction time. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

BRIDGMAN, P.W. (1950-51). The operational aspect of meaning. Synthese, 8, 251-259.

BRILLOUIN, L. (1949). Life, thermodynamics and cybernetics. Amer. Scientist, 37, 554-568.

BRILLOUIN, L. (1950). Thermodynamics and information theory. Amer. Scientist, 38, 594-599.

BRILLOUIN, L. (1951a). Information theory and most efficient codings for communication or memory devices. J. appl. Physics, 22, 9, 1108-1111.

BRILLOUIN, L. (1951b). Maxwell's demon cannot operate - information and entropy. I. J. appl. Physics, 22, 3, 334-337.

BRILLOUIN, L. (1951c). Physical entropy and information. II. J. appl. Physics, 22, 3, 338-343.

BRILLOUIN, L. (1956). Science and information theory. New York: Academic Press.

BROADBENT, D.E. (1955). The concept of capacity and the theory of behaviour. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

BROSIN, H.W. (1953). Information theory and clinical medicine (psychiatry). In R.A. Patton (Ed.), Current trends in information theory, 140-188. Pittsburgh, Pa.: Univer.of Pittsburgh Press.

BROWN, G.S. (1955). Chance and control - some implications of randomization. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

BROWN, G.S. and CAMPBELL, D.P. (1948). Principles of servomechanisms - dynamics and synthesis of closed loop control systems. New York: Wiley.

BROWNLEE, K.A. (1955). Comments on McGill's paper (1955a). In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

BRUCE, D.J. (1955). Effects of context upon intelligibility of heard speech. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

BURKS, A.W. and WRIGHT, J.B. (1953). Theory of logical nets. Proc. I.R.E. 41, 10, 157-1365.

BURTON, A.C. (1939). The properties of. the steady state as compared to those of equilibrium as shown in characteristic biological behavior. J. cell. comp. Physiol. 14, 327.

BURTON, N.G. and LICKLIDER, J.C.R. (1955). Long-range constraints in the statistical structure of printed English. Amer. J. Psychol. 68, 650-655.

BUSH, R.R. and MOSTELLER, F. (1951). A mathematical model for simple learning. Psychol. Rev. 58, 313.

BUSH, R.R. and MOSTELLER, F. (1955). Stochastic models for learning. New York: Wiley. Also London: Chapman and Hall.

***C***

CANNON, W. (1923). The wisdom of the body. New York: Norton.

CECCATO, S. and MARETTI, E. (1955). Suggestions for mechanical translation. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

CECCATO, S. and MARETTI, E. (1956). Construction of a. translating machine. Methodos, 8.

CHAO, Y.R. (1955). Meaning in language and how it is acquired. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and socia.l systems. Transactions of the tenth conference. New York: Josiah Macy, Jr. Foundation.

CHAPANIS, A. (1954). The reconstruction of abbreviated printed messages. J. exp. Psychol. 48, 496-510.

CHAPPLE, E.D. (1940). Measuring human relations - an introduction to the study of the interaction of individuals. Genet. Psychol. Monogr. 22, 1-147

CHERRY, E.C. (1950). The.history of the theory of information. In Information theory, first London symposium. London: Ministry of Supply, 22-24. Also (1951), Proc. I.E.E. 98, 383. Also as Cherry (1952).

CHERRY, E.C. (1952) The communication of information - an historical review. Amer. Scientist, 4), 641-664; 724-725.

CHERRY, E.C. (1954a). On the mathematics of social communication. Int. soc. Sci. Bull. 6, 591-609.

CHERRY, E.C. (1954b). Organisms and mechanisms. Advancement of Sci. 40, 393.

CHERRY, E.C. (1955). 'Communicatian theory' - and human behaviour. In University College London, Communication research centre, Studies in communication. London: Secker and Warburg.

CHERRY, E.C. (1957a). On human communication - a review, a survey, and a criticism. New York: Wiley.

CHERRY, E.C. (1957b) Minds and machines. II - The present state of brain models. B.B.C. Third programme talk, reported in The Listener, Jan 3.

CHERRY, E.C. and GOURIET, G.G. (1953). Some possibilities for the compression of television signals by recoding. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

CHERRY, E.C., HALLE, M. and JAKOBSON, R. (1953). Toward the logical description of languages in their phonemic aspect. Language, 29, 34.-36.

CHURCH, A. (1936). An unsolvable problem of elementary number theory. Amer. J. Math. 58, 345-363.

CHURCHMAN, C.W. and ACKOFF, R.L. (1947). An experimental definition of personality. Phil. Sci. 14, 304-332.

CHURCHMAN, C.W. and ACKOFF, R.L. (1950). Purposive behaviour and cybernetics. Soc. Forces, 29, 1, 32- 39.

CLAVIER, A.G. (1948). Evaluation of transmission efficiency according to Hartley's expression of information content. Elec. Comm. 25, 414.

CLEAVE, J.P. (1955). A programme for Braille transcription. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

COBURN, H.E. (1951). The brain analogy. Psychol. Rev. 58, 155-178.

COBURN, H.E. (1952). The brain analogy - a discussion. Psychol. Rev. 59, 6, 453.

COHEN, F. ( ). Some analytical and practical aspects of Wiener's theory of prediction. Technical Report No.69. Research Laboratory of Electronics, M.I.T.

COHN, S.H. (1953). The role of cybernetics in physiology. Sci. Mon., N.Y., 76, 85-89.

COSSA, P. (1950). La cybernetique ou l'art de tenir le mecanisme pour demontre. (Cybernetics or the art of holding mechanism for demonstration.) Ann. med.-psychol. 2,1-10.

COSSA, P. (1955). La cybernetique - "Du cerveau humain aux cerveaux artificiels". (Cybernetics - "From human brain to artificial brains.") Paris: Masson.

COYLE, G.L. (1930). The social process in organised groups. New York: Smith.

CRAIK, K.J.W. (1947). Theory of the human operator in control systems. I - The operator as an engineering system. Brit. J. Psychol. 38, 56-61.

CRAIK, K.J.W. (1948). Theory of the human operator in control systems. II - Man as an element in a control system. Brit. J. Psychol. 38, 142-148.

CRONBACH, L.J. (1953). A consideration of information theory and utility theory as tools for psychometric problems. Bureau of Educational Research, Univer. of Illinois.

CRONBACH, L.J. (1955). On the non-rational application of information measures in psychology. In H. Quastler (Ed.) Information theory in psychology. Glencoe, Ill.: Free Press.

CROSSMAN, E.R.F.W. ( ). The measurement of discrimination.

CROSSMAN, E.R.F.W. (1953). Entropy and choice time - the effect of frequency unbalance on choice-response. Quart. J. exp. Psychol. 5, 41-51.

CROZIER, W.J. (1951). Physiology and computation devices. In Proceedings of a second symposium on large-scale digital calculating machinery. Cambridge, Mass.: Harvard Univer. Press.

CULBERTSON, J.T. (1950). Consciousness and behaviour - a neural analysis of behaviour and of consciousness. Dubuque, Ia: Brown

CULBERTSON, J.T. (1952). Hypothetical robots. RAND Project P-296.

CULBERTSON, J.T. (1956). Some uneconomical robots In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton: Princeton Univer. Press. D

DANCOFF, S.M. and QUASTLER, H. (1953). The information content and error rate of living things. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

DAVID, H.T. et al. ( ). Sampling distributions for information functions. Report of Control Systems Laboratory, Univer. of Illinois, Urbana.

DAVIS, H. (1952). Information theory, 3 - Applications of information theory to research in hearing. J. Speech Hearing Disorders. 17, 189-197.

DAVIS, H.M. (1948). Mathematical machines. Sci. Amer. 180, 4, 29-40.

DAVIS, K.H., BIDDULPH, R. and BALASHEK, S. (1953). Automatic recognition of spoken digits. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

DAVIS, M.D. (1956). A note on universal Turing machines. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton: Princeton Univer. Press.

de LATIL, P. (1953). La Pensee artificielle -Introduction a la cybernetique. (Artificial thought - Introduction to cybernetics.) Paris: Gallimard.

de LEEUW, K., MOORE, E.F., SHANNON, C.E. and SHAPIRO, N. (1956). Computability of probabilistic machines. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J: Princeton Univer. Press.

DEININGER, R.I. and FITTS, P.M. (1955). Stimulus-response compatibility, information theory and perceptual-motor performance. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

DELORAINE, E. (1949). Pulse modulation. Proc. I.R.E. 37, 702-705.

DELPECH, L. (1953). Psychanalyse et cybernetique. (Psychoanalysis and cybernetics). Prox. XIth Int. Congr. Phil. 7, 155-161.

DEMPSEY, E.W. (1951). Homeostasis. In S.S. Stevens (Ed.), Handbook of experimental psychology. New York: Wiley.

DENBIGH, K.G. (1948). The kinetics of open reaction systems. Trans. Faraday Soc. 44, 158-163.

DEUTSCH, J.A. (1953). A new type of behaviour theory. Brit. J. Psychol, 44, 304-317.

DEUTSCH, J.A. (1954). A machine with insight. Quart. J. exp. Psychol. 6, 6-11

DEUTSCH, K. W. (1953a). Nationalism and social communication. Cambridge, Mass: Technology Press.

DEUTSCH, K.W. (1948/9). Some notes on research on the role of models in the natural and social sciences. Synthese, 7, 506-533.

DEUTSCH, K.W. (1949a). Innovation, entrepreneurship, and the learning process. In Change and the entrepreneur. Cambridg, Mass: Harvard Univer. Press.

DEUTSCH, K.W. (1949b). Some notes on research on the history of entrepreneurship, innovation and decision-making. In Explorations in entrepreneurial research, 8-16.

DEUTSCH, K.W. (1950a). Higher education and the unity of knowledge. In Goals for American education, ninth conference symposium on science, philosophy and religion. New York: Harper.

DEUTSCH, K.W. (1950b). Nationalism, communication and community. In Perspectives on a troubled decade, tenth conference syrnposium on science, philosophy and religion. New York: Harper.

DEUTSCH, K.W. (195la). Mechanism, organism, and society - some models in natural and social science. Phil. Sci. 18, 230-252.

DEUTSCH, K.W. (1951b). Mechanism, teleology, and mind - the theory of communications and some problems in philosophy and social science. Phil. phenomenol. Res. 12, 185-223.

DEUTSCH, K.W. (1952a). Communication theory and social science. Amer. J. Orthopsychiat. 22, 469-483.

DEUTSCH, K.W. (1952b). On communication models in the social sciences. Publ. Opin. Quart. 16, 356-380.

DEUTSCH, K.W. (1953b). Nationalism and the social scientists. In Lyman Bryson et al. (Eds.), Foundations of world organization. Eleventh conference symposium on science, philosophy and religion. New York: Harper.

DIEBOLD, J. (1952). Automation. New York: Van Nostrand.

DINEEN, G.P. (1955). Programming pattern recognition. In Proc. Western Joint Computer Conf., I.R.E., A.I.E.E., A.C.M.

DUBARLE, D. (1950). Existe-t-il des machines a penser? (Do thinking machines exist?) Rev. Quest. Sci. 11, 209-230.

DUBOULOZ, P. and CORRIOL, J. (1951). A propos de la cybernetique. (In regard to cybernetics). Ann. med-psychol. 1, 1-10.

DUNBAR, M. J. (1950). Feedback systems and oceanography. Amer. Sci. 38, 4-9 599-603.

***E***

EARP, C.W. (1948). Relationship between rate of transmission of information, frequency, bandwidth, and signal-to-noise ratio. Elec. Comm. 25, 178-195.

EISENHART, C. (1949). Cybernetics - a new discipline. Science, 109, No.2834, 397-399.

EL-A'LEM, M.A. (1953). Cybernetics. (In Arabic) Egypt. J. Psychol. 8, 315-326.

ELIAS, P. (1953). Optics and Communication Theory. J. opt. Soc. Amer. 43, 229-232.

ELIAS, P. (1954). Error free coding. Trans. I.R.E. (PGIT), 4, 30

ELIAS, P. (1955). Coding for two noisy channels. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

ELIOT, T.D. Reactions to predictive assumptions. Amer. sociol. Rev. 2, 508-517.

ELISON, D.G. (1949a). The application of operational analysis to human motor behaviour. Psychol. Rev. 56, 9-17.

ELISON, D.G. (1949b). Application of servo theory to human motor behaviour. Proc. Ind. Acad. Sci. 58, 290.

ELLSON, D.G. (1955). A method for technological predictions. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

***F***

FAIRBANKS, G. (1954.). Systematic research in experimental phonetics. I- A theory of the speech mechanism as a servo-system. J. Speech Hearing Disorders, 19, 133-139.

FAIRTHORNE, R.A. ( ). Automata and information. J. Doc. (London), 8, 3, 164.

FAIRTHORNE, R.A. (1953). Information theory and clerical systems. J. Doc. (London), 9, 2, 101-116.

FAIRTHORNE, R.A. (1955). Some clerical operations and languages. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

FANO, R.M. ( ). The transmission of information (Part II). Technical report No 149, Research Laboratory of Electronics, M.I.T.

FANO, R.M. (1949). The transmission of informatiom.. Technical report No.65, Research Laboratory of Electronics, M.I.T.

FANO, R.M. (1950). The information theory point of view in speech communication. J. acoust. Soc. Amer. 22, 6, 691-696.

FARLEY, B.G. and CLARK, W.A. (1955). Simulation of self-organizing systems by a digital computer. Proc. Western Joint Computer Conf., I.R.E., A.I.E.E., A.C.M.

FARQUHARSON, R. (1955). Strategic information in games and in voting. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

FATTU, N.A. (1951). Computational technics. Rev. educ. Res. 21, 415-431.

FAVERGE, J.M. (1953a). Le language des communications dans l'analyse du travail. (The language of communications in job analysis.) Bull, Cent. Etud.. Rech. psychotech. 2(1), 2-12.

FAVERGE, J.M. (1953b). La theorie de l'information en psychologie experimentale. (The theory of information in experimental psychology. psychology.) Annee psychol. 53, 463-476.

FEINSTEIN, A. (1954). A new basic theorem of information theory. Trans. I.R.E. (PGIT), 4, 2.

FESTINGER, L et al. ( ). Theory and experiments in social communication. Ann Arbor, Mich.: Research Centre for Group Dynamics.

FISHER, R.A. (1935). The logic of inductive inference. J. roy statist. Soc. 98, 1, 39-54.

FISHER, R.A. (1953). Statistical information. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

FITTS, P.M. (1953). The influence of response coding on performance in motor tasks. In R.A. Patton (Ed.), Current trends in information theory. Pittsburg, Pa.: Univer. Of Pittsburg Press.

FITTS, P.M. (1954). The information capacity of the human motor system in controlling the amplitude of movement. USAF Pers. Train. Res. Cent. Res. Bull. No.54, 41. Also (1954) J. exp. Psychol. 47, 381-391.

FITTS, P.M. and MULLER, P. (1955). Rate of information transfer as a function of the penalty assigned to wrong decisions. Wright Air. Dev. Center Tech. Report.

FITTS, P.M. and SEEGER, C.M. (1953). S-R compatibility - spatial characteristics of stimulus and response codes. J. Exp. Psychol. 46, 199-210.

FITTS, P.M., WEINSTEIN, M., RAPPAPORT, M. ANDERSON, N. and LEONARD, J.A. (1956). Stimulus correlates of visual pattern recognition - a probability approach. J. Exp. Psychol. 51, 1-11.

FLEISHER, H. (1955). An introduction to the theory of information. Libr. Quart. 25, 326-332.

FRANK, L.K. (Ed.), (1948). Teleological mechanisms - symposium. N.Y. Acad. Sci. 50, Art. 4, 189.

FRICK, C.F. and. MILLER, G.A. (1951). A statistical description of operant conditioning. Amer. J. Psychol. 64, 20-36.

FRICK, F.C. and KLEMMER, E.T. (1951) .Assimilation of information from dot and matrix patterns. Amer. Psychol. 5, 80, 267. Also (1953). J. exp. Psychol. 45, 15-19.

FRIEDMAN, M. and SAVAGE, L.J. (1948). The utility analysis of choices involving risk. J. Polit. Econ. 56, 279.

FRITZ, E.L. and GRIER, G.W. Jr., (1955). Pragmatic communication. In H. Quastler (Ed.), Information theory in psychology. Glencoe: Free Press.

FRY, D.B. (1950). Communication theory and linguistic theory. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed, 120-125.

FRY, D.B. and DENES, P. (1953). Mechanical speech recognition. In W. Jackson (Ed.), Conmunication theory, second London symposium. London: Butterworths.

FRY, D.B. and DENES, P. (1955). Experiments in mechanical speech recognition. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

FUCKS, W. (1955). Mathematical theory of word formation. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

***G***

GABOR, D. (1946). Theory of communication. J. I.E.E. 93, 3, 439

GABOR, D. (1947a). Acoustical quanta and the theory of hearing. Nature, Lond., 159, 303.

GABOR, D. (1947b). New possibilities in speech transmission. J.Inst. elec. Engng, 94, 3, 369. Also (1948) J. I.E.E. 95, 3.

GABOR, D. (1950a). Communication theory and physics. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed. Also (1950) Phil. Mag. 41, 7, 1161. Also (1951) Rev. Opt. (theor. instrum.).

GABOR, D. (1950b). Communication theory, past, present and prospective.In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

GABOR, D. (1951). Lectures on communication theory. Cambridge, Mass: M.I.T.

GABOR, D. (1953). A summary of communication theory. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

GABOR, D. (1954). Communication theory and cybernetics. Trans. I.R.E. (P.G. on Non-Linear .Circuits).

GABOR, D. (1955). Optical transmission. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

GARDNER, M. (1952). Logic machines. Sci. Amer. 186, 3, 68-73.

GARNER, W.R. (1953). An informational analysis of absolute judgments of loudness. J. exp. Psychol. 46, 373-380.

GARNER, W.R. and HAKE, H (1951). The amount of information in absolute judgments. Psychol. Rev. 58, 446-459.

GARNER, W.R. and McGILL, W. J. ( ). Relation between uncertainty, variance, and correlation analysis.

GEORGE, F.H. (1953a). Formalization of language systems for behaviour theory. Psychol. Rev. 60, 4, 232-240.

GEORGE, F.H. (1953b). "Machines" as behavioural models. Rationalist Annu.

GEORGE, F.H. (1953c) A note on theory construction in science. Methodos, 5, 141-152.

GEORGE, F.H. (1957a). Minds and machines. III - Machines and human behaviour. B.B.C. Third programme talk, reported in The Listener, Jan 10.

GEORGE, F.H. (1957b). The applications of cybernetics. Technology, 5, 1, 182.

GEORGE, F.H. and HANDLON, J.H. (1955). Toward a general theory of behaviour. Methodos, 7, 25-44.

GERARD, R. W. (1951). Some of the problems concerning digital notions in the central nervous system. In H. von Foerster (Ed.), Transactions of the seventh conference on cybernetics. New York: Josiah Macy, Jr. Foundation.

GERARD, R.W. (1953a). Central excitation and inhibition. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

GERARD, R.W. (1953b). What is memory? Sci. Amer. 189, 118-126.

GITTLESON, Y. (1950). Sacred cows in collision. Amer. Sci. 38, 4, 603-609.

GLASER, R. and SCHWARTZ, T.A. (1954). Scoring problem - solving test items by measuring information. Educ. psychol. Measmt. 14, 665-671.

GOLAY, M.J.E. (1949). Notes on digital coding. Proc. I.R.E. 37, 657.

GOLD, T. (1950). Hearing. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

GOLDMAN, S. (1953a). Information theory. New York: Prentice-Hall. Also London: Constable.

GOLDMAN, S. (1953b). Information theory of noise reduction in modulation systems. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

GOLDMAN, S. (1953c). Some fundamentals of information theory. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

GOLDSTEIN, K. (1940). Human nature. Cambridge, Mass: Harvard Univer. Press.

GONSETH, F. (1950). L'organisation des robots sensorimoteurs et l'intuition geometrique. (The organisation of sensorimotor robots and the geometric intuition.) Dialectica, 4, 214-223.

GOOD, L.J. (1950). Probability and the weighing of evidence. Griffen.

GOOD, L.J. (1953). The appropriate mathematical tools for describing and analysing uncertainty. Paper given before the British Association, Sept. 8th. Also (1954) In C.F. Carter, G.P. Meredith, and G.L.S. Shackle (Eds.), Uncertainty and Business Decisions. Liverpool: Liverpool Univer. Press.

GOODWIN, R.M. (1947). Dynamic coupling with especial reference to markets having production lags. Econometrica, 15, 3, 181-204.

GRANT, D.A. (1953). Information theory and the discrimination of sequences in stimulus events. In R.A. Patton, Current trends in information theory. Pittsburgh: Univer. of Pittsburgh Press.

GRANT, D.A. (1954). The discrimination of sequences in stimulus events and the transmission of information. Amer. Psychologist, 9, 62-68.

GREGORY, R. L. (1955). An experimental treatment of vision as an information source and noisy channel. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

GREGORY, R.L. (1953). On physical model explanations in psychology. Brit. J. Phil. Sci. 4-, 192-197.

GRUENBERGER, F. (1953). Computing manual. Third edition. Milwaukee: Univer. of Wisconsin Press.

GUILLARD, G.Th. (1954). La. cybernetique. (Cybernetics). Paris: Presses Universitaires de France.

GUILLAUME, P. (1954a). Cybernetique et psychologie. (Cybernetics and psychology.) J. Psychol. norm. path. 47-51, 360-378.

GUILLAUME, P. (1954b). Cybernetique et psychologie. II - Machines et systemes physiques. (Cybernetics and Psychology. II - Machines and physical systems.) J. Psychol. Norm. Path. 47-51, 486-499.

***>H***

HAKE, H.W. (1955a). A note on the concept of "channel capacity" in psychology. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

HAKE, H.W. (1955b). The perception of frequency of occurrence and the development of "expectancy" in human experimental subjects. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

HALDANE, J.B.S. (1952). The mechanical chess-player. (Comment on Ashby, 1952). Brit. J. Phil. Sci., 3, 189-191.

HALSTEAD, W.C. (1947). Brain and intelligence. Chicago, Ill.: Univer. of Chicago Press.

HAMMING, R.W. (1950). Error detecting and error correcting codes. Bell Syst. tech. J. 29, 147-160.

HANSEL, C.E.M. (1950). New machines. Bull. Brit. psychol. Soc. 1, 10, 392.

HARARY, F. and ROSS, I.C. (1954). The number of complete cycles in a communication network. J. soc. Psychol. 40, 329-332.

HARTLEY, R.V.L. (1928). Transmission of information. Bell Syst. tech. J. 7, 535-537.

HARTMAN, B.0. and WETHERBEE, J.K. (1956). 'Beta' a special purpose computer for studies in the human control of complex equipment. U.S. Army med. Res. Lab. Rep. No.236, i.

HARTREE, D.R. (1948). An historical survey of digital calculating machines. Proc. roy. Soc. 195, 265.

HARTREE, D.R. (1949). Calculating instruments and machines. Urbana: Univer. of Illinois Press. Also (1950). Cambridge, England: Cambridge Univer. Press.

HARVARD UNIVERSITY COMPUTATION LABORATORY (1948). Symposium on large-scale digital calculating machinery. Ann. Comput. Lab. Harv. 16.

HARVARD UNIVERSITY COMPUTATION LABORATORY. (1950). Symposium on large-scale digital calculating machinery. Ann. Comput. Lab. Harv. 26.

HAUROWITZ, F. (1953). Protein synthesis and immunochemistry. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

HAYEK, F.A. (1952). The sensory order. London: Kegan Paul.

HAZELL, K. (1949). The C.N.S. is a living electrical system. Med. Pr. 221, 364-366.

HEBB, D.O. (1949). The organisation of behaviour. New York: Wiley.

HEFFERLINE, R.F. (1955). Communication theory: I. Integration of arts and science. Quart. J. Speech, 41, 223-233.

HERTZ, D. and LESSER, S. (1951). People in groups. Sci. Amer. 184, 2, 26-28.

HERTZ, D. and LIVINGSTONE, R.T. (1950) Contemporary organizational theory. Human relations, 3, 4.

HICK, W.E. (1948). The discontinuous functioning of the human operator in pursuit tasks. Quart. J. exp. Psychol. 1, 36.

HICK, W.E. (1950). Information theory in psychology. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed. 130-134

HICK, W.E. (1951). Information theory and intelligence tests. Brit. J. Psychol., Statist Sect., 4, 157-164.

HICK, W.E. (1952a). The mechanical chess-player. (Comment on Ashby, 1952). Brit. J. Phil. Sci. 3, 353-355.

HICK, W.E. (1952b). On the rate of gain of information. Quart. J. exp. Psychol. 4, 11-26.

HICK, W.E. (1954). The impact of information theory on psychology. Advanc. Sci. 40, 397.

HOAGLAND, H. (1949). Rhythmic behaviour of the nervous system. Science, 109, 157-164.

HOCHBERG, J. and McALISTER, E. (1953). A quantitative approach to figural 'goodness'. J. exp. Psychol. 46, 361-364.

HOCKETT, C.F. (1952). An approach to the quantification of semantic noise. Phil. Sci. 19, 257-260.

HOMANS, G. (1950). The human group. New York: Harcourt Brace.

HOUSEHOLDER, A.S. and LANDAHL, H.D. (1945). Mathematical biophysics of the central nervous system. Bloomington, Ind.: Principia Press.

HUFFMAN, D.A. (1953). A method for the construction of minimum-redundancy codes. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

HUFFMAN, D.A. (1955). The synthesis of linear sequential coding networks. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

HUGGINS, W.H. (1949). Linear systems and group dynamics. Mimeographed paper.

HUGGINS, W.H. (1953). A theory of hearing. In W. Jackson (Ed.), Communication theory, second London Symposium. London: Butterworths.

HUGGINS, W.H. and LICKLIDER, J.C.R. (1951). Place mechanisms of auditory frequency analysis. J. acoust. Soc. America, 23, 3, 290-299.

HUIZINGA, E. (1953). The sense of hearing - its significance in human beings. Proc. Int. Course Paedo-Audiology, Groningen University, 9-15.

HULL, C.I. (1937). Mind, mechanism and adaptive behaviour. Psychol. Rev. 44, 1-32.

HUTCHINSON, G.E. (1948). Circular Causal systems in Ecology. Ann. New York Acad. Sci. 50, art. 4, 221-245.

HUTCHINSON, G.E. (1953). Turbulence as random stimulation of sense organs. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

HYMAN, R. (1953). Stimulus information as a determinant of reaction time. J. exp. Psychol. 45, 188-196.

***I***

INNIS, H.A. (1949). The bias of communications. Canad. J. econ. polit. Sci. 15, 4, 457-476.

INSTITUTION OF RADIO ENGINEERS (1953). Convention record. Part 8 - Information theory.

IRWIN, M.R. (1953). Genes and antigens. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

***J***

JACOBSON, H. (1950). The information capacity of the human ear. Science, 112, 143-144.

JACOBSON, H. (1951a). Information and the human ear. J. acoust. Soc. Amer. 23, 463-471.

JACOBSON, H. (1951b). The information capacity of the human eye. Science, 113, 292-293.

JAMES, H.F., NICHOLLS, N.B. and PHILLIPS, R.S. (1948). Theory of servomechanisms. New York: Penguin Books.

JELONEK, Z. (1953). A comparison of transmssion systems. In W. Jackson, (Ed. ), Communication theory, second London symposium. London: Butterworths.

***K***

KALMUS, H. (1950). A cybernetical aspect of genetics. J. Hered. 41, 19-22.

KAPP, R. 0. (1955). The observer, the interpreter and the object observed. Methodos, 25-26, .3-12.

KAPP, R.O. (1954). Living and lifeless machines. Brit. J. Phil. Sci. 5, 91-103.

KECSKEMETI, P. (1952). Meaning, communication and value. Chicago, Ill: Univer. of Chicago Press.

KEMENY, J.G. (1953). A logical measure function. J. Symb. Logic. 18, 289.

KEMENY, J.G. (1955). Man viewed as a machine. Sci. Amer. (April), 58-67.

KENNEDY, J. L (1952). The uses and limitations of mathematical models, game theory, and systems analysis in planning end problem solution. In J.C. Flanagan et al (Eds.), Current trends - psychology in the world emergency. Pittsburgh, Pa.: Univer. of Pittsburg Press.

KING, G.W. (1952). Information. Sci. Amer. l87, 3.

KING, G.W. (1953). The Monte Carlo method as a natural mode of expression in operations research. J. Operat. Res. Soc. Amer. 1, 33-58.

KIRK, J.R. (1953). Communication theory and methods of fixing belief. Etc. Rev. gen. Semant. 10, 298-305.

KLEENE, S.C. (1951). Representation of events in nerve nets and finite automata. U.S. Air Force, Project Rand, Research Memorandum. Rand Corporation, Santa Monica, California. Also (1956) In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J: Princeton Univer. Press.

KLEIN, M.J. (1953). Order, organisation and entropy. Brit. J. Phil. Sci. 4, 158-160.

KLEMMER, E.T. (1955 ). Tables for computing informational measures. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

KLEMMER, E.T. and MULLER, P.F. Jr. (1953). The rate of handling information - key pressing responses to light patterns. U.S.A.F. Hum. Fact. Operat. Res. Lab. Memo. Report No. 34. Operations Applications Laboratory, Air Research and Development Command.

KOEFOED, J. (1955). A neuronic model of the inner ear. In E.C. Cherry, (Ed.), Information theory, third London symposium. London: Butterworths.

KOLMOGOROFF, A. (1942). Interpolation und Extrapolation von stationaren zufalligen Folgen. (Interpolation and extrapolation of stationary random sequences.) Bull. Acad. Sci., U.S.S.R. Ser. Math. 5, 3.

KONORSKI, J. (1950). Mechanisms of learning. Symposia of the Society for Experimental Biology. No.4 - Physiological mechanisns in animal behaviour. Cambridge, England: Cambridge Univer. Press.

KORSYBSKI, A. (1948). Science and sanity. (3rd ed.). Lancaster, Pa.: Science Press.

KREEZER, G. L (1949). An inverse decibel log frequenqy method for determination of the transfer functions of psychological systems. Science, 681-684.

KRULEE, G.K. (1954). Information theory and man-machine systems. J. Operat. Res. Soc. Amer. 2, 320-328.

KUBIE, L.S. (1930). A theoretical application to some neurological problems of the properties of excitation waves which move in closed circuits. Brain, 53, 166-177.

KUBIE, L.S. (1949). Neurotic potential and human adaptation. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the sixth conference. New York: Josiah Macy, Jr. Foundation.

KUBIE, L.S. (1951). The relationship of symbolic function in language formation and in neuroses. In H. von Foerster (Ed.), Cybernetics - circular , causal and feedback mechanisms in biological and social systems. Transactions of the seventh conference. New York: Josiah Macy Jr. Foundation.

KUBIE, L.S. (1952). Communication between sane and insane hypnosis. In H. Von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social. Systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

KUBIE, L.S. (1953). The place of emotions in the feedback concept. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New Yor:k: Josiah Macy, Jr. Foundation.

KULLBACK, S. (1952). An application of information theory to multivariate analysis. Ann. math. Statist. 23, 88-102.

KULLBACK, S. and LEIBLER, R.A. (1951). On information and sufficiency. Ann. math. Statist. 22, 79-87.

***L***

LAEMMEL, A.E. ( ). General theory of communication. Microwave Res. Inst. Polytechnic Brooklyn.

LAEMMEL, A.E. (1951). Characteristics of communication systems. Report R-233-50, PIB-178, Microwave Res. Inst., Polytechnic Inst. Brooklyn.

LAEMMEL, A.E. (1952). Efficiency of codes as a function of their message length. Symposium on applications of communication theory. London. I.E.E.

LAEMMEL, A.E. (1953). Efficiency of noise-reducing codes. In W.Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

LAEMMEL, A.E. (1955). A general class of codes and their physical realization. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

LANGER, S.K. (1942). Philosophy in a new key. Cambridge, Mass.: Harvard Univer. Press. Also (1948) New York: Penguin books.

LAPLUME, J. (1948). Sur le nombre de signaux discernables. (On the number of discernable signals). C. R. Acad. Sci. ,Paris. 226, 1348 - 1349.

LASHLEY, K.S. (1951). The problem of serial order in behaviour. In L.A. Jeffress (Ed.), Cerebral mechanisms in behaviour. New York: Wiley.

LAUER, H., NESNICK, R. and MATSON, I.E. (1945 ) Servomechanism fundamentals. New York: McGraw-Hill.

LAWRENCE, W. (1953). The synthesis of speech from signals which have a low information rate. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

LEAVER, E.W. and BROWN, J.J. (1951). Electronics and human beings. Harpers Mag. 203 (1215), 88-93.

LEAVITT, H.J. (1951). Some effects of certain conmunication patterns on group performance. J. abnorm. soc. Psychol. 46, 1, 38-50.

LEAVITT, H.J. and MUELLER, R.A.H. (1951). Some effects of feedback on communication. Hum. Relat. 4, 401-410.

LEE, B.S. (1950). Effects of delayed speech feedback. J. acoust. Soc. Amer. 22, 6, 824-826.

LEE, Y.W. ( ). Application of statistical methods to communication problems. Technical Report No.181, Research Laboratory of Electronics, M.I.T.

LEE, Y.W. and WIESNER, J.B. (1950) Correlation functions and communication applications. Electronics, 23, 6, 86-92.

LEONARD, J.A. (1954). The effect of partial advance information. Applied Psychology Research Unit. APU. 217/54.

LEONARD, J.A. (1955). Factors which influence channel capacity. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

LEVINSON, N. (1948). A heuristic exposition of Wiener's mathematical theory of prediction and filtering. Appendix C to N. Wiener, Cybernetics. New York: Wiley.

LEWIN, K. (1947). Frontiers in group dynamics, II. Hum. Relat. 1, 2.

LICKLIDER, J.C.R. (1949). The intelligibility and information content of quantized speech. Amer. Psychologist. 4, 234.

LICKLIDER, J.C.R. (1950). The manner in which and extent to which speech can be distorted and remain intelligible. In H. Von Foerster, (Ed), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the seventh conference. New York: Josiah Macy, Jr. Foundation.

LICKLIDER, J.C.R. (1951). A duplex theory of pitch perception. Experientia (Basel) 7, 4, 128-134

LICKLIDER, J.C.R. (1955). Auditory frequency analysis. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

LICKLIDER, J.C.R. and MILLER, G.A. (1951). The perception of speech. In S.S. Stevens (Ed.), Handbook of experimental psychology. New York: Wiley.

LINSCHITZ, H. (1953a). Information and physical entropy. .In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

LINSCHITZ, H. (1953b). The information content of a bacterial cell. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

LINFOOT, E.H. (1955). Informations theory and optical images. J. opt. Soc. Amer. 45, 808-819.

LOCKE, W.N. and BOOTH, A.D. (1955). Machine translation of languages. New York: Technology Press, M.I.T. and Wiley. Also London: Chapman and Hall.

LOEB, J. (1953). Communication theory of transmission of simple drawings. In W.Jackson (Ed.), Comnunication theory, second London symposium. London: Butterworths.

LORGE, I. (1955). How the psychologist views communication. Teach. Coll. Rec. 57, 2, 72-19.

LOTKA, A.J. (1925). Elements of physical biology. Baltimore, Md: Williams and Wilkins.

LUCE, R.D. (......). A survey of the theory of selective information and some of its behavioural applications. Bur. Appl. Soc. Res. Tech. Report No. 8, Columbia Univer., New York.

LUCE, R.D. (1950). Connectivity and generalised cliques in sociometric structures. Psychometrika, 15, 169-190.

LUCE, R.D. and PERRY, A.D. (1949). A method of matrix analysis of group structure. Psychometrika 14, 95-116.

***M***

MAATSCH, J.L. and BEHAN, R.A. (1953).A more rigorous theoretical language. Psychol. Rev. 60, 3, 189-196.

MacDONALD, D.K.C. (1949). Some statistical properties of random noise. Proc. Cambridge. phil. Soc. (England), 45, 368.

MacDONALD, D.K.C. (1950). Fluctuations and theory of noise. In lnformation theory, first London symposium. London: Ministry of Supply. Mimeographed.

MacDONALD, D.K.C. (1952). Information theory and its application to taxonomy. J. appl. Phys. 23, 529.

MacDONALD, D.K.C. (1954). Information theory and knowledge. J. appl. Phys. 25, 619.

MACE, C.A. (1953). Homeostasis, needs and values. Brit. J. Psychol. 44, 4, 200-210.

MacGOLL, L.A. (1945). Servomechanisms. New York: Van Nostrand.

MacKAY, D.M (1956a). The epistemological problem for automata. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

MacKAY, D.M. (1949). On the combination of digital and analogical techniques in the design of analytical engines. Mimeographed. (May 20th)

MacKAY, D.M. (1950a). Entropy, time and information. In Information theory, first London Symposium. London: Ministry of Supply. Mimeographed.

MacKAY, D.M. (1950b). The nomenclature of information theory. In Information theory, first London Symposium. London: Ministry of Supply. Mimeographed. Also (1952) In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

MacKAY, D.M. (1950c). Quantal aspects of scientific information. Phil. Mag. 7, 41, 289-311. Also (1950) in Information theory, first London Symposium. London: Ministry of Supply. Mimeographed.

MacKAY, D.M. (1951a). In search of basic symbols. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

MacKAY, D.M. (1951b). Mind-like behaviour in artifacts. (Reply to Mays, 1952) Brit. J. Phil. Sci. 2, 105-121.

MacKAY, D.M. (1952a). Mentality in machines - symposium. Proc. Aristotelian Soc. Supplementary Vol. 26.

MacKAY, D.M. (1952b). Mind-like behaviour in artefacts. (Comment on May's comment, 1952). Brit. J. Phil. Sci. 3, 352-353.

MacKAY, D.M. (1953a). The effects of relaxation time on the relative efficiency of binary PCM, PIM, and PPM. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

MacKAY, D.M. (1953b). Generators of information. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

MacKAY, D.M. (1954a). On comparing the brain with machines. Advanc. Sci. 40. Also (1954) Amer. Scientist, 42, 261-268.

MacKAY, D.M. (1954b). Operational aspects of some fundamental concepts of human communication. Synthese, 9, 182.

MacKay, D.M. (1955a). The place of 'meaning' in the theory of information. In E.C. Cherry (Ed), Information theory, third London symposium. London: Butterworths.

MacKAY, D.M. (1955b). Supra-logical behaviour in automata. (Abstract) Acta Psychol. 11, 204-205.

MacKAY, D.M. (1956b). Towards an information-flow model of human behaviour. Brit. J. Psych. 47, 30.

MacKAY, D.M. and McCULLOCH, W.S. (1952). The limiting information capacity of a neuronal link. Bull. math. Biophysics, 14, 127.

MacMILLAN, R.H. (1951). An introduction to the theory of control. London: Cambridge Univer. Press.

MACRAE, D. G. (1951). Cybernetics and social science. Brit. J. Sociol. 2, 135-149.

MANDELBROT, B. (1951). Mecanique statistique et theorie de l'information. (Statistical mechanics and the theory of information.) C.R.Acad.Sci., Paris, 232, 1638-1640, and 2003-2005.

MANDELBROT, B. (1953a). Communication theory. London: Butterworths

MANDELBROT, B. (1954). Structure formelle des textes et communication: deux etudes. (Formal structure of texts and communication: two studies. Word, 10, 1-27.

MANDELBROT, B. (1955). On the language of taxonomy: an outline of a 'thermo-statistical' theory of systems of categories with Willis (natural) structure. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

MANDELBROT, B. 1953b) An informal theory of the statistical theory of language. In W. Jackson (Ed), Communication theory, second London symposium. London: Butterworths.

MARCOU, P. and DAGUET, J. (1955) New methods of speech transmission. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths

MASON, S.J. (1951). On the logic of feedback. D.Sc. thesis, M.I.T.

MAXWELL, C. (1868) On governors. Proc. Roy.Soc. 16, 270-283.

MAYNE, R. (1951). Some engineering aspects of the mechanism of body control. Elec. Engng. 70, 3.

MAYS, W. (1951). The hypothesis of cybernetics. (Comment on Wisdom, 1951). Brit. J. Phil. Sci. 2, 249-250.

MAYS, W. (1952a). Can machines think? Philosophy, 27, 148-162.

MAYS, W. (1952b). Mind-like behaviour in artefacts and the concept of mind. (Comment on MacKay, 1951). Brit. J. Phil. Sci. 3, 191 -193.

MAYS, W. (1956). Minds and machines-I. B.B.C. Third programne talk, reported in The Listener, Dec. 27.

McCALLUM, D.M. and SMITH, J.B. (1951a). Mechanized reasoning. Electron. Engng., 23, 278, 126-132.

McCALLUM, D.M. and SMITH, J.B. (1951b). Feedback logical computors. Electron. Engng., 23, 286, 458-461.

McCARTHY, J. (1956). The inversion of functions defined by Turing machines. In C.E. Shannon and J. McCarthy (Eds.), Automata studies, Princeton, NJ: Princeton Univer. Press.

McCULLOCH, W.S. (1944). The functional organization of the cerebral cortex. Physiol. Rev. 3, 390-407.

McCULLOCH, W.S. (1945). A heterarchy of values determined by the topology of nerve nets. Bull. Math. Biophys. 7, 89-93.

McCULLOCH, W.S. (1946). Finality and form. 15th James Arthus Lecture, New York Acad. Sci. Also (1952) Springfield, Ill.: Thomas.

McCULLOCH, W.S. (1947a). Machines that think and want. Lecture to American Psychological Association.

McCULLOCH, W.S. (1947b). Modes of functional organization of the cerebral cortex. Federation Proc. 6, 2, 448-452.

McCULLOCH, W.S. (1948a). A recapitulation of the theory, with a forecast of several extensions. Teleological Mechanisms. Ann. N.Y. Acad. Sci. 50, 4, 247-258.

McCULLOCH, W.S. (1948b). Through the den of the metaphysician. Lecture at the University of Virginia. Also (1951) Thales, Presses Universitaires de France, Paris. Also (1954) Brit. J. Phil. Sci. 5, 18-31.

McCULLOCH, W.S. (1949). The brain as a computing machine. Elec. Engng. 68, 492-497.

McCULLOCH, W.S. (1950). Why the mind is in the head. Dialectica, 4, 192-205. Also (1951) In L.A. Jefress (Ed.), Cerebral mechanisms in behaviour. New York: Wiley.

McCULLOCH, W.S. (1953). Information in the head. In R.A. Patton. (Ed.), Current trends in information theory, 92-118. Pittsburgh, PA.: Univer. of Pittsburgh Press.

McCULLOCH, W.S. (1955). Summary of the points of agreement reached in the previous nine conferences on cybernetics. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the tenth conference. New York: Josiah Macy, Jr. Foundation.

McCULLOCH, W.S. and PFEIFER, J. (1949). Digital computers called brains. Sci. Monthly, 69, 368-376.

McCULLOCH, W.S. and PITTS, W. (1943). A logical calculus of the ideas immanent in nervous activity. Bull. math. Biophys. 5, 115-133.

McCULLOCH, W.S. and PITTS, W. (1947). How we know universals. Bull. math. Biophys. 9, 127-147.

McCULLOCH, W.S. and PITTS, W. (1948). The statistical organization of nervous activity. Biometrics, 4, 91-99.

McGILL, W.J. (1954). Multivariate information transmission. Psychometrika, 19, 97-116.

McGILL, W.J. (1955a). Isomorphism in statistical analysis. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

McGILL, W.J. (1955b). The relation between uncertainty and variance. Proc. 1954 conf. test Probl. Educ. Test Serv. 37-42.

McGILL, W.J. and QUASTLER, H. (1955). Standardized nomenclature - an attempt. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

McMILLAN, B. (1953a). The basic theorems of information theory. Ann. math. Statist. 24, 196.

McMILLAN, B. (1953b). Mathematical aspects of informtion theory. In R.A. Patton, Current trends in information theory. Pittsburgh, Pa.: Pittsburgh Univer. Press.

MEAD, M. (1951). Experience in learning primitive languages through the use of learning high level linguistic abstractions. In H. von Foerster (Ed.), Cybernetics - crcular, causal and feedback mechanisms in biological and social systems. Transactions of the seventh conference. New York: Josiah Macy, Jr. Foundation.

MESZAR, J. (1953). Switching systems as mechanical brains. Bell labs. record, 31, 63-69.

MEYER-EPPLER, W. and DARIUS, G. (1955). Two-dimensiona1 photographic auto-correlation of pictures and alphabet letters. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

MILLER, G.A. (1947). Population, distance, and circulation of information. Amer. J. Psychol. 60, 276-284.

MILLER, G.A. (1950). Language engineering. J. acoust. Soc. Amer. 22, 6, 720-725.

MILLER, G.A. (1951a). Language and communication. New York: McGraw Hill.

MILLER, G.A. (1951b) Speech and language. In S.S. Stevens (Ed.). Handbook of experimental psychology. New York: Wiley.

MILLER, G.A. (1953a). Information theory and the study of speech. In R.A. Patton (Ed.), Current trends in information theory. Pittsburgh, Pa.: Univer. of Pittsburgh Press.

MIlLER, G.A. (1953b). What is information measurement? Amer. Psychologist, 8, 3-11.

MILLER, G.A. (1954a). Communication. Annu. Rev. Psychol.

MILLER, G.A. (1954b). Psycholinguistics. In G. Lindzey (Ed.), Handbook of social psychology II Cambridge, Mass: Addison-Wesley.

MILLER, G.A. (1955) Note on the bias of information estimates. In H. Quastler (Ed,), Information theory in psychology. Glencoe, Ill: Free Press.

MILLER, G.A. (1956) The magical number seven, plus or minus two - some limits on our capacity for processing information. Psychol. Rev. 63, 2, 81-97.

MILLER, G.A. and FRICK, C.F. (1949) .Statistical behaviouristics and sequences of responses. Psychol. Rev. 56, 6.

MILLER, G.A. and SELFRIDGE, J.A. (1950). Verbal context and the recall of meaningful material. Amer. J. Psychol. 63, 176-185.

MILLER, G.A., HEISER, G.A. and LITCHEN, W. (1951) The intelligibility of speech as a function of the context of test materials. J. Exp. Psychol. 41, 5.

MILLER, I. (1954). Auditory perception in relation to amount of information and speech-to-noise ratio. Dissertation Abstr. 14, 2136. Abstract of Ph.D. thesis, Purdue Univer.

MILLER, R.B., FOLLEY, J.D. Jr. and SMITH, P.R. (1953). Trouble shooting in electronics equipment, - a proposed method. Pittsburgh, Pa: Amer. Inst. for Research.

MINISTRY OF SUPPLY (1950). Bibliography of information on servomechanisms and related subjects. Prepared for the Interdepartmental Technical Committee on Servomechanisms. London: Technical Information Bureau, Ministry of Supply.

MINSKY, M.I. (1953). Theory of neural-analog reinforcement systems and its application to the brain-model problem. PhD dissertation, Princeton Univer.

MINSKY, M.I. (1954). Neural-analog networks and the brain-model problem. Princeton Univer. Microfilmed.

MINSKY, M.I. (1956). Some Universal elements for finite automata. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

MOOERS, C. (1955). Information retrieval on structured content. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

MOOERS, C. N. (1952). Machines for information retrieval, learning and translating. Invited paper circulated at the symposium on machine translation organized by Y. Bar-Hillel at M.I.T.

MOORE, E.F. (1956). Gedanken-experiments on sequential machines. In C.E. Shannon and J. Mcarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

MOORE, E.F. and TUMIN (1949). Some social functions of ignorance. Amer. sociol. Rev. 14, 6,787-795.

MOREHOUSE et al. (1950). An electro-analog method of investigating problems in economic dynamics - inventory oscillations. Econometrica, 18, 313-328.

MORRIS, C W. (1946). Signs, language and behaviour. New York: Prentice-Hall.

MOSIER, R.D. (1952). Cybernetics and the educative process. Calif. J. educ. Res. 3, 147-150. ,

MOWRER, O.H. (1954). Ego pscyhology, cybernetics, and learning theory. In Kentucky Symposium - learning theory, personality theory, and clinical research. New York: Wiley.

MUNDY-CASTLE, A.C. (1953). Cybernetics. S. African Med. J. 27, 49-53.

MUNSON, V.A. and KARLIN, J. E. (1954). Measurement of human channel transmission characteristics. J. acoust. Soc. Amer. 26, 542-553.

MURPHEE, O.D. (1954). Maximum rates of form perception and the alpha rhythm - an investigation and test of current nerve net theory. J. exp. Psychol. 48, 57-61.

MURRAY, F.J. (1948). The theory of mathematical machines. New York: Kings Crown Press.

***N***

NAGEL, E. (1951). Mechanistic explanations and organismic biology. Phil. phenomenol. Res. 11, 327-338.

NEGLEY, G. (1951). Cybernetics and theories of mind. J. Phil. 48, 19, 574-582.

NEWELL, A. (1955). A chess-playing machine. Proc. Western Joint Computer Conf. I.R.E, A.I.E.E,.A.C.M.

NEWMAN, E.B. (1951). The pattern of vowels and consonants in various languages. Amer. J. Psychol. 64, 369-379.

NEWMAN, E.B. (1951a). Computation methods useful in analysing series of binary data. Amer. J. Psychol. 64, 369-379.

NEWMAN, E.B. and GERSTMAN, L.J. (1952). A new method for analysing printed English. J. exp. Psychol. 44, 114-125.

NORTH, J. D. ( ). The rational behaviour of mechanically extended man. Boulton Paul Aircraft Ltd.

NORTH, J.D. (1955). Application of commmunication theory to the human operator. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

NORTHROP, F.S.C. (1948). The neurological and behaviouristic basis of the ordering of society by means of ideas. Science, 107, 2782, 411-417.

NYQUIST, H. (1924.) .Certain factors affecting telegraph speed. Bell Syst. tech. J. 3, 324.

NYQUIST, H. (1928). Certain topics in telegraphic transmission theory. Trans. A.I.E.E. 47, 617.

NYQUIST, H. (1932). Regeneration theory. Bell Syst. tech. J. 126.

***O***

OETINGER, A. (1952). Programming a. digital computer to learn. Phil. Mag. 7, 43, 1243-1263.

OGDEN, C.K. and RICHARDS, I.A. (1930). The meaning of meaning. London: Kegan Paul. Also New York: Harcourt Brace.

OLDFIELD, R.C. (1954). Memory mechanisms and the theory of schemata. Brit. J. Psychol. 45, 14.

OLIVER, B.M., PIERCE, J.R. and SHANNON, C.E. (1948). The philosphy of PCM. Proc. I.R.E. 36, 1324.

ORBELI, L.A. (1949). Vtoria signal naia sistema. (The second signal system). Neuropatol. i Psikhiat. 18(5), 8-19.

OSBORNE, J.W., QUASTLER, H., TWEEDELL, K.W. and WILSON, K.V. (1955). Human performance in information transmission - III. Technical report No. R-68, Control Systems Laboratory, Univer. of Illinois, Urbana.

OSGOOD, C.E. (1955). Fidelity and reliability. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

OSTOW, M. (1949). Entropy changes in mental activity. J. nerv. ment. Dis. 110, 502-506.

OSTOW, M. (1951). The entropy concept and psychic function. Amer. Scientist. 39, 140-145.

***P***

PAKSWER, S. (1954). Information, entropy, and inductive logic. Phil. Sci. 21, 254-259.

PATTON, R.A. (Ed.), (1953). Current trends in information theory. Pittsburgh, Pa.: Univer. of Pittsburgh Press.

PENFIELD, W. (1952). Memory mechanisms. A.M A. Arch. Neurol. Psychiat. 67, 178-198.

PETERS, R.W. (1954). Competing rnessages - the effect of interfering messages upon the reception of primary messages. US Naval Sch. Aviat. Med. Res. Rep. Project No. NM 001 064.01.27.

PETERSON, G.E. (1952). Information theory. 2 - Applications of information theory to research in experirnental phonetics. J. Speech Hearing Disorders 17, 175-187.

PETERSON, G.E. (1953). The information-bearing elements of speech. In W.Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

PIAGET, J. (1953). Structures operationelles et cybernetique. (Functional structures and cybernetics). Annee Psychol. 53, 379-390.

PIGORS, P. (1949 ). Effective communication in industry. What is its basis? National Ass. of Manufacturers, Lt. Rush Toland memorial study No. 1.

PINKERTON, R.C. (1956). Information theory and melody. Sci. Amer. 194-, 2, 77-86.

PINSKY, L. (1951). Do machines think about machines thinking? Mind, 60, 397-398.

PIRENNE, M.H. (1951). Mind-like behaviour in artefacts and the concept of mind. (Comment on MacKay, 1951). Brit. J. Phil. Sci. 2, 315.

PITTS, W. (1953). Investigations on synaptic transmission. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

POLANYI, M. (1951). The hypothesis of cybernetics. Brit. J. Phil. Sci. 2, 312.

POLLACK, I. (1951). The assimilation of sequentially encoded information. Amer. Psychologist, 5, 8, 266-267. Also (1953) Amer. J. Psychol., 66, 3, 421-435.

POLLACK, I. (1952). The information of elementary auditory displays. J. acoust. Soc. Amer. 24, 745-749.

POLLACK, I. and PICKS, L. (1954). Information of elementary multidimensional auditory displays. J. acoust. Soc. Amer. 26, 155.

POPPER, K.R. (1950). Indeterminism in quantum physics and in classical Physics. (Part II, section 9.) Brit. J. Phil. Sci. 1, 173-195.

POST, E. (1936). Finite combinatory processes - formulation 1. J. Symbol. Logic, 1, 103-105.

POULTON, E.C. (1953). Two-channel listening. J. exp. Psychol. 46, 91-96.

POULTON, E.C. (1954). Eye-hand span in simple serial tasks. J. exp. Psychol. 47, 403-410.

PRIGOGINE, I. (1947). Etude thermodynamique des phenomenes irreversibles. (The thermodynamic study of irreversible phenomena.) Paris.

PRIGOGINE, I. and WIAME, J.M. (1946). Biologie et thermodynamique des phenomenes irreversibles. (Biology and thermodynamics of irreversible phenomena.) Experientia. (Basel), 2, 450-451.

PRINZ, D.G. (1952). Robot chess. Research, 5, 261-266.

PUIG ADAM, P. (1951). Sobre cibernetica - genesis y problemas. (Concerning cybernetics - genesis and problems.) Rev. Psicol. gen. apl., Madrid, 6, 515-525.

***Q***

QUASTLER, H. (1953a). Feedback mechanisms in cellular biology. In H. von Foerster (Ed.), Cybernetics -circular, causal and feedback mechansims in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

QUASTLER, H. (1953b). The measure of specificity. In H. Quastler (Ed), Information theory in biology. Urbana: Univer. of Illinois Press.

QUASTLER, H. (1953c): The specificity of elementary biological functions. In H. Quastler (Ed.) Information theory in biology. Urbana, Ill: Univer. of Illinois Press.

QUASTLER, H. (1955a). Approximate estimation of information measures. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

QUASTLER, H. (1955b). Information theory terms and their pscyhological correlates. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

QUASTLER, H. (1955c). Studies of human channel capacity. In E.O. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

QUASTLER, H. and WULFF, V.J. (1955a). Human performance in information transmission - I and II. Technical report No. R-62, Control Systems Laboratory, Univer. of Illinois, Urbana.

QUASTLER, H. and WULFF, V.J. (1955b). Human performance in information transmission - V. Technical report No. R-70, Control Systems Laboratory, University of Illinois, Urbana.

***R***

RABEL, G. (1948). Mathematical instruments and calculating machines. Science News, VII. London: Penguin Books, 122-125.

RAFFERTY, J.A. (1950). Mathematical model in biological theory. Amer. Scientist, 38, 4, 549.

RAPOPORT, A. (1950). Science and the goals of man. New York: Harper.

RAPOPORT, A. (1950-51). Mathematical biophysics, cybernetics and significs. Synthese, 8, 182-193.

RAPOPORT, A. (1953). What is information? Etc. Rev. gen. Semant. 10, 247-260.

RAPOPORT, A. (1955). Technological models of the nervous system. Psychiat. Res. Rep. No.2, 119-131.

RAPOPORT, A. and SHIMBEL, A. (1949a). Cybernetics and mathematical biology. Etc. Rev. gen. Semant.

RAPOPORT, A. and SHIMBEL, A. (1949b). Mathematical biophysics, cybernetics and general semantics. Etc. Rev. Gen. Semant. 6, 145-159.

RASHEVSKY, N. (1938). Mathematical biophysics. Chicago, Ill.: Univer. of Chicago Press. (Second edition, much revised, 1948.)

RASHEVSKY, N. (1945a) Mathematical biophysics of abstraction and logical thinking. Bull. Math. Biophys. 7, 133-148.

RASHEVSKY, N. (1945b) Some remarks on the Boolean algebra of nervous nets in mathematical biophysics. Bull. Math. Biophys. 7, 203-211.

RASHEVSKY, N. (1946). The neural mechanism of logical thinking. Bull. math. Biophys. 8, 1, 29-40.

RASHEVSKY, N. (1951). A note on imitative behaviour and information. Bull. math. Biophys. 13, 3.

RAYMOND, R. C. (1951). The well-informed heat engine. Amer. J. Phys. 19, 2, 109-111.

RAYMOND, R.C. (1950). Communication, entropy and life. Amer. Scientist, 38, 2, 273-278.

REICH, E. (1951). The game of 'gossip' analysed by the theory of information. Bull. math. Biophys. 13, 313-318.

RICE, S.O. (1944). Mathematical analysis of random noise. Bell Syst. tech. J. 23, 282-332 and 24, 46-156.

RICE. S.O. (1950). Communications in the presence of noise - probability of error for two encoding schemes. Bell Syst. tech. J. 29, 1, 60-93.

RICHARDS, D.L and SWAFFIELD, J. (1953). Measurement of the communciation rate of speech link - a preliminary appraisal of the problem. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

RICHARDS, D.L. (1953). Some aspects of the behaviour of telephone users as affected by the physical properties of the circuit. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

RICHARDS, I.A. (1952). Communication between men - meaning of language. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

RICHARDS, P.I. (1951). Machines which can learn. Amer. Scientist, 39, 4, 711- 716.

RICHARDS, P.I. (1952). On game-learning machines. Sci. Mon., N.Y., 74, 201-205.

RICHARDSON, L.F. (1939). Generalised foreign politics. Brit. J. Psychol. Monog. Suppl. 23.

RIGNANO, E. (1926). Man not a machine. London: Paul, Trench and Trubner.

RODDAM, T. (1949) Communication theory, old and new. Science news XII. London: Penguin Books.

ROGERS, M.S. (1953) An application of information theory to the problem of the relationship between meaningfullness of material and performance in a learning situation. Dissertation Abstr. 13,600. Univer. Microfilms, Ann Arbor, Mich., Publ. No. 5164-.

ROGERS, M.S. and GREEN, B.F.(1955).The moments of sample information when the alternatives are equally likely. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

ROSENBLITH, W.A. (1949). Cybernetics - book review of Wiener (1948b). Ann. Amer. Acad. 264, 187.

ROSENBLUETH, A. and WIENER, N. (1945). The role of models in Science. Phil. Sci. 12, 316-322.

ROSENBLUETH, A., WIENER N. and BIGELOW, J. (1943). Behaviour, purpose and teleology. Phil. Sci. 10, 1, 18-24.

ROTHSTEIN, J. (1951). Information, measurement, and quantum mechanics. Science, 114, 171-175.

RUARK, A.E. (1951). Information theory. Part of Report No.145, Programs Research Unit, Institute for Cooperative Research, The John Hopkins University.

RUESCH, J. (1952). The therapeutic process. IV - The tberapeutic process from the point of view of communication theory. Amer. J. Orthopsychiat. 22, 690-700.

RUESCH, J. and BATESON, G. (1949). Structure and process in social relations. Psychiatry, 12, 2, 105-124.

RUESCH, J. and BATESON, G. (1951). Communication. The social matrix of psychiatry. New York: Norton.

RUSHTON, W.A.H. (1950). The problem of the information which the brain receives from the eye. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

RUYER, R. (1952). Le probleme de l'informationet la cybernetique. (The problem of information and cybernetics.) J. Psychol. norm. path. 45, 385-418.

***S***

SADOSKY, M. (1954). Cibernetica - realidades y falacias. (Cybernetics - facts and falacies.) Acta neuropsiquiat Argent. 1, 97-103.

SADOSKY, M. (1955). Cibernetica (conclusion) - matematicas, logia y maquinas. (Cybernetics (conclusion) - mathematics, logic and machines.) Acta. Neuropsiqiat. Argent. 1, 300-307.

SAMSON, E.W. (1953). Fundamental natural concepts of information theory. Etc. Rev. Gen. Semant. 10, 283-297.

SAMUEL, A.L. (1953). Computing bit by bit or digital computers made easy. Proc. I.R.E. 41, 10, 1223-1230.

SAMUELSON, P.A. (1947). Foundations of economic analysis. (part II and Appendix B.) Cambridge: Harvard Univer. Press.

SAPIR, E. (1931 ). Communication. Encyclopedia of the social sciences. Vol IV. New York: Macmillan.

SCHAFER, T.H. (1955). A basic experiment in detection. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

SCHNEIRIA, T.D. and PEIL, G. (1948). The army ant. Sci. American, 178, 6, 22-26.

SCHNEIRLA, T.D. (1951). The levels concept in the study of social organisation in animals. In J.H. Rohrer and M. Sherif (Eds.), Social psychology at the crossroads. New York: Harper.

SCHOUTEN, J.F. (1955). Ignorance, knowledge and information. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

SCHRAMM, W. (1955). Information theory and mass communication. Journalism Quart. 32, 131-146.

SCHRODINGER, E. (1944). What is life? Cambridge, Eng.: Cambridge Univer. Press. Also (1945) New York: Macmillan.

SCHUTZENBERGER, M.P. (1955). On some measures of information used in statistics. In E.C. Cherry (Ed. ), Information theory, third London symposium. London: Butterworths.

SELFRIDGE, O.G. (1955). Pattern recognition and learning. In E.C. Cherry (Ed.), Information theory, third Iondon symposium. London: Butterworths.

SENDERS, J.W. (1955). Man's capacity to use information from complex displays. In H. Quastler (Ed.), Iniformation theory in psychology. Glencoe, Ill: Free Press.

SENDERS, V.L (1955). The effect of number of subjects on the estimate of transmitted information. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

SENDERS, V.L. and COHEN, J. (1955). The effects of sequential dependencies on instrument reading performance. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

SERRELL, R. (1953). Elements of Boolean algebra for the study of information handling systems. Proc. I.R.E. 41, 10, 1366-1380.

SHANNON, C.E. (1938). A symbolic analysis of relay and switching circuits. Elec. Engng. Transactions Suppl. 57, 713-723.

SHANNON, C.E. (1948). A mathematical theory of communication. Bell Syst. tech. J. 27, 379-424 and 623-657.

SHANNON, C.E. (1949a). Communication in the presence of noise. Proc. I.R.E. 37, 10-21.

SHANNON, C.E. (1949b). Communication theory of secrecy systems. Bell Syst. tech. J. 28, 656-715.

SHANNON, C.E. (1949c). Synthesis of tvo-terminal switching circuits. Bell Syst. tech. J. 28, 59-98.

SHANNON, C.E. (1950a). Chess-playing machine. Sci. Amer. 182, 2, 48-51.

SHANNON, C.E. (1950b). Communication theory - exposition of fundamentals. In Information theory, first London symposium, London: Ministry of Supply. Mimeographed.

SHANNON, C.E. (1950c). General treatment of the problem of coding. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

SHANNON, C.E. (1950d). The lattice theory of information. In Informaation theory, first London symposium. London: Ministry of Supply. Mimeographed.

SHANNON, C.E. (1950e). Memory requirements in a telephone exchange. Bell Syst. tech. J. 29, 3, 343-349.

SHANNON, C.E. (1950f). Programming a computer for playing chess. Phil. Mag. 41, 256-275.

SHANNON, C.E. (1950g). Recent developments in communication theory. Electronics, 23, 80-84.

SHANNON, C.E. (1951a).. Prediction and entropy of printed English. Bell Syst. tech. J. 30, 1, 50-64.

SHANNON, C.E. (1951b). The redundancy of English. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the seventh conference. New York: Josiah Macy, Jr. Foundation.

SHANNON, C.E. (1952). Presentation of a maze-solving machine. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

SHANNON, C.E. (1953). Computers and automata. Proc. I.R.E. 41, 1235-1241.

SHANNON, C.E. (1956). A universal Turing machine with two internal states. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

SHANNON, C.E. and WEAVER, W. (1949). The mathematical theory of communication. Urbana, Ill: Univer. of Illinois Press.

SHEPARD, H.A. ( ). Social system of a research group. Mimeographed.

SHIMBEL, A. (1949 ). Input-output problems in simple-nerve ganglion systems. Bull. math. Biophys. 11, 165-171.

SHIMBEL, A. (1952). Some elementary considerations of neural models. Bull. math. Biophys. 14, 68-71.

SHOLL, D.A. (1956). The organisation of the cerebral cortex. New York: Wiley.

SHOLL, D.A. and UTTLEY, A.M. (1953). Pattern discrimination and the visual cortex. Nature, London, 172, 387-388.

SIMON, H.A. ( ). .An exploration into the use of servomechanism theory in the study of production control. Cowels Commission discussion paper - Economics, No.288. Mimeographed copy for private circulation.

SIMON, H.A. (1948a). Administrative behaviour. New York: Macmillan.

SIMON, H.A. (1948b). A study of decision-making processes in administrative organisation. New York: Macmillan.

SIMON, H.A., SMITHBURG, D. and THOMPSON, V.A. (1950). Public administration. New York: Knopf.

SLATER, E. (1950). Statistics for the chess computer and the factor of mobility. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

SLEPIAN, D. (1955). A class of binary signalling alphabets. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

SLUCKIN, W. (1954). Minds and machines. London: Penguin Books.

SMITH, E.S. (1944). Automatic control engineering. New York: McGraw-Hill.

SMITH, K. (1951). Psychology and the concept of 'Life'. Psychol. Rev. 58, 5, 330.

SOMENZI, V. (1955). Can induction be mechanized? In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

SPIETH, W., CURTIS, J.F. and WEBSTER, J.C. (1954). Responding to one of two simultaneous messages. J. acoust. Soc. Amer. 26, 391-396.

SPILSBURY, R.T. (1952). Mentality in machines. Symposium. Proc. Aristotelian Soc. Supplementary Vol. 16.

STAGNER, R. (1951). Homeostasis as a unifying concept in personality theory. Psychol. Rev. 58, 5-17.

STEVENS, S. (1950). Proceedings of the speech communication conference at M.I.T.; introduction - a definition of communication. J. acoust. Soc. Amer. 22, 689-690.

STORR, A. (1956). A note on cybernetics and analytical psychology. J. anal. Psychol. 1, 93-95.

STRACHEY, C.S. (1952). Logical or non-mathematical programmes. Proc. Ass. Computing Machinery, Toronto, 46-49.

STRAUS, O.H. (1950). The relation of phonetics and linguistics to communication theory. J. acoust. Soc. Amer. 22, 6, 709-711.

STROUD, J.M. (1948). The moment function hypothesis. MA. Thesis, Stanford Univer.

STROUD, J.M. (1950). Psychological moment in perception - discussion. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the sixth conference. New York: Josiah Macy, Jr. Foundation.

STROUD, J.M. (1951). The development of language in early childhood. In H. von Foerster (Ed.), Cybernetics -circular, causal and feedback mechanisms in biological and soical systems. Transactions of the seventh conference. New York: Josiah Macy, Jr. Foundation.

STROUD, J.M. (1955). The fine structure of psychological time. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

SWEET, A.L. (1953). Some problems in the application of cognitive theory to personality functioning. J. Pers. 22, 41-51.

SZILARD, I. (1929). Uber die Entropieverminderung in einem thermodynamischen system bei Eingriffen intelligenter Wesen. (The diminution of entropy in a thermodynamic system caused by the intervention of intelligent beings.) Z. Physik, 53, 840-856.

***T***

TAKADA, Y. (1954). Tsushin riron ni tsuite. (On the mathematical theory of communication.) Jap. J. Psychol. 25, 110-11 7.

TANNER, W.P.Jr. (1955). On the design of psychophysical experiments. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

TAYLOR, R. (1950). Comments on a mechanistic conception of purposefulness. Phil. Sci. 17.

TAYLOR, W.K. (1955). Electrical simulation of some nervous system functional activities. In E.C. Cherry (Ed.), Information theory, third Londan symposium. London: Butterworths.

THALER, G.J. and BROWN, R.G. (1953). Servomechanism analysis. New York: McGraw-Hill.

THOMAS, W.H. (1953). Fundamentals of digital computer programming. Proc. I.R.E. 41, 10, 1245-1249.

THOMS0N, R. and SLUCKIN W. (1954). Machines, robots and minds. Durham Univer. J., (England) 46, 116-122.

THOMSON, R. and SLUCKIN, W. (1953). Cybernetics and mental functioning. Brit. J. Phil. Sci. 3, 130-146.

TOLMAN, E.C. (1932). Purposive behaviour in animals and men. Berkeley: Univer. of California Press.

TOLMAN, E.C. (1938). Principles of statistical mechanics. Oxford: Clarendon Press.

TRIMMER, J.D. (1949). Instrumentation and cybernetics. Sci. Mon. N.Y. 69, 328-331.

TRIMMER, J.D. (1950). Response of physical systems. New York: Wiley.

TSIEN, H.S. (1951). Engineering cybernetics. New York: McGraw-Hill.

TULLER, W.G. ( ). Theoretical limitations on the rate of transmission of information. Technical Report No. 114, Research Laboratory of Electronics, M.I.T. Also (1949). Proc. I.R.E. 37, 468

TURING, A.M. (1937). On computable numbers with reference to the Entscheidungsproblem. Proc. London math. Soc. 2-42, 230-265.

TURING, A.M. (1950). Computing machinery and intelligence. Mind, 59, 433-460. Also (1954). Methodos, 23, 6.

TURING, A.M. (1948). Intelligent machinery. Unpublished paper.

TUSTIN, A. (1953). Do modern mechanisms help us to understand the mind? Brit. J. Psychol. 44, 1, 24.

TWEEDELL, K.S. (1953). Identical twinning and the information content of zygotes. In H. Quastler (Ed.), Information theory in Biology. Urbana, Ill: Univer. of Illinois Press.

***U***

UTTLEY, A.M. (1950). Information, machines and brains. In Informaation theory, first London symposium. London: Ministry of Supply. Mimeographed.

UTTLEY, A.M. (1954a). The classification of signals in the nervous system. Ministry of Supply, R.R.E. memorandum No. 1047. Also (1954) E.E.G. Clin. Neurophysiol. 6, 479-494.

UTTLEY, A.M. (1954b) The probability of neural connections. Ministry of Supply, R.R.E. memorandum No 1948. Also (1955) Proc. roy. Soc., series B, 144, 916.

UTTLEY, A.M. (1955). The conditional probability of signals in the nervous system. Ministry of Supply, R.R.E. memorandunr No.109.

UTTLEY, A.M. (1956a). Conditional probability machines and conditioned reflexes. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

UTTLEY, A.M. (1956b). Temporal and spatial patterns in a conditional probability machine. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

***V***

van der POL, B. (1955). An iterative translation test. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

van SOEST, J.L. (1955). Some consequences of the finiteness of information. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

van VLECK, J. and MIDDLETON, D. (1946). A theoretical comparison of the visual, aural, and meter reception of pulsed signals in the presence of noise. J. appl. Phys. 17, 940.

VIGNERON, H. (1914). Les automates. (Automata) La Natura.

VILLE, J. (1948). Theorie et applications de signal analytique. (Theory and applications of analytic signals.) Cables et transmission, 2, 61.

von BERTALANFFY, L (1942). Theoretische Biologie (Theoretical biology.) Berlin.

von BERTALANFFY, L. (1940). Der Organismus als physikalisches System, betrachtet. (The organism considered as a physical system.) Naturwissenschaften, 28, 521-531.

von BERTALANFFY, L. (1944). Bemerkungen zum Modell der Biologischen Elementareinheiten. (Observations on a model for the elementary units of biology.) Naturwissenschaften, 32, 26-32.

von BERTALANFFY, L. (1948). Das Weltbild der Biologie. (The biological attitude.) In Weltbild und Menschenbild, III. Internat. Hochschulwochen. des Oesterr. College, Salzburg. 251-274.

von BERTALANFFY, L. (1949). Das biologische Weltbild. (The biological attitude.) Bern. Also (1952) as Problems of Life. London: Watts.

von BERTALANFFY, L. (1950a). An outline of general system theory. Brit. J. Phil. Sci. 1, 134.

von BERTALANFFY, L. (1950b). The theory of open systems in physics and biology. Science, III. 23.

von BERTALANFFY, L. (1952). Theoretical models in biology and psychology. In D. Krech and G.S. Klein (Eds.), Theoretical models in personality theory. Durham, N.C.: Duke Univer. Press.

von FOERSTER, H (1950). Quantum theory of memory. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the sixth conference. New York: Josiah Macy, Jr. Foundation.

von FOERSTER, H. (1948). Das Gedachtnis. (Memory.) Vienna.

von NEUMANN, J. (1949). Cybernetics - book review of Wiener (1948b) Physics Today, 2, 5, 33-34.

von NEUMANN, J. (1951). The general and logical theory of automata. In LA. Jeffress (Ed.), Cerebral Mechanisms in Behaviour. New York: Wiley.

von NEUMANN, J. (1952). Probabilistic logics and the synthesis of reliable organisns from unreliable components. California Institute of Technology Lectures - notes taken by R.S. Pierce. Also (1956) in C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

von NEUMANN, J. and MORGENSTERN, A. (1947). Theory of games and of economic behaviour. Princeton, N.J.: Princeton Univer. Press.

***W***

WAISHE, F.M.R. (1952). The hypothesis of cybernetics. (Comment on Wisdom, 1951). Brit. J. Phil. Sci. 2, 161-163.

WALL, P.D., LETTVIN, J.Y., McCULLOCH, W.S. and PITTS, W.H. (1955). Factors limiting the maximum impulse transmitting ability of an afferent system of nerve fibres. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

WALTER, W. G. (1955). Studies on activity of the brain. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the tenth conference. New York: Josiah Macy, Jr. Foundation.

WALTER, W.G. (1950a). An electro-mechanical "animal ". Dialectica, 4, 206-213. Also (1950 Discovery, 11, 90-93.

WALTER, W.G. (1950b). Features in the electro-physiology of mental mechanisms. In D. Richter (Ed.), Perceptives in Neuropsychiatry. London: H.K. Lewis.

WALTER, W.G. (1950c). The functions of electrical rhythms in the brain. J. ment. Sci. 96, 402.

WALTER, W.G. (1950d). An imitation of life. Sci. Amer. 182, 5.

WALTER, W.G. (1950e). Possible features of brain functions and their imitation. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

WALTER, W.G. (1950f). Rhythm and reason. E.E.G. Clin. Neurophysiol. 2, 203.

WALTER, W.G. (1951). A machine that learns. Sci. Amer. 185, 2, 60-63.

WALTER, W.G. (1952). Patterns in your head. Discovery, 13, 56-62.

WALTER, W.G. (1953). The living brain. London: Duckworth.

WALTER, W.G. (1954). Theoretical properties of diffuse projection systems in relation to behaviour and consciousness. In Brain Mechanisms and Consciousness - Symposium. Oxford: Blackwell.

WALTER, W.G. and DOVEY, V.J. (1947). Etude analytique des rhythmes corticaux induits par une stimulation lumineuse intermittente. (An analytic study of cortical rhythms induced by an intermittent light stimulus.) Marseille Med. I, 240-248.

WALTER, W.G. and WALTER, V.J. (1949). Central (cortical) effects of rhythmic sensory (visual) stimulation. EEG. clin. Neurophysiol. 1, 57-86.

WALTER, W.G., DOVEY, V.J. and. SHIPTON, H. (1946). Analysis of the electric response of the human cortex to photic stimulation. Nature, London, 158, 540-541.

WEAVER, W. (1948a). Probability, rarity, interest, and surprise. Sci. Mon., N.Y.,67.

WEAVER, W. (1948b) Science and complexity. Amer. Scientist, 36, 4, 536-544.

WEAVER, W. (1949). The mathematics of commmunication. Sci. Amer. 181, 1, 11-15.

WEAVER, W. (1952). Information theory: 1. Information theory to 1951 - a non-technical review. J. Speech Hearing Disorders.17, 166-174.

WEAVER, W. (1953). Recent contributions to the mathematical theory of communication. Etc. Rev. gen. Semant. 10, 261-281.

WEBER, C.O. (1949). Homeostasis and servo-mechanisms for what? Psychol. Rev. 56, 234-239.

WEBSTER, J.C. and THOMPSON, P.O. (1954). Responding to both of two overlapping messages. J. acoust. Soc. Amer. 26, 396-402.

WEI, T. (1948). On matrices of neural nets. Bull. math. Biophys. 10, 63-67.

WEINBURG, M. (1951). Mechanism in neurosis. Amer. Sci. 39, 74-99.

WERNER, H. (1951). On the development of word meanings. In H. Von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisns in biological and social systems. Transactions of the seventh conference. New York: Josiah Macy, Jr. Foundation.

WESTCOTT, J.H (1950). Criteria of prediction and discrimination. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

WESTON, J.D. (1949). A note on the theory of communication. Phil. Mag. 40, 449.

WHORF, B.L. (1950) .Four articles on metalinguistics. Reprinted from Technolog;y Rev. and Language, Culture and Personality. Washington D.C.: Foreign Service Inst., Dept. of State.

WIENER, N. (1948a). Cybernetics. Sci. Amer. 179, 5, 14-19.

WIENER, N. (1948b). Cybernetics; or control and communication in the animal and the machine. New York: Wiley.

WIENER, N. (1948c) Time, communication, and the nervous system. In L.K. Frank et al. (Eds.), Teleological Mechanisms - Symposium. Ann. N.Y. Acad. Sci. 50, 197-220.

WIENER, N. (1949a). Extrapolation, interpolation and smoothing of stationary time series. .New York: Wiley.

WIENER, N. (1949b). New concept of communication engineering. Electronics, 22, 1, 74-77.

WIENER, N. (1950a). The human use of human beings - Cybernetics and society. Boston, Mass: Houghton Mifflin.

WIENER, N. (1950b). Sensory prothesis. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the sixth conference, New York: Josiah Macy, Jr. Foundation.

WIENER, N. (1950c). Speech, language and learning. J. acoust. Soc. Amer. 22, 6, 696-697.

WIENER, N. and ROSENBLUETH, A. (1950). Purposeful and non-purposeful behavior. Phil. Sci. 17.

WILKES, M.V. (1951a). Automatic calculating machines. J. roy. Soc. Arts, 100, 56-90.

WILKES, M.V. (1951b). Can machines think? Spectator 6424, 177-178. Also.(1953) Proc. I.R.E., 41, 10, 1230-1234.

WILKES, M.V., WHEELER, D.J. and GILL, S. (1951). The preparation of programs for an electronic digital computer. Cambridge, Mass.: Addison-Wesley.

WILLIS, R. (1954). Estimating the scalability of a series of items. Psychol. Bull. 51, 511-516.

WILSON, K. van N. (1954). Information transmission and optimal coding in natural language message. Dissertation Abstr. 14, 1802-1803. Abstract of Ph.D thesis, Univer. of Illinois.

WISDOM, J.O. (1951). The hypothesis of cybernetics. Brit. J. Phil. Sci. 2, 1-24.

WISDOM, J.O. (1952). Mentality in machines - Symposium. Proc. Aristotelian Soc. Supplementary Vol. 26.

WOODWARD, P.M. (1950). Theory of radar information. In Information theory, first London Symposium. London: Ministry of Supply. Mimeographed.

WOODWARD, P.M. (1953). Probability and information theory. New York: McGraw-Hill.

WOODWARD, P.M. and DAVIES, I.L. (1950). A theory of radar information. Phil. Mag. 41, 1001.

WOODWARD, P.M. and DAVIES, I.L. (1952). Information theory and inverse probability in telecommunication. Proc. I.E.E. 99, 3, 37.

WRIGHT, H.W. (1954). The significance of communication for psychological theory. Canad. J. Psychol. 8, 32-40.

WYCOFF, L.B., Jr. (1954). A mathematical model and an electronic model for learning. Psychol. Rev. 61, 89.

***X***

***Y***

YNGVE, V.H. (1954). The machine and the man. Mech. Translation, 1, 20-22.

YNGVE, V.H. (1955). The translation of languages by machine. In E.C. Cherry (Ed.), Infomation theory, third London symposium. London: Butterworths.

YOUNG, J.Z. (1951a). Doubt and certainty in science. Oxford: Clarendon Press.

YOUNG, J.Z. (1951b). Growth and plasticity in the nervous system. Proc. roy. Soc., London, Series B, 139, 18.

YOUNG, J.Z. (1953) .Discrimination and learning in octopus. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological. and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

***Z***

ZIPF, G.K. (1949). Human behaviour and the principle of least effort. Cambridge Mass: Addison Wesley.

***SYMPOSIA***

ADOLPH, A. (Ed.), (1943). Physiological regulations. Lancaster, PA.: Cartell Press.

AERO MEDICAL LABORATORY. (1948). Application of operational analysis to human motor behaviour. Memo. Report MCREXD 694-2J.

BOWDEN, B.V. (Ed.), (1953). Faster than thought. London: Pitman.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. (1954). Symposium on cybernetics. Advancement of Sci. 40.

CHERRY, E.C. (Ed.), (1955). Information theory, third London symposium, Ministry of Supply. September 12-16, 1955. London: Butterworths. New York: Academic Press.

de BROGLIE, L. (Ed.), ( ). La cybernetique. (Communication theory.) Report of conference. Paris: Rev. Opt.

FERRANTI LTD. (1951). The Ferranti Nimrod digital calculator.

HARVARD UNIVERSITY COMPUTATION LABORATORY. (1951). Synthesis of electronic computing and control circuits. Cambridge, Mass.: Harvard Univer. Press.

HJGH SPEED AUTOMATIC CALCULATING MACHINES. (1950). Report of conference at the University Mathematical Laboratory, Cambridge, England. Ministry of Supply.

INFORMATION THEORY. (1950). First London symposium, Ministry of Supply. London: Mimeographed. Also (1950) Proc. I.R.E.

JACKSON, W. (Ed.), (1953). Communication theory, second London syposium, Ministry of Supply. London: Butterworths. New York: Academic Press.

JEFFRESS, L.A. (Ed.), (1951). Cerebra1 mechanisms in behaviour. The Hixon Symposium. New York: Wiley.

LICKLIDER, J.C.R. (Ed.), (1955). Problems in human communication and control. Cambridge, Mass.

QUASTLER, H. (Ed.), (1953). Essays on the use of information theory in biology. Urbana, Ill.: Univer. of Illinois Press.

QUASTLER, H. (Ed.), (1955). Information theory in psychology. Glencoe, Ill.: Free Press.

RICHTER, D. (Ed.), (1950). Persectives in neuropsychiatry. London: H.K. Lewis.

SCIENTIFIC AMERICAN EDITORS. (1955). Automatic control. New York: Simon and Schuster.

SERVOMECHANISMS. (1951). Selected Government Research Report, Vol. 5, London: H.M. Stationery office.

SHANNON, C.E. and McCARTHY, J. (Eds.), (1956). Automata studies. Ann. Math. Stud. No. 34, Princeton, N.J.: Princeton Univer. Press.

SIGNIFICS CONFERENCE. (1953). Semantic and signific aspects of modern theories of communication. Synthese, IX, 3, 3-5.

TILTS, P.M. (Ed.), (1951). Human engineering for an effective air-navigation and traffic control. National Research Council. 12, 88.

TUSTIN, A. (Ed.), (1951). D.S.I.R., Cranfield confererence on automatic control. London: Butterworths.

UNIVERSITY COLLEGE LONDON. (1955). Studies in communication. Communications research centre. London: Secker and Warburg.

von FOERSTER, H. (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of: (1950). Sixth conference, March 24-25, 1949. (1951). Seventh conference, March 23-24,1950. (1952). Eighth conference, March 15-16,1951. (1953). Ninth conference, March 20-2l, 1952. (1955). Tenth conference, April 22-24, 1953. New York: Josiah Macy, Jr. Foundation.

WISDOM, J.O., SPILBURY, R.J., and MacKAY, D.M. (1952) Mentality in machines - symposium. Proc. Aristotelian Soc., supplementary Vol., 26.

# *Communications Strategy*

by Charles A. Sherwood

· **Composite A**

· **Composite B**


WARNING: SPECIAL ACCESS REQUIRED
TOP SECRET
File Name:
File No.
WARNING: SPECIAL ACCESS REQUIRED

· **Composite C**


WARNING: SPECIAL ACCESS REQUIRED
TOP SECRET
File Name:
File No.
WARNING: SPECIAL ACCESS REQUIRED

# Human auditory system response to Modulated electromagnetic energy

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Frey, Allan H. Human auditory systems response to modulated electromagnetic energy.
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The intent of this paper is to bring a new phenomenon to the attention of physiologists. Using extremely low average power densities of electromagnetic energy, the perception of sounds was induced in normal and deaf humans. The effect was induced several hundred feet from the antenna the instant the transmitter was turned on, and is a function of carrier frequency and modulation. Attempts were made to match the sounds induced by electromagnetic energy and acoustic energy. The closest match occurred when the acoustic amplifier was driven by the rf transmitter's modulator. Peak power density is a critical factor and, with acoustic noise of approximately 80 db, a peak power density of approximately 275 mw/cm2 is needed to induce the perception at carrier frequencies of 425 mc and 1,310 mc. The average power density can be at least as low as 400 uw/cm2. The evidence for the various possible sites of electromagnetic energy sensor are discussed and locations peripheral to the cochlea are ruled out.

A significant amount of research has been concerned with the effects of radio-frequency (rf) energy on organisms (electromagnetic energy between 1Kc and 100 Gc). Typically, this work has been concerned with determining damage resulting from body temperature increase. The average power densities used have been on the order of 0.1-1 w/cm2 used ove many minutes to several hours. In contrast, using average power densities measured in microwatts per square centimeter, we have found that other effects, which are transient, can be induced with this energy. Further, these effects occur the instant the transmitter is turned on. With appropriate modulation, the perception of various sounds can be induced in clinically deaf, as well as normal, human subjects at a distance of inches up to thousands of feet from the transmitter. With somewhat different transmitter parameters, we can induce the perception of severe buffeting of the head, without such apparent vestibular symptoms as dizziness or nausea. Changing transmitter parameters again, one can induce a "pins-and -needles" sensation.

Experimental work with these phenomena may yield information on auditory system functioning and, more generally, information on nervous system function. For example, this energy could possibly be used as a tool to explore nervous system coding, possibly using Neider and Neff's procedures (1), and for stimulating the nervous system without the damage caused by electrodes. Since most of our data have been obtained on the "rf sound" and only the visual system has previously been shown to respond to electromagnetic energy, this paper will be concerned only with the auditory effects data. As a further restriction, only data from human subjects will be reported, since only these data can be discussed meaningfully at the present time. The long series of studies we performed to ascertain that we were dealing with a biologically significant phenomenon (rather than broadcasts from sources such as loose fillings in teeth) are summarized in another paper (2), which also reports on the measuring instruments used in this work. The intent of this paper is to bring this new phenomenon to the attention of physiologists. The data reported are intended to suggest numerous lines of experimentation and indicate necessary experimental controls. Since we were dealing with a significant phenomenon, we decided to explore the effects of a wide range of transmitter parameters to build up a body of knowledge which would allow us to generate hypotheses and determine what experimental controls would be necessary. Thus, the numbers given are conservative; they should not be considered precise, since the transmitters were never located in ideal laboratory environments. Within the limits of our measurements, the orientation of the subject in the rf field was of little consequence. Most of the transmitters used to date in the experimentation have been pulse modulated with no information placed on the signal. The rf sound has been described as being a buzz, clicking, hiss, or knocking, depending on several transmitter parameters, i.e., pulse width and pulse-repetition rate (PRF). The apparent source of these sounds is localized by the subjects as being within, or immediately behind, the head. The sound always seem to come from within or immediately behind the head, no matter how the subject twists or rotates in the rf field.

Our early experimentation, performed using transmitters with very short square pulses and high pulse repetition rates, seemed to indicate that we were dealing with harmonics of the PRF. However, our later work has indicated that this is not the case; rather, the rf sound appears to be the incidental modulation envelope on each pulse, as shown in Fig. 1

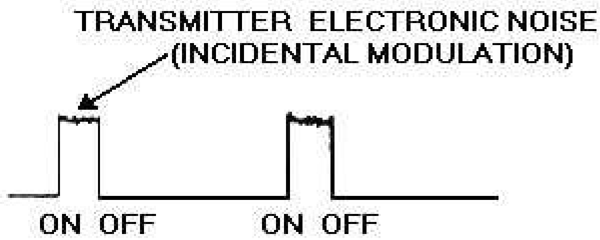
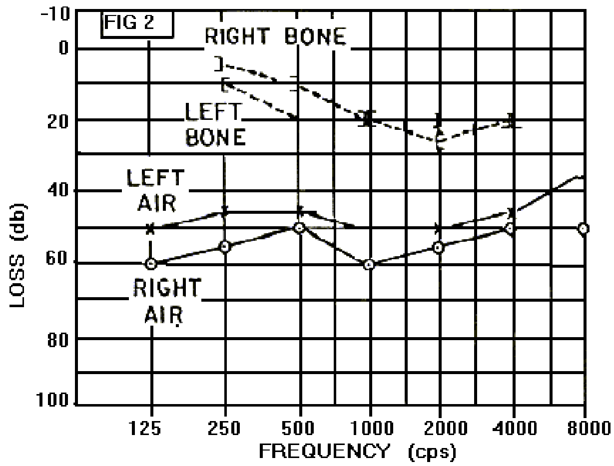



Fig 1 Oscilloscope representation of transmitter output over time (pulse-modulated)

Some difficulty was experienced when the subjects tried to match the rf sound to ordinary audio. They reported that it was not possible to satisfactorily match the rf sound to a sine wave or white noise. An audio amplifier was connected to a variable bandpass filter and pulsed by the transmitter pulsing mechanism. The subjects, when allowed to control the filter, reported a fairly satisfactory match. The subjects were fairly well satisfied when all frequencies below 5Kc audio were eliminated and the high-frequency audio was extended as much as possible. There was, however, always a demand for more high-frequency components. Since our tweeter has a rather good high frequency response, it is possible that we have shown an analogue of the visual phenomenon in which people see farther into the ultraviolet range when the lens is eliminated from the eye. In other words, this may be a demonstration that the mechanical transmission system of the ossicles cannot respond to as high a frequency as the rest of the auditory system. Since the rf bypasses the ossicle system and the audio given the subject for matching does not, this may explain the dissatisfaction of our subjects in their matching. At one time in our experimentation with deaf subjects, there seemed to be a clear relationship between the ability to hear audio above 5Kc and the ability to hear rf sounds. If a subject could hear above 5Kc, either by bone or air conduction, then he could hear the rf sounds. For example, the threshold of a subject whose audio-gram appears in Fig. 2 was the same average power density as our normal subjects. Recently, however, we have found people with a notch around 5Kc who do not perceive the rf sound generated by at least one of our transmitters.




Audiogram of deaf subject (otosclerosis) who had a "normal" rf sound threshold

THRESHOLDS

TABLE 1 Transmitter parameters

| Trans-mitter Cycle | Frequency mc | Wave-length cm | Pulse Width usec | Pulses/Sec | Duty |
|---|---|---|---|---|---|
| A | 1,310 | 22.9 | 6 | 224 | .0015 |
| B | 2,982 | 10.4 | 1 | 400 | .0004 |
| C | 425 | 70.6 | 125 | 27 | .0038 |
| D | 425 | 70.6 | 250 | 27 | .007 |
| E | 425 | 70.6 | 500 | 27 | .014 |
| F | 425 | 70.6 | 1000 | 27 | .028 |
| G | 425 | 70.6 | 2000 | 27 | .056 |
| H | 8,900 | 3.4 | 2.5 | 400 | .001 |

As shown in Table 1, we have used a fairly wide range of transmitter parameters. We are currently experimenting with transmitters that radiate energy at frequencies below 425 mc, and are using different types of modulation, e.g., pulse-repetition rates as low as 3 and 4/sec. In the experimentation reported in this section, the ordinary noise level was 70-90 db (measured with a General Radio Co. Model 1551-B sound-level meter). In order to minimize the rf energy used in the experimentation, subjects wore Flent antinoise ear stoppers whenever measurements were made. The Ordinary noise attenuation of the Flents is indicated in Fig. 3. Although the rf sounds can be heard without the use of Flents, even above an ambient noise level of 90 db, it appears that the ambient noise to some extent "masked" the rf sound.

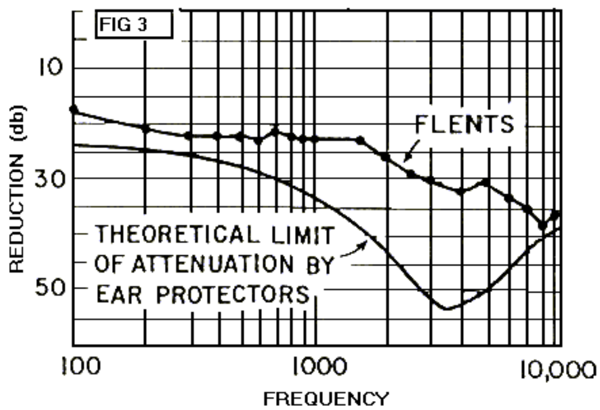



**FIG 3 Attenuation of ambient sound with Flent antinoise ear stopples (collated from Zwislocki (3) and Von Gierke (4)**

TABLE 2 Threshold for perception of rf sound (ambient noise level 70 - 90 db)

| Trans-mitter | Frequency mc | Duty Cycle | Avg Power Density mw/cm2 | Peak Power Density mw/cm2 | Peak Electric Field v/cm | Peak Magnetic Field amp turns/m |
|---|---|---|---|---|---|---|
| A | 1,310 | .0015 | 0.4 | 267 | 14 | 4 |
| B | 2,982 | .0004 | 2.1 | 5,250 | 63 | 17 |
| C | 425 | .0038 | 1.0 | 263 | 15 | 4 |
| D | 425 | .007 | 1.9 | 271 | 14 | 4 |
| E | 425 | .014 | 3.2 | 229 | 13 | 3 |
| F | 425 | .028 | 7.1 | 254 | 14 | 4 |

Table 2 gives the threshold for perception of the rf sounds. It shows fairly clearly that the critical factor in perception of rf sound is the peak power density, rather than the average power density. The relatively high value for transmitter B was expected and will be discussed below. Transmitter G has been omitted from this table since the 20 mw/cm2 reading for it can be considered only approximate. The field-strength-measuring instruments used in that experiment did not read high enough to give an accurate reading. The energy from transmitter H was not perceived, even when the peak power density was as high as 25 w/cm2. When the threshold energy is plotted as a function of the rf energy (Fig 4), a curve is obtained which is suggestive of the curve of penetration of rf energy into the head. Figure 5 shows the calculated penetration, by frequency of rf energy, into the head. Our data indicate that the calculated penetration curve may well be accurate at the higher frequencies but the penetration at the lower frequencies may be grater than that calculated on this model.

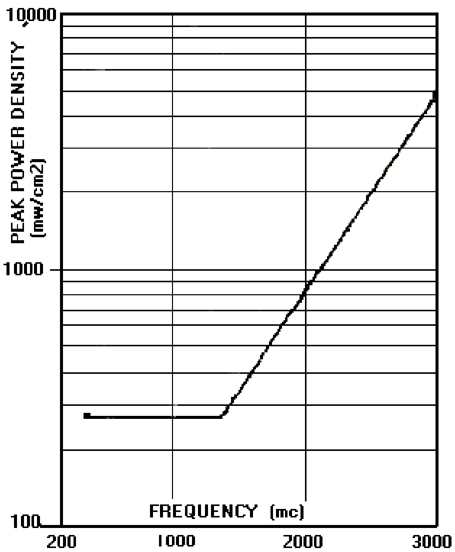



Fig 4 Threshold energy as a function of frequency of electromagnetic energy (ambient noise level 70 - 90 db)

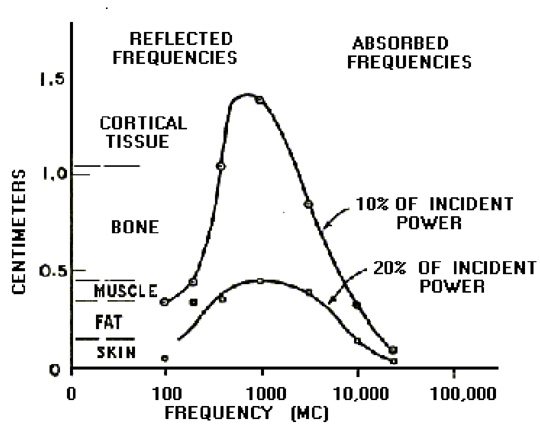



FIG 5 Microwave power distribution in the forehead model neglecting resonance effects and considering only first reflections (from Nieset et al (5), modified)

As previously noted, the thresholds were obtained in a high ambient noise environment. This is an unusual situation as compared to obtaining thresholds of regular audio sound. Our recent experimentation leads us to believe that, if the ambient noise level were not so high, these threshold field strengths would be much lower. Since one purpose of this paper is to suggest experiments, it might be appropriate to theorize as to what the rf sound threshold might be if we assume that the subject is in an anechoic chamber. It is also assumed that there is no transducer noise.

Given: As a threshold for the rf sound, a peak power density of 275 mw/cm2 determined in an ambient noise environment of 80 db. Earplugs attenuate the ambient noise to 30 db.

If: 1 mw/cm2 is set equal to 0 db, then 275 mw/cm2 is equal to 24 db.

Then: We can reduce the rf energy 50 db to -26 db as we reduce the noise level energy from 50 db to 0 db. We find that -26 db rf energy is approximately 3 uw/cm2.

Thus: In an anechoic room, rf sound could theoretically be induced by a peak power density of 3 uw/cm2 measured in free space. Since only 10% of this energy is likely to penetrate the skull, the human auditory system and a table radio may be one order of magnitude apart in sensitivity to rf energy.

RF DETECTOR IN AUDITORY SYSTEM

One possibility that seems to have been ruled out in our experimentation is that of a capacitor type effect with the tympanic membrane and oval window acting as plates of a capacitor. It would seem possible that these membranes, acting as plates of a capacitor, could be set in motion by rf energy. There are, however, three points of evidence against this possibility. First, when one rotates a capacitor in an rf field, a rather marked change occurs in the capacitor as a function of its orientation in the field. When our subjects rotate or change positions of their heads in the field, the loudness of the rf sound does not change appreciably. Second, the distance between these membranes is rather small, compared with the wavelengths used. As a third point, we found that one of our subjects who has otosclerosis heard the rf sound.

Another possible location for the detecting mechanism is in the cochlea. We have explored this possibility with nerve-deaf people, but the results are inconclusive due to factors such as tinnitus. We are currently exploring this possibility with animal preparations. The third likely place for the detection mechanism is the brain. Burr and Mauro (6) presented evidence that indicates that there is an electrostatic field about neurons. Morrow and Sepiel (7) presented evidence that indicates the existence of a magnetic field about neurons. Becker (personal communication) has done some work indicating that there is longitudinal flow of charge carriers in neurons. Thus, it is reasonable to suspect that possibly the electromagnetic field could interact with neuron fields. As yet, evidence of this possibility is inconclusive. The strongest point against is that we have not found visual effects although we have searched for them. On the other hand, we have obtained other nonauditory effects and found that the sensitive area for detecting rf sounds is a region over the temporal lobe of the brain. One can shield, with a 2-in.sq. piece of fly screen, a portion of the strippled area shown in Fig. 6 and completely cut off the rf sound.

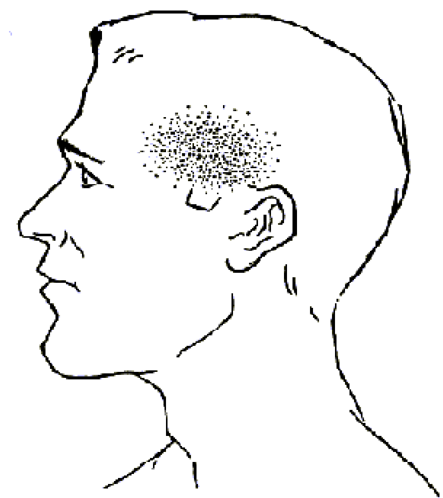


FIG 6 Area most sensitive to electromagnetic energy (shaded portion)

Another possibility should also be considered. There is no good reason to assume that there is only one detector site. On the contrary, the work of Jones et al (8), in which they placed electrodes in the ear and electrically stimulated the subject, is sufficiently relevant to suggest the possibility of more than one detector site. Also, several sensations have been elicited with properly modulated electromagnetic energy. It is doubtful that all of these can be attributed to one detector. As mentioned earlier, the purpose of this paper is to focus the attention of physiologists on an unusual area and stimulate additional work on which interpretations can be based. Interpretations have been deliberately omitted from this paper since additional data are needed before a clear picture can emerge. It is hoped that the additional exploration will also result in an increase in our knowledge of nervous system functions.

**REFERENCIES:**

Neider, P.C., and W.D.Neff. Science 133: 1010,1961.
Frey, A.H. Aero Space Med. 32: 1140, 1961.
Zwislocki, J. Noise Control 4: 42, 1958.
Von Gierke, H. Noise Control 2: 37, 1956.
Niest, R., L Pinneo, R. Baus, J. Fleming, and R. McAfee. Ann. Rept. USA Rome Air Development Command,TR-61-65, 1961
Burr, H., and A. Mauro. Yale J Biol.and Med. 21:455, 1949.
Morrow, R., and J. Seipel. J. Wash. Acad. SCI. 50: 1, 1960.
Jones, R.C.,S.S. Stevens, and M.H. Lurie. J.Acoustic.Soc. Am. 12: 281, 1940.

**United States Patent** **3,773,049**
**Rabichev , et al.** **November 20, 1973**

# APPARATUS FOR THE TREATMENT OF NEUROPSYCHIC AND SOMATIC DISEASES WITH HEAT, LIGHT, SOUND AND VHF ELECTROMAGNETIC RADIATION

**Abstract**

An apparatus for the treatment of neuropsychic and somatic disorders wherein light-, sound-, VHF electromagnetic field-pulses and radiation from light-, sound-, VHF electromcagnetic field- and heat-sources, respectively, are simultaneously applied by means of a control unit to the patient's central nervous system with a predermined repetition rate. The light radiation and sound radiation sources are made so as to exert an adequate and monotonous influence of the light-and sound-radiation on the patient's visual analyzers and auditory analyzers, respectively.

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**Current U.S. Class:** **607/1** ; 600/28
**Field of Search:** 128/1C,1R,1.3,24.1,362,380,399,404,410,419P,422

**References Cited [Referenced By]**

**U.S. Patent Documents**

| | | |
|---|---|---|
| 3103219 | September 1963 | Chadner |
| 3576185 | April 1971 | Schulz et al. |
| 3213851 | October 1965 | Currea |
| 2859731 | November 1958 | Sutton |
| 3470870 | October 1969 | Schoffer |

**Foreign Patent Documents**

| | | |
|---|---|---|
| 619,129 | Mar., 1961 | IT |
| 1,183,607 | Dec., 1964 | DT |
| 826,766 | Jan., 1960 | GB |

*Primary Examiner:* Kamm; William E.

## *Claims*

What is claimed is:

1. An apparatus for the treatment of neuropsychic and somatic diseases, said apparatus comprising a control unit means for simultaneously periodically activating apparatus connected thereto in a pulsed manner at a selected repetition rate; a light-radiation source essentially comprising at least one electric bulb electrically connected with said control unit means, such that light pulses are generated by said light-radiation source influencing the central nervous system of the patient having one of said diseases who faces said source; a sound radiation source essentially comprising an electric generator of pulse oscillations, a small dynamic loud-speaker means for converting said oscillations into acoustic signals imitating the sound of falling drops of water, said electric generator being electrically connected with said control unit means for actuation thereby whereby sound pulses of said sound-radiation source influence the central nervous system of the patient; a VHF electromagnetic-field source essentially comprising a generator of sinusoidal electric oscillations of the waves metric range, electrically connected with said control unit means and disposed in proximity to the patient's ganglia, pulses from said VHF electromagnetic field source acting upon the nervous system of the patient; said light-radiation source producing an adequate and monotonous action of the light-radiation of the patient's visual analyzer; said sound radiation source producing an adequate and monotonous influence of the sound radiation on the patient's auditory analyzer; said control unit means controlling said light-radiation, sound-radiation and VHF electromagnetic-field source so as to provide for a simultaneous generation of said light, sound and VHF electromagnetic pulses and directing said pulses to act upon the patient's central nervous system, all said pulses following at a predetermined repetition rate and ensuring suppression of the patient's nervous activity; and a power supply means to supply said lightradiation, sound-radiation and VHF electromagnetic-field sources and said control unit.

2. An apparatus according to claim 9, further including a heat radiation source comprising an electrical coil surrounded by a heat-insulating shield and provided with an air-forcing motor, said heat source being disposed in the proximity of the patient's integument, said motor of said heat-radiation source being electrically connected with said control unit means and controlled thereby so as to ensure a heat irradiation flow onto the patient's integument at the same time as said VHF electromagnetic-field pulses and sound pulses are sent at an assigned repetition rate, so as to contribute to the inhibition of the patient's nervous activity.

3. An apparatus according to claim 1, wherein said light-radiation source comprises at least one blue-light lamp adapted to be placed at the level of the patient's eyes.

4. An apparatus according to claim 1, wherein said light-radiation source comprises at least one green-light lamp adapted to be placed at the level of the patient's eyes.

5. An apparatus according to claim 4, wherein an even number of said green-light lamps are provided and are adapted to be arranged symmetrically with respect to the saggital plane of the patient and at a minimal angle relative to the axis of the respective eye.

6. An apparatus according to claim 1, wherein said electromagnetic field source comprises an oscillator means having a control means, and wherein said control unit means is a chopper provided with a rotatable cam gear having electric contacts which periodically connect said power supply source with the circuit of the incandescent lamps, with the electric generator of pulse oscillations which are converted in a small dynamic loudspeaker into acoustic signals imitating the sound of falling drops of water, as well as grounding the control means of the oscillator means.

7. An apparatus according to claim 1, wherein said electromagnetic field source comprises an oscillator means having a control means, and wherein said control unit means comprises an electronic timer means having at least one thyratron and a resistor-capacitor delay trigger circuit means therefor, said thyratron including an anode circuit comprising a series connected electro-mechanical relay having contacts connecting the power supply source with the circuit of the incandescent lamps, with the electric generator of pulse oscillations converted in a small dynamic loudspeaker into acoustic signals imitating the sound of falling drops of water, as well as grounding the control means of the oscillator means.

8. An apparatus according to claim 7, further including a heat radiation source, and wherein said electronic timer having at least one thyratron with an anode circuit comprising a series connected electro-mechanical relay having contacts connecting the power supply source with the circuit of the incandescent lamps, with the electric generator of pulse oscillations converted in a small dynamic loudspeaker into acoustic signals imitating the sound of falling drops of water, as well as grounding the grid of the oscillator means, further connects the power supply with said heat radiation source, and has a potentiometer electrically connected with said timer to provide for a predetermined repetition rate of said VHF electromagnetic-field, light and sound pulses, and for the control of said heat radiation depending on the individual features of the patient.

## *Description*

The present invention relates to physiotherapeutic apparatus, and more particularly to apparatus for the treatment of inorganically caused neuropsychic and somatic disorders, such as neuroses, psychoses, insomnia, hypertension, tonic disease, ulcer, stammering, bronchial asthma, intestinal dyskinesia, cardioneurosis, vegeto-vascular neurosis, eczema, asthenic and reactive disturbances. The apparatus of the present invention may find successful application in sports- and military medicine, i.e., in such situations as:

THE START OF A CRUCIAL SPORTS COMPETITION OR A SIMILAR SPORTS DEMONSTRATION;

CASES OF EXTREMELY HIGH NEUROTENSION, AS OBSERVED IN COMBATANT UNIT SOLDIERS AND IN PATIENTS OF FIELD MILITARY HOSPITALS.

Known are apparatus for the treatment of neuropsychic and somatic disorders in which light and sound pulses are emitted by light radiation sources and sound radiation sources to act upon the patient's central nervous system.

In said apparatus use is made of light- and sound radiation sources. The sound emission includes speech sounds recorded on a magnetic tape, as well as ultrasound. Under the treatment conditions the patient's head and the upper portion of his body are enclosed in a chamber which is made in the form of a kind of sarcophagus.

Thus in the above-said apparatus, only one curative factor is employed, namely that of speech formulae of a hypnotic suggestion as recorded on a magnetic tape and designed to produce a suggestive effect via channels of the second signal system (intellect, mind, psyche). Whenever the patient is psychologically reluctant to admit suggestive formulae, such an apparatus is of no avail as far as that particular case is concerned. Light- and ultrasound emission, used in the apparatus of the prior art, do not, in fact, play an independent curative role, but are rather of an auxiliary nature, for their action on the patient's central nervous system is continuous and intended to inhibit the same so that an appropriate background could be prepared to facilitate the suggestive treatment itself. The background factors themselves are physiologically inadequate being beyond the ranges of aural and ocular perception and sometimes involving an adverse effect upon the patient's condition. It should be stressed that the chamber used in accomodating the patient's head and the upper portion of his body has an unfavourable effect upon the patient, because it is made, as said above in the form of a sarcophagus and may give rise to negative phychic responses.

The present invention is aimed at providing an apparatus for the treatment of neuropsychic and somatic diseases, which ensures a rhythmic and remotely controlled action of at least three physical factors upon the patient's nervous system.

With this and other objects in view, the invention resides in the apparatus for the treatment of neuropsychic and somatic diseases in which light pulses and sound pulses from light sources and sound sources, respectively, act upon the patient's central nervous system, wherein there is provided an VHF electromagnetic field source installed in the immediate proximity of the patient's ganglia, and a control unit which is electrically connected with the sources of light radiation, sound radiation and VHF electromagnetic field radiation and which effects control over these sources so as to enable said sources under control to send to the central nervous system simultaneous light pulses, sound pulses and VHF electromagnetic pulses at an assigned pulse repetition rate thereby causing a state of inhibition in the patient under treatment, the light radiation sources and sound radiation sources being embodied in such a way that an adequate and monotonous influence of the sound and light radiations is exerted upon the patient's visual analyser and auditory analyser.

In order to intensify the curative effect and to make for an accelerated transfer from vigilance to what is nearly normal physiological sleep it is reasonable that a source of heat radiation be added and installed in the immediate proximity to the patient's skin surface, said source being electrically connected with a control unit and controlled by the latter so that heat radiation is sent to the patient's skin surface simultaneously with the pulses from the VHF electromagnetic field source, light source and sound source, said puises following at an assigned repetition rate causing the inhibition to be irradiated.

The light radiation source may be made in the form of at least one lamp, blue or green in colour, which is installed at the patient's eye level.

When using an even number of lamps, said lamps are installed symmetrically in respect of the patient's saggital sinus plane.

The control unit may be embodied as a chopper in conjunction with a cam mechanism providing for generation of pulses at a certain repetition rate.

In order to extend the pulse repetition range it is reasonable that an electronic timer be provided including at least one thyratron.

With due regard to the patient's individual features said electronic timer should be equipped with a potentiometer to control the pulse repetition rate of VHF electromagnetic field radiation, light radiation and sound radiation, as well as heat radiation, said electronic timer being electrically connected with a potentiometer. Due to such construction the present apparatus for the treatment of neuropsychic and somatic disorders allows improvement of the mobility and intensity of nervous processes, normalization of the affected functional derangements as apparent from the removal of pathological symptoms, decrease in manifestations of autonomic angioneurosis and neurotic symptoms, a longer and sounder sleep.

Other objects and advantages of the present invention will be made apparent upon a consideration of the specific illustrative embodiments as described herein with reference to the drawings, wherein:

FIG.I shows a schematic electrical circuit of one embodiment of an apparatus for the treatment of neuropsychic and somatic disorders;

FIG.2 is another embodiment of same.

The apparatus for the treatment of neuropsychic disorders comprises, in accordance with the present invention, source I through 4 (FIGS I and 2) of light radiation, sound radiation and VHF electromagnetic field radiation, heat radiation respectively, wherein light pulses, sound pulses, VHF electromagnetic pulses and heat radiation act upon the central nervous system of a patient (not shown in the drawing). The apparatus also includes control unit 5 which is electrically connected with said sources I through 4 and controls the same so as to enable them to send to the central nervous system simultaneous light radiation pulses, sound radiation pulses, heat radiation pulses and VHF electromagnetic field radiation pulses at an assigned pulse repetition rate thereby causing a state of inhibition in the patient under treatment.

The sources I through 4 are oriented in respect of the patient as follows:

the light radiation source I is placed at the level of the patient's eyes at a distance of 40 to 50 cm therefrom;

the sound radiation source 2 is placed in the proximity of the patient under treatment at a distance of 40 to 50 cm him;

the VHF electromagnetic field radiation source 3 is placed in the immediate proximity of the patient's ganglia, preferably at the level of carotid sinuses, 3 to 4 cm away from the patient's skin surface, as is the case with the present apparatus;

the heat radiation source 4 is also placed close to the patient's skin surface, i.e., in the immediate proximity of the face skin surface.

The sources I and 2 of light radiation and sound radiation, respectively, provide for an adequate and monotonous action thereof upon the visual and auditory analyzers.

According to the first embodiment of the apparatus for the treatment of neuropsychic and somatic disorders (FIG.I) the control unit 5 is a chopper with a cam mechanism 6 and contacts 7 through I0. The cams of the cam mechanism 6 are rotated by an electric motor II fed from a power supply unit, which is mains supply in this specific case. The electric motor II makes 60 r.p.m. thereby providing for an assigned pulse repetion rate of sixty pulses per minute of light radiation pulses, sound radiation pulses, VHF electromagnetic field radiation pulses and heat radiation pulses.

Light radiation source I is an incandescent lamp, blue in colour, which is electrically connected with a secondary winding I4 of a transformer I5 through a resistor I2 which serves to control the intensity of light radiation, contacts 7 of the vibrator and a switch I3, the transformer I5 being in turn electrically connected with the a.c. mains.

Sound radiation source 2 is a small-size loudspeaker I6 which is electrically connected with another secondary winding 21 of the transformer I5 through a diode I7, variable resistor I8, constant resistor I9, contacts 8 of the vibrator and switch 20. The sound radiation source provides for an imitation of rain drop noise. Besides, it can be employed to imitate the noise of the surf.

The VHF electromagnetic field radiation sources 3 is a push-pull oscillator 22 with an inductance coil 23 and resistor 24. Electrodes 25 make the load of said oscillator 22. The VHF electromagnetic field source is fitted with a switch 26 and controlled by the contacts 10 of the chopper.

The heat radiation source 4 is a hot spiral wire 27 which is surrounded by a screen 28 made of thermal insulator. The heat flow from the hot wire is removed by means of a blower 29 rotated by an electric motor 30. The heat radiation 4 is controlled by a switch 31 via the contacts 9 of the vibrator.

The present device is equipped with a common mains switch 32. The sources I, 2 and 4 of light radiation, sound radiation and heat radiation, respectively, are mounted in the same casing (not shown in the drawing).

According to the second embodiment of the present apparatus the control unit 5 is an electronic timer made of cold cathode thyratron 33 with an electromagnetic relay 34, potentiometer 35 and resistor 36 in the plate circuit thereof. The electronic timer also includes a capacitor 37 and a resistor 38. The electronic timer has contacts 39 through 42. The potentiometer 35 controls the assigned pulses repetition rate of VHF electromagnetic field radiation, light radiation, sound radiation and heat radiation within the 10 to 100 pulses per second range, depending upon the patient's individual features.

The light radiation source I includes two incandescent lamps 43 and 44, green in colour, which are installed symmetrically in respect of the patient's sagittal sinus plane, at the eye level. This position provides for a better therapeutic effect because the patient is no longer subject to light beam convergence action whenever use is made of the Paurquignet effect. The light radiation intensity is controlled by the resistor 12. The light source I is equipped with a signal lamp 45.

The sound radiation source 2 is not substantially different from that in the first embodyment as described above. The difference between them consists in the presence of a capacitor 46. The sound radiation source 2 is equipped with a signal lamp 47.

The VHF electromagnetic field source is the same as that of the first embodiment, with a signal lamp 48 added.

The heat radiation source 4 is the same as that of the first embodiment but the blower is not shown in FIG.2.

The light radiation source I is electrically connected with a bridge-type d.c. power supply unit 50 through a resistor 12, switch 49 and contacts 39 of the electronic timer.

The sound radiation source 2 is electrically connected with the d.c. power supply unit 50 through a switch 51 and contacts 40 of the electronic timer.

The VHF electromagnetic field source 3 is equipped with a switch 52.

The hot spiral wire 27 of the heat radiation source 4 is fed from the mains through a switch 53, while the electric motor 30 of the blower 29 is fed from the d.c. power supply unit 50 via a variable resistor 54, switch 55 and contacts 42 of the electronic timer.

In accordance with the second embodiment of the present apparatus it can be switched on and off by means of the mains switch 56.

The principle of operation of the apparatus according to the first embodiments as follows.

The patient is either put to bed or seated in a deep arm-chair. The apparatus is moved to the head of said bed or chair. The electrodes 25 of the VHF electromagnetic field source are mounted at the level of carotid sinuses 3 to 4 centimetres away from the surfice of the neck skin.

The casing, with the sources I, 2 and 4 of light radiation, sound radiation and heat radiation mounted therein, is placed above the patient's head at a distance from 40 to 50 centimetres from his face. The apparatus is switched on by means of the mains switch 32. The switches 13, 20, 26 and 31 are used to turn on the sources I through 4 of light radiation, sound radiation, VHF electromagnetic field radiation and heat radiation.

Due to this procedure the patient's receptors are simultaneously acted upon by 60 p/min pulses of blue light radiation, sound radiation which is made similar to the rain drop noise, VHF electromagnetic field radiation as well as by heat radiation, all these having an effect on the retina, on the auditory sensory endings, carotide sensory ganglia and thermal receptors in the face skin, respectively.

A simultaneous transmission of the pulses and heat radiation is due to contacts 7 through 10 of the vibrator. The length of the pulse effect added to that of heat radiation as obtained by means of the cam mechanism 6 amounts to 15.times. 10.sup..sup.-2 sec.

The nerve pulses due to the action by stimuli, such as pulses of light radiation, sound radiation, VHF electromagnetic pulse radiation, as well as heat radiation, are transmitted to the thalamus opticus (sensory collector) via sensory nerve filament and sympathetic nerve trunk.

The simultaneous arrival of brain wave impulses at the thalamus opticus provides for an intensified rhythmic activity of its neural formations due to the interference effect. The rhythm of superimposed stimuli as then synchronized with the activities of the thalamus opticus neural formations (external synchronization). The rhythm as assigned by the apparatus is adopted by the subcortical neural formations being transmitted from the thalamus opticus to the subcortical fields of the visual, auditory and cutaneous analyzers. In the appropriate cortical centres of visual, auditory, and cutaneous analyzers. In the appropriate cortical centres of visual analysers the mono-tonous pulses cause focuses of inhibition to be formed which would intensify in strength and irradiate in space in the course of the same treatment session as well as due to the successive sessions. The primary focus inhibition, once and whenever it occured, would spread all over the cortical field bringing about natural sleep. During the initial treatment sessions the extent of irradiation may be quite insignificant because of the patient's inhibition inertia due to this or that neuropsychic disorder in the patient under treatment. In the course of successive treatment session the trace responses as retained in above-said cortical centres would cause the stimuli to be accumulated so that the inhibition tends to be intensified.

Besides, in the course of successive treatment sessions new conditioned reflex associations are put into effect either because of the procedure itself or due to its specific time, or because of any other isolated factor, all contributing to the irradiation of inhibition phenomena throughout the cortical centres in the cerebral hemispheres.

The whole system of stimuli which is addressed to the patient's organism makes use of the first signal system channels, i.e., the receptor zones of the appropriate analyzers, so that the second signal system channels (mind, intellect, psyche) are avoided thereby providing for a curative effect, no matter the patient's psychic condition or his attitude towards the treatment procedure. Besides, the second signal system channels, once unblocked, affords some opportunities for a simultaneous suggestive and rhythm therapy action thereby increasing the treatment effect.

The present invention makes use of a plurality of sources which are distant stimuli of different physical nature being such oscillatory phenomena as act upon the receptors to the adequate physiologic extents giving rise to no alterations which would exceed the physiologic constants limits involved. That is why the action exerted upon the patient's organism is mild and humane. Besides, provision is made both for a separate control of every factor and for a joint application of a required combination thereof so that the electrohypnotic treatment could be quite individual.

The second embodiment of this apparatus is based on the same principles of operation as the first embodiment thereof. The difference can be described as follows.

By means of a potentiometer 35 in conjunction with the electronic timer the pulse repetition rate of light pulses, sound pulses, VHF electromagnetic field pulses, as well as heat radiation, can be made to vary with due regard to the patient's individual characteristics.

The possibility of alterations both in pulse repetition rate and in the operation made of the apparatus under consideration provides for a controlled variation of biorhythms in the appropriate range as suggested by the principle of rhythm assimilation named after A.A.Ukhtomsky.

In the second embodiment of the apparatus, the light radiation pulses are sent by incandescent lamps 43 and 44, green in color, which are mounted at eye level and symmetrical with respect to sinus plane, so that the convergence effect is eliminated (the eyeball convergence would give birth to a stimulation focus thereby preventing the progress of somnolescent inhibition).

The application of green light permits utilization of Paurquignet's effect to achieve an optimum influence on the visual analyzers.

The following procedure is recommended for the treatment of neuropsychic and somatic disorders using the apparatus of the present invention.

At a first treatment session the duration of the VHF exposure should be 10 minutes, at a second one - 15 minutes, at a third one - 20 minutes, at a fourth one - 25 minutes, and at all succeeding sessions it should be 30 minutes. The other radiation sources may be operated for 30 to 60 minutes. On the average, 30 minutes is required for one treatment-session. The patient may lie with his face upwards and eyes open, though it would be better for him to close his eyes to be ready to fall asleep. At the first treatment-session, the intensities of sound-, light-, and heat-radiation are selected to suit the particular patient.

Using the second embodiment of the apparatus, during the first minutes of the treatment session, the pulse repetition rate should be 20 to 40 pulses per minute (instead of 50 to 60 pulses per minute which is the normal case).

During the successive treatment-sessions the intensity of the exposure may remain the same as that used at the first session. The pulse repetition rate, however, may be gradually decreased later on from session to session.

The development of inhibition processes at a treatment-session is characterized by a very gradual progress. This manifests itself in a somewhat slower pulse, lower integument temperature and arterial pressure, relaxation of sceletal muscles, onset of somnolescence.

With each successive session the onset of all these phenomena takes less time while the phenomena themselves become more pronounced, bringing about a general improvement of the patient's state of health accompanied with a better sleep at night.

During the treatment session, the patient experiences gentle, tranquilizing sensations, which result in psychical relaxation and, gradual transference from vigilance to sleep. An active reproduction of inhibition of processes, if regularly repeated, each treatment-session makes a sort of training the patient for a better neuro-dynamic performance.

Clinical applications of the proposed apparatus are as follows. The apparatus of the present invention may be used for the treatment of patients in the 4 to 70 years bracket. One hundred patients, 4 to 18 years old, and 200 patients over 18 years old underwent the appropriate treatment. Among these patients were the following cases: neurasthenia, neurosis involving delusion, insomnia, asthenic, depressive and reactive states, postinfections and traumatic cerebrasthenia, diencephalic syndrome, vegeto-vascular dystonia, hypertension, bronchial asthma, stammering, rheumatic Sydenham's chorea.

The treatment was effected with respect to ambulatory clinic- and hospital patients. No side effects, complications or harmful actions were observed. Contraindications: infectious diseases, cancer, schizophrenia in its advanced stage (e.g., involving delirious phenomena), and hyperthyreosis.

The apparatus of the present invention for treating neuropsychic and somatic diseases is a physical therapy apparatus to be used for treating insomnia, hypertension, infantile stammering, and other diseases arising from nervous exhaustion and prostration, nervous break-down.

This apparatus is reliable, convenient, safe and simple to control and use, portable, and if necessary, may be placed at the bed-head when dealing with a bed case.

The use of the apparatus is not confined to any age-bracket. Even infants were effectively treated. The apparatus may be used in hospitals as well as in out-patient clinics.

The operation of the apparatus is quite economical: its power consumption is very small. The treatment sessions are effected by para medical personnel. Not to disturb the patient a remote control from an adjacent room may be exercised.

For the first time in medical practice, thanks to the apparatus of the present invention, use is made of a complex of four physical factors acting simultaneously on the respective receptors, said factors operating with predetermined rhythm pattern, and the sources of respective radiation being placed at a predetermined distance from the patient's receptors, so that it could bring about such a state of the nervous system which is characteristic of rest and sleep.

The synergetic action of the factors used in the apparatus result not in a simple sum of respective effects produced by each of said factors, but creates quite a new qualitative phenomenon, wherein interference - and resonance-processes, associated with the radiation from the pertinent sources, cause the inhibition process to be irradiated within the brain centres, which is a distinguishing feature of the present type rhythm therapy.

**Human Perception of Illumination with Pulsed Ultrahigh-Frequency Electromagnetic Energy**

*Abstract. A psychophysical study of the perception of "sound" induced by illumination with pulse-modulated, ultrahigh-frequency electromagnetic energy indicated that perception was primary dependent upon peak power and secondarily dependent upon pulse width. The average power did not significantly affect perception. Perceived characteristics of pitch and timbre appeared to be functions of modulation.*

Field tests with radar indicate that humans and cats perceive low-power pulse-modulated, radio-frequency (rf) energy (1-3). Human subjects reported they perceived "sounds" that were in the nature of buzzes and hisses. The energy perceived was not acoustic energy; rather, it was electromagnetic (EM) energy in the ultrahigh-frequency (UHF) band of the spectrum. These findings can be related to other reports of sensory and behavioral phenomena associated with low-power rf energy. Analytical reviews of these and other reports and implications of the reviewed reports that bear on our understanding of information transfer and storage in living organisms can be found in the literature (3-5)

In the field tests with radar, A.H.F> determined the portion of the EM spectrum that was effective in inducing the "sounds" and the approximate thresholds. Perception occurred when the subject was illuminated with energy from approximately that portion of the EM spectrum defined as the UHF band, that is from 0.3 to 3 GHz (6) This is the portion of the spectrum at which EM energy passes into and through the head. At higher frequencies the energy is largely absorbed by the skin, and at lower frequencies it tends to be reflected by the body (2). An approximate threshold for perception, when the subject was in a noisy environment, occurred at a peak power density of 267 $mw/cm^2$ and an average power density of 0.4 $mw/cm^2$ . The data suggested that the average power was not an important variable, but no definitive statement about its role in perception could be made. The perception had the following characteristics, (.i) it did not involve an energy transduction of EM to acoustic energy, for example, by fillings in the teeth; (ii) it differed from the electrophonic effect; and (iii) it could not be accounted for by an explanation involving radiation pressure against the skin (3, 4).

The field studies raised questions that could not be answered at that time because of lack of suitable laboratory sources of rf energy. Suitable rf energy sources are now available. Thus, we address ourselves to the following questions.

Is perceived loudness a function of peak power, average power, or both ?

What is the required energy density for perceptual threshold ?

Is there a minimal or optimal pulse width ?

Are there modulation characteristics that yield the perception of pitch ?

We performed a series of psychophysical experiments with humans placed in an rf anechoic chamber. The rf anechoic chamber constructed of rf energy absorber (Eccosorb FR 340) minimised rf energy reflections. The EM energy source was a pulse signal source (Applied Microwave Laboratory) emitting energy at a carrier frequency of 1.245 GHz. The energy was conveyed by air line (General Radio model 874) and RG-8 coaxial cable to a coax-to waveguide adaptor (Scientific Atlanta model 11-1.1) and standard-gain horn antenna (7) The horn antenna emitted the energy within the rf anechoic chamber. The antenna was orientated such that the energy was vertically polarised, although pilot experiments indicated that horizontally polarised energy yielded similar data. The rf parameters used are shown in table 1. The pulse repetition rate was selected so that it produced a buzzing "sound".

**Table 1** ***Radio frequency parameters used at each test condition. A pulse rate of 50 pulses per second was used in each case. The constant values shown were rounded for clarity.***

| Test condition number | Peak power (mw/cm2) | Average power (mw/cm2) | Pulse width (usec) |
|---|---|---|---|
| | **Peak power varied** | | |
| **1** | **90** | **0.32** | **70** |
| **2** | **105** | **0.32** | **60** |
| **3** | **125** | **0.32** | **50** |
| **4** | **210** | **0.32** | **30** |
| **5** | **315** | **0.32** | **20** |
| **6** | **630** | **0.32** | **10** |
| **6a** | **630** | **1.26** | **40** |
| | **Average power varied** | | |
| **1** | **370** | **0.19** | **10** |
| **2** | **370** | **0.37** | **20** |
| **3** | **370** | **0.55** | **30** |
| **4** | **370** | **0.93** | **50** |
| **5** | **370** | **1.11** | **60** |
| **6** | **370** | **1.29** | **70** |

All rf energy measurements reported here were taken with a half-wave dipole antenna located where the centre of the subjects head was placed during data collection. The dipole antenna was supported by a wooden pole in order to minimise field disturbance during measurement. The dipole was connected by an RG-58 coaxial cable to an attenuator (Microlab model AF 20) outside the chamber. The attenuator was connected to a thirmistor mount (Hewlett-Packard model 430C) The cable within the chamber was oriented for minimum field disturbance. This measurement equipment yields an average power measurement from which the peak power is derived by the standard duty cycle formula (8) The signal attenuation due to the cable and to the attenuator is accounted for in the reported measurements. There is an inherent and unspecifiable error in the EM field-distorting effect of the measuring instrument and the biological object.

The psychophysical technique of magnitude estimation was used in these experiments. Four trained subjects with clinically normal hearing were tested individually within the rf anschoic chamber. The subject sat on a wooden stool with his back to the horn antenna. We fixed his head in space by having him place his chin on an acrylic rest mounted on a vertical wooden pole. He used a multikey hand switch to signal a number as a report of the loudness he perceived. The subject was told that the first rf sound he would hear in each trial would be a reference sound that was assigned the number 100 and that the second sound he heard would differ in loudness from trial to trial. It was the subject's task to assign a number to the loudness of the second rf sound with reference to the first rf sound. The reference fr sound was selected as being approximately in the middle loudness range. A brief dim light signaled the subject that a trial would begin. After a variable period of up to 5 seconds, the reference rf sound was presented for 2 seconds. A silent period of approximately 5 seconds followed, and then the rf sound of variable loudness was presented for 2 seconds. The subject would then indicate with the hand switch the number he assigned to the loudness. On some occasions, in order to account for the possibility of false positives, no rf sound was presented at the time that the variable rf sound should have been presented. Before starting a session, the subject was given two warm up trials. Each test condition (Table 1) is defined by a specific peak power, average power, pulse width, and pulse repetition rate. We randomised the order of presentation of these sets of rf parameter by using a table of random numbers. There were three randomised repetitions of the series.

**The results are presented in Fig 1.**

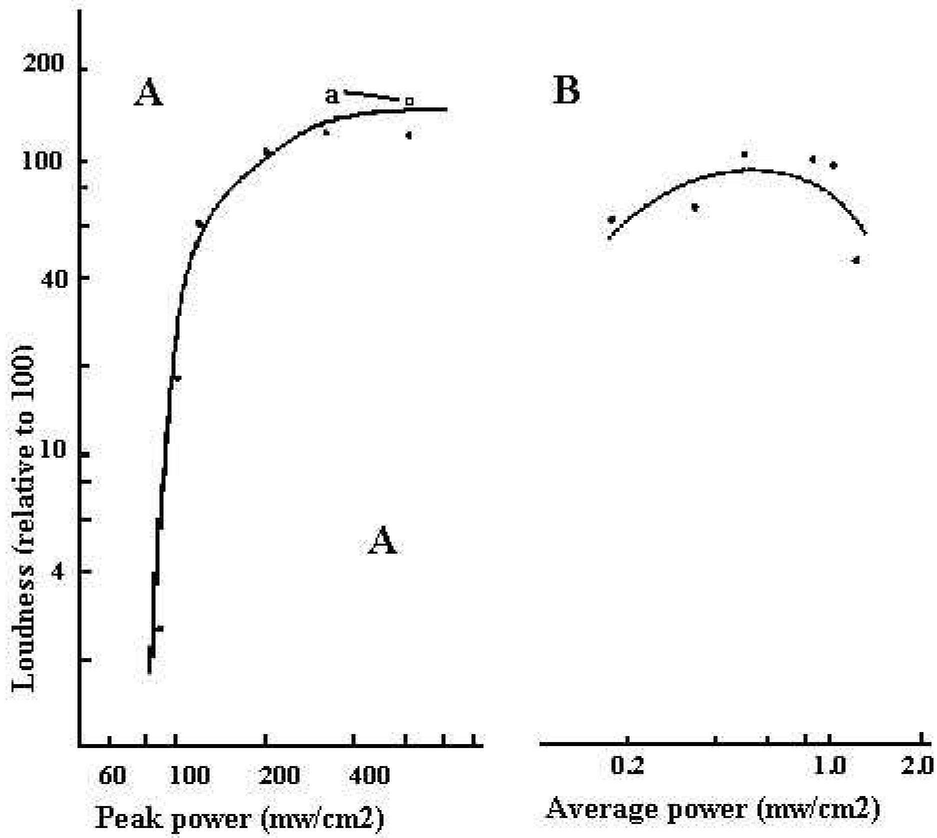


Fig 1 (A) Perceived loudness plotted as a function of peak power. The data from each subject consisted of three repetitions of each set of rf parameters shown under each test condition in Table 1. The average power was held constant by decreasing the pulse width while raising the peak power. (B) Perceived loudness plotted as a function of average power for the same subjects as in (A). The average power was increased by increasing the pulse width while holding peak constant.

The point plotted for each test condition number represents the median of all subjects and all repetitions. The graph shown in Fig 1A was derived from the results of a test series in which we studied the effect of varying the peak power while holding the average power constant, as specified in Table 1. The average power as held constant by varying the pulse width. The graph shown in Fig 1B was derived from the results obtained in a series of tests in which the average power was allowed to vary while the peak power was held constant, as specified in Table 1. The data obtained were reliable, as is typical from trained subjects in psychophysical experiments. The curves fitted to the data are estimations and are intended only as a guide for the reader's eye. The precise shape or slope of the curves will require many more studies for definition because of the sensitivity of judgements of sensory magnitude to details of experimental procedure (9).

Once a minimum pulse width is used, perceived loudness is a function of peak power (Fig 1, A and B). The location of the point for test condition 6 is in consistent with what would be expected. The data represented by this point were obtained when a 10-µsec pulse width was used. Since a consideration of all data shown in Fig 1 indicates that this pulse width is outside the optimal band for loudness, we tested the possibility that the apparent inconsistency was due to the use of a nonoptimal pulse width. We therefore presented to the subjects the same peak power, but with a pulse width within the optimal band, that is, 40µsec. The average of the data so obtained is represented by the square labelled *a* in Fig 1A. Its location indicates that the apparent decrease in perceived loudness at test condition 6 is due more to the pulse width being less than optimal than to an actual decrease in perceived loudness at the high peak power level. The data plotted in Fig 1B indicate that, in addition to an apparent minimum pulse width, there may be a maximum pulse width defining an optimal band of pulse widths for perceived loudness. It appears that average power does not determine loudness except when it is incidentally involved in producing a minimum pulse width for optimal effect.

In one test series, we varied the average power by changing the pulse repetition rate while holding the pulse width constant. We found that the quality of the sound is in part determined by the repetition rate. The subjects reported sounds that had pitch as well as timbre characteristics. This confused subjects who were instructed to judge loudness. The data do not support the hypothesis of radiation pressure against the skin conveyed by bone conduction to the ear; the energy available is far below the threshold for bone conduction. Nor do the data support a mechanism involving radiation pressure against the tympanic membrane, external auditory meatus, or round window. For example, there are no significant effects of changing head orientation as would be expected if radiation pressure was an important factor. Moreover, a series in which the Gelle test (10) was used with plastic air tubes yielded negative results for rf sound and positive results for acoustic sound.

In summary, the perceived loudness of the rf sound as judged by the magnitude estimation technique, and within the limitation of the rf parameters investigated here, is a function of peak power rather than average power. Calculations from the data presented indicate that in this particular experiment, the peak power required for perception is somewhat less than 80 mw/cm². A band of optimal pulse widths seems to exist for the effect. There are also rf modulation parameters that cause subjects hearing "sounds" with definite pitch and timbre characteristics

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**References and Notes.**

1. . A. H. Frey, Aerosp. Med. 32, 1140 (1961)
2. . -------, J. Appl. Physiol. 17,689 (1962)
3. . --------,Psychol, Bull. 63, 322 (1965)
4. . ---------,Inst, Elec. Electron. Eng. Eng. Trans. Microwave Theory Tech. MTT-19, 153 (1971)
5. . A. Pressman, Electromagnetic Fields and Life ,(Plenum, New York, 1970); K. Marha, J. Musil, H. Tuha, Electronic Fields and the Life Environment (San Francisco Press, San Francisco, 1971)
6. . R. Graf, Modern Dictionary of Electronics (Sams, Indianapolis, ed. 2, 1963)
7. . W. Slayton, Electronics (July 1955), p. 150.
8. . Peak power is equal to the average power divided by the duty cycle.
9. . R. M. Warren, J. Acoust. Soc. Amer. 48, 1397 (1970)
10. . The Gelle test procedure is dependent on the fact that any force exerting sudden inward pressure on the stapes pushes the ossicles further into the oval window. This increases intralabyrinthine pressure and reduces sound perception, irrespective of whether the sound wave has reached the tympanum by air conduction or by bone conduction.
11. . This work was supported by the US Office of Naval Research and the US Army.

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| **United States Patent** | **3,951,134** |
|---|---|
| **Malech** | **April 20, 1976** |

Apparatus and method for remotely monitoring and altering brain waves

### Abstract

Apparatus for and method of sensing brain waves at a position remote from a subject whereby electromagnetic signals of different frequencies are simultaneously transmitted to the brain of the subject in which the signals interfere with one another to yield a waveform which is modulated by the subject's brain waves. The interference waveform which is representative of the brain wave activity is re-transmitted by the brain to a receiver where it is demodulated and amplified. The demodulated waveform is then displayed for visual viewing and routed to a computer for further processing and analysis. The demodulated waveform also can be used to produce a compensating signal which is transmitted back to the brain to effect a desired change in electrical activity therein.

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### References Cited [Referenced By]

### U.S. Patent Documents

| | | |
|---|---|---|
| 2860627 | November 1958 | Harden et al. |
| 3096768 | July 1963 | Griffith, Jr. |
| 3233450 | February 1966 | Fry |
| 3483860 | December 1969 | Namerow |
| 3495596 | February 1970 | Condict |
| 3555529 | January 1971 | Brown et al. |
| 3773049 | November 1973 | Rabichev et al. |
| 3796208 | March 1974 | Bloice |

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## *Claims*

What is claimed is:

1. Brain wave monitoring apparatus comprising

means for producing a base frequency signal,

means for producing a first signal having a frequency related to that of the base frequency and at a predetermined phase related thereto,

means for transmitting both said base frequency and said first signals to the brain of the subject being monitored,

means for receiving a second signal transmitted by the brain of the subject being monitored in response to both said base frequency and said first signals,

mixing means for producing from said base frequency signal and said received second signal a response signal having a frequency related to that of the base frequency, and

means for interpreting said response signal.

2. Apparatus as in claim 1 where said receiving means comprises

means for isolating the transmitted signals from the received second signals.

3. Apparatus as in claim 2 further comprising a band pass filter with an input connected to said isolating means and an output connected to said mixing means.

4. Apparatus as in claim 1 further comprising means for amplifying said response signal.

5. Apparatus as in claim 4 further comprising means for demodulating said amplified response signal.

6. Apparatus as in claim 5 further comprising interpreting means connected to the output of said demodulator means.

7. Apparatus according to claim 1 further comprising

means for producing an electromagnetic wave control signal dependent on said response signal, and

means for transmitting said control signal to the brain of said subject.

8. Apparatus as in claim 7 wherein said transmitting means comprises means for directing the electromagnetic wave control signal to a predetermined part of the brain.

9. A process for monitoring brain wave activity of a subject comprising the steps of

transmitting at least two electromagnetic energy signals of different frequencies to the brain of the subject being monitored,

receiving an electromagnetic energy signal resulting from the mixing of said two signals in the brain modulated by the brain wave activity and retransmitted by the brain in response to said transmitted energy signals, and,

interpreting said received signal.

10. A process as in claim 9 further comprising the step of transmitting a further electromagnetic wave signal to the brain to vary the brain wave activity.

11. A process as in claim 10 wherein the step of transmitting the further signals comprises

obtaining a standard signal,

comparing said received electromagnetic energy signals with said standard signal,

producing a compensating signal corresponding to the comparison between said received electrogagnetic energy signals and the standard signal, and

transmitting the compensating signals to the brain of the subject being monitored.

***Description***

## BACKGROUND OF THE INVENTION

Medical science has found brain waves to be a useful barometer of organic functions. Measurements of electrical activity in the brain have been instrumental in detecting physical and psychic disorder, measuring stress, determining sleep patterns, and monitoring body metabolism.

The present art for measurement of brain waves employs electroencephalographs including probes with sensors which are attached to the skull of the subject under study at points proximate to the regions of the brain being monitored. Electrical contact between the sensors and apparatus employed to process the detected brain waves is maintained by a plurality of wires extending from the sensors to the apparatus. The necessity for physically attaching the measuring apparatus to the subject imposes several limitations on the measurement process. The subject may experience discomfort, particulary if the measurements are to be made over extended periods of time. His bodily movements are restricted and he is generally confined to the immediate vicinity of the measuring apparatus. Furthermore, measurements cannot be made while the subject is conscious without his awareness. The comprehensiveness of the measurements is also limited since the finite number of probes employed to monitor local regions of brain wave activity do not permit observation of the total brain wave profile in a single test.

## SUMMARY OF THE INVENTION

The present invention relates to apparatus and a method for monitoring brain waves wherein all components of the apparatus employed are remote from the test subject. More specifically, high frequency transmitters are operated to radiate electromagnetic energy of different frequencies through antennas which are capable of scanning the entire brain of the test subject or any desired region thereof. The signals of different frequencies penetrate the skull of the subject and impinge upon the brain where they mix to yield an interference wave modulated by radiations from the brain's natural electrical activity. The modulated interference wave is re-transmitted by the brain and received by an antenna at a remote station where it is demodulated, and processed to provide a profile of the suject's brain waves. In addition to passively monitoring his brain waves, the subject's neurological processes may be affected by transmitting to his brain, through a transmitter, compensating signals. The latter signals can be derived from the received and processed brain waves.

## OBJECTS OF THE INVENTION

It is therefore an object of the invention to remotely monitor electrical activity in the entire brain or selected local regions thereof with a single measurement.

Another object is the monitoring of a subject's brain wave activity through transmission and reception of electromagnetic waves.

Still another object is to monitor brain wave activity from a position remote from the subject.

A further object is to provide a method and apparatus for affecting brain wave activity by transmitting electromagnetic signals thereto.

## DESCRIPTION OF THE DRAWINGS

Other and further objects of the invention will appear from the following description and the accompanying drawings, which form part of the instant specification and which are to be read in conjunction therewith, and in which like reference numerals are used to indicate like parts in the various views;

FIG. 1 is a block diagram showing the interconnection of the components of the apparatus of the invention;

FIG. 2 is a block diagram showing signal flow in one embodiment of the apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, specifically FIG. 1, a high frequency transmitter 2 produces and supplies two electromagnetic wave signals through suitable coupling means 14 to an antenna 4. The signals are directed by the antenna 4 to the skull 6 of the subject 8 being examined. The two signals from the antenna 4, which travel independently, penetrate the skull 6 and impinge upon the tissue of the brain 10.

Within the tissue of the brain 10, the signals combine, much in the manner of a conventional mixing process technique, with each section of the brain having a different modulating action. The resulting waveform of the two signals has its greatest amplitude when the two signals are in phase and thus reinforcing one another. When the signals are exactly 180.degree. out of phase the combination produces a resultant waveform of minimum amplitude. If the amplitudes of the two signals transmitted to the subject are maintained at identical levels, the resultant interference waveform, absent influences of external radiation, may be expected to assume zero intensity when maximum interference occurs, the number of such points being equal to the difference in frequencies of the incident signals. However, interference by radiation from electrical activity within the brain 10 causes the waveform resulting from interference of the two transmitted signals to vary from the expected result, i.e., the interference waveform is modulated by the brain waves. It is believed that this is due to the fact that brain waves produce electric charges each of which has a component of electromagnetic radiation associated with it. The electromagnetic radiation produced by the brain waves in turn reacts with the signals transmitted to the brain from the external source.

The modulated interference waveform is re-transmitted from the brain 10, back through the skull 6. A quantity of energy is re-transmitted sufficient to enable it to be picked up by the antenna 4. This can be controlled, within limits, by adjusting the absolute and relative intensities of the signals, originally transmitted to the brain. Of course, the level of the transmitted energy should be kept below that which may be harmful to the subject.

The antenna passes the received signal to a receiver 12 through the antenna electronics 14. Within the receiver the wave is amplified by conventional RF amplifiers 16 and demodulated by conventional detector and modulator electronics 18. The demodulated wave, representing the intra-brain electrical activity, is amplified by amplifiers 20 and the resulting information in electronic form is stored in buffer circuitry 22. From the buffers 22 the information is fed to a suitable visual display 24, for example one employing a cathode ray tube, light emitting diodes, liquid crystals, or a mechanical plotter. The information may also be channeled to a computer 26 for further processing and analysis with the output of the computer displayed by heretofore mentioned suitable means.

In addition to channeling its information to display devices 24, the computer 26 can also produce signals to control an auxiliary transmitter 28. Transmitter 28 is used to produce a compensating signal which is transmitted to the brain 10 of the subject 8 by the antenna 4. In a preferred embodiment of the invention, the compensating signal is derived as a function of the received brain wave signals, although it can be produced separately. The compensating signals affect electrical activity within the brain 10.

Various configurations of suitable apparatus and electronic circuitry may be utilized to form the system generally shown in FIG. 1 and one of the many possible configurations is illustrated in FIG. 2. In the example shown therein, two signals, one of 100 MHz and the other of 210 MHz are transmitted simultaneously and combine in the brain 10 to form a resultant wave of frequency equal to the difference in frequencies of the incident signals, i.e., 110 MHz. The sum of the two incident frequencies is also available, but is discarded in subsequent filtering. The 100 MHz signal is obtained at the output 37 of an RF power divider 34 into which a 100 MHz signal generated by an oscillator 30 is injected. The oscillator 30 is of a conventional type employing either crystals for fixed frequency circuits or a tunable circuit set to oscillate at 100 MHz. It can be a pulse generator, square wave generator or sinusoidal wave generator. The RF power divider can be any conventional VHF, UHF or SHF frequency range device constructed to provide, at each of three outputs, a signal identical in frequency to that applied to its input.

The 210 MHz signal is derived from the same 100 MHz oscillator 30 and RF power divider 34 as the 100 MHz signal, operating in concert with a frequency doubler 36 and 10 MHz oscillator 32. The frequency doubler can be any conventional device which provides at its output a signal with frequency equal to twice the frequency of a signal applied at its input. The 10 MHz oscillator can also be of conventional type similar to the 100 MHz oscillator herebefore described. A 100 MHz signal from the output 39 of the RF power divider 34 is fed through the frequency doubler 36 and the resulting 200 MHz signal is applied to a mixer 40. The mixer 40 can be any conventional VHF, UHF or SHF frequency range device capable of accepting two input signals of differing frequencies and providing two output signals with frequencies equal to the sum and difference in frequencies respectively of the input signals. A 10 MHz signal from the oscillator 32 is also applied to the mixer 40. The 200 MHz signal from the doubler 36 and the 10 MHz signal from the oscillator 32 combine in the mixer 40 to form a signal with a frequency of 210 MHz equal to the sum of the frequencies of the 200 MHz and 10 MHz signals.

The 210 MHz signal is one of the signals transmitted to the brain 10 of the subject being monitored. In the arrangement shown in FIG. 2, an antenna 41 is used to transmit the 210 MHz signal and another antenna 43 is used to transmit the 100 MHz signal. Of course, a single antenna capable of operating at 100 MHz and 210 MHz frequencies may be used to transmit both signals. The scan angle, direction and rate may be controlled mechanically, e.g., by a reversing motor, or electronically, e.g., by energizing elements in the antenna in proper synchronization. Thus, the antenna(s) can be of either fixed or rotary conventional types.

A second 100 MHz signal derived from output terminal 37 of the three-way power divider 34 is applied to a circulator 38 and emerges therefrom with a desired phase shift. The circulator 38 can be of any conventional type wherein a signal applied to an input port emerges from an output port with an appropriate phase shift. The 100 MHz signal is then transmitted to the brain 10 of the subject being monitored via the antenna 43 as the second component of the dual signal transmission. The antenna 43 can be of conventional type similar to antenna 41 herebefore described. As previously noted, these two antennas may be combined in a single unit.

The transmitted 100 and 210 MHz signal components mix within the tissue in the brain 10 and interfere with one another yielding a signal of a frequency of 110 MHz, the difference in frequencies of the two incident components, modulated by electromagnetic emissions from the brain, i.e., the brain wave activity being monitored. This modulated 110 MHz signal is radiated into space.

The 110 MHz signal, modulated by brain wave activity, is picked up by an antenna 45 and channeled back through the circulator 38 where it undergoes an appropriate phase shift. The circulator 38 isolates the transmitted signals from the received signal. Any suitable diplexer or duplexer can be used. The antenna 45 can be of conventional type similar to antennas 41 and 43. It can be combined with them in a single unit or it can be separate. The received modulated 110 MHz signal is then applied to a band pass filter 42, to eliminate undesirable harmonics and extraneous noise, and the filtered 110 MHz signal is inserted into a mixer 44 into which has also been introduced a component of the 100 MHz signal from the source 30 distributed by the RF power divider 34. The filter 42 can be any conventional band pass filter. The mixer 44 may also be of conventional type similar to the mixer 40 herebefore described.

The 100 MHz and 110 MHz signals combine in the mixer 44 to yield a signal of frequency equal to the difference in frequencies of the two component signals, i.e., 10 MHz still modulated by the monitored brain wave activity. The 10 MHz signal is amplified in an IF amplifier 46 and channeled to a demodulator 48. The IF amplifier and demodulator 48 can both be of conventional types. The type of demodulator selected will depend on the characteristics of the signals transmitted to and received from the brain, and the information desired to be obtained. The brain may modulate the amplitude, frequency and/or phase of the interference waveform. Certain of these parameters will be more sensitive to corresponding brain wave characteristics than others. Selection of amplitude, frequency or phase demodulation means is governed by the choice of brain wave characteristic to be monitored. If desired, several different types of demodulators can be provided and used alternately or at the same time.

The demodulated signal which is representative of the monitored brain wave activity is passed through audio amplifiers 50 a, b, c which may be of conventional type where it is amplified and routed to displays

58 a, b, c and a computer 60. The displays 58 a, b, c present the raw brain wave signals from the amplifiers 50 a, b, c. The computer 60 processes the amplified brain wave signals to derive information suitable for viewing, e.g., by suppressing, compressing, or expanding elements thereof, or combining them with other information-bearing signals and presents that information on a display 62. The displays can be conventional ones such as the types herebefore mentioned employing electronic visual displays or mechanical plotters 58b. The computer can also be of conventional type, either analog or digital, or a hybrid.

A profile of the entire brain wave emission pattern may be monitored or select areas of the brain may be observed in a single measurement simply by altering the scan angle and direction of the antennas. There is no physical contact between the subject and the monitoring apparatus. The computer 60 also can determine a compensating waveform for transmission to the brain 10 to alter the natural brain waves in a desired fashion. The closed loop compensating system permits instantaneous and continuous modification of the brain wave response pattern.

In performing the brain wave pattern modification function, the computer 60 can be furnished with an external standard signal from a source 70 representative of brain wave activity associated with a desired nuerological response. The region of the brain responsible for the response is monitored and the received signal, indicative of the brain wave activity therein, is compared with the standard signal. The computer 60 is programmed to determine a compensating signal, responsive to the difference between the standard signal and received signal. The compensating signal, when transmitted to the monitored region of the brain, modulates the natural brain wave activity therein toward a reproduction of the standard signal, thereby changing the neurological response of the subject.

The computer 60 controls an auxiliary transmitter 64 which transmits the compensating signal to the brain 10 of the subject via an antenna 66. The transmitter 64 is of the high frequency type commonly used in radar applications. The antenna 66 can be similar to antennas 41, 43 and 45 and can be combined with them. Through these means, brain wave activity may be altered and deviations from a desired norm may be compensated. Brain waves may be monitored and control signals transmitted to the brain from a remote station.

It is to be noted that the configuration described is one of many possibilities which may be formulated without departing from the spirit of my invention. The transmitters can be monostratic or bistatic. They also can be single, dual, or multiple frequency devices. The transmitted signal can be continuous wave, pulse, FM, or any combination of these as well as other transmission forms. Typical operating frequencies for the transmitters range from 1 MHz to 40 GHz but may be altered to suit the particular function being monitored and the characteristics of the specific subject.

The individual components of the system for monitoring and controlling brain wave activity may be of conventional type commonly employed in radar systems.

Various subassemblies of the brain wave monitoring and control apparatus may be added, substituted or combined. Thus, separate antennas or a single multi-mode antenna may be used for transmission and reception. Additional displays and computers may be added to present and analyze select components of the monitored brain waves.

Modulation of the interference signal retransmitted by the brain may be of amplitude, frequency and/or phase. Appropriate demodulators may be used to decipher the subject's brain activity and select components of his brain waves may be analyzed by computer to determine his mental state and monitor his thought processes.

As will be appreciated by those familiar with the art, apparatus and method of the subject invention has numerous uses. Persons in critical positions such as drivers and pilots can be continuously monitored with provision for activation of an emergency device in the event of human failure. Seizures, sleepiness and dreaming can be detected. Bodily functions such as pulse rate, heartbeat reqularity and others also can be monitored and occurrences of hallucinations can be detected. The system also permits medical diagnoses of patients, inaccessible to physicians, from remote stations.

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# Method and apparatus for translating the EEG into music to induce and control various psychological and physiological states and to control a musical instrument


### Abstract

A method and apparatus for applying a musical feedback signal to the human brain, or any other brain, to induce controllable psychological and physiological responses. A signal representing the ongoing electroencephalographic (EEG) signal of a brain preferably is obtained from the electrode location on the scalp known as CZ or P3 in clinical notation. A signal processor converts the ongoing EEG into electrical signals which are converted into music by synthesizers. The music is acoustically fed back to the brain after a time delay calculated to shift the phase of the feedback in order to reinforce specific or desired ongoing EEG activity from the scalp position of interest. The music is comprised of at least one voice that follows the moment-by-moment contour of the EEG in real time to reinforce the desired EEG activity. The music drives the brain into resonance with the music to provide a closed loop or physiological feedback effect. Preferably, the musical feedback comprises additional voices that embody psychoacoustic principles as well as provide the content and direction normally supplied by the therapist in conventional biofeedback. The invention contemplates numerous applications for the results obtained.



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**References Cited [Referenced By]**

**U.S. Patent Documents**

| | | |
|---|---|---|
| 3699234 | October 1972 | Adachi |
| 3705948 | December 1972 | Tomisawa |

| | | |
|---|---|---|
| 3753433 | August 1973 | Bakerich et al. |
| 3821949 | July 1974 | Hartzell |
| 3837331 | September 1974 | Ross |
| 3855998 | December 1974 | Hidalgo-Briceno |
| 3882850 | May 1975 | Bailin |
| 3884218 | May 1975 | Monroe |
| 3978847 | September 1976 | Fehmi et al. |
| 4031883 | June 1977 | Fehmi et al. |
| 4126125 | November 1978 | Agoston |
| 4141344 | February 1979 | Barbara |
| 4228807 | October 1980 | Yagi et al. |
| 4275744 | June 1981 | Thornton |
| 4289121 | September 1981 | Kupriyanovich |
| 4334545 | June 1982 | Shiga |
| 4335710 | June 1982 | Williamson |
| 4354505 | October 1982 | Shiga |
| 4407299 | October 1983 | Culver |
| 4454886 | June 1984 | Lee |
| 4462411 | July 1984 | Richards |
| 4493327 | January 1985 | Bergelson et al. |

**Other References**

Baltimore Magazine, May 1986, "Music of the Hemispheres". .
The Peabody, "Electronic and Computer Music at the Peabody Conservatory", Geoffrey Wright, presented at the International Computer Music Conference, 21 Aug. 1985, Vancouver, B.C. .
The Baltimore Sun, Feb. 14, 1986, "Music From the Mind". .
The Johns Hopkins University Gazette, Mar. 11, 1986, "New Field of Psychoacoustics Melds Music and Medicine". .
Johns Hopkins Magazine, Apr. 1986, "Brain Waves Make Music-Literally". .
The Evening Sun, May 14, 1982, "Art, Psychology Meet in Wave Music". .
Fort Lauderdale News, May 14, 1982, "This `New Wave` Comes From the Brain". .
Business Week, Jul. 8, 1985, "Racking the Brain to Create `Live` Stereo Sound". .
The Post, May 14, 1982, "Art, Psychology Meet in Brain Wave Music". .
The Banner, May 13, 1982, "Music (?) Tapped from Brain". .
The Times, May 1982, "Scientific Music Researcher Finds New Wave in Brain Waves". .
Purchase Order from Eastman Kodak Company, Rochester, N.Y. to Dr. Joel

Knispel, dated Jul. 12, 1982, with Statement describing Job/Services. .
The News, May 13, 1982, "Art, Psychology Meet in Brain Wave Music"..

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***Claims***

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What is claimed is:

1. A biofeedback apparatus useful for creating music, comprising:

means for receiving an ongoing EEG signal from at least one region of the brain of a biological entity, said at least one region of the brain responding to acoustical stimulation, said ongoing EEG signal having a voltage amplitude exhibiting semiperiodic change;

means for translating said ongoing EEG signal into music, said translating means including

means for generating an acoustical indication of the semiperiodic change in said ongoing EEG signal, and

means for generating musical flavor and adding said musical flavor to said acoustical indication;

means for directing said music so as to be received by the brain; and

means for delaying said directing means for a period of time determined so that the brain response to said music occurs with a predetermined phase relationship with respect to the ongoing EEG signal received from said region of the brain.

2. A biofeedback apparatus as claimed in claim 1, further comprising means for anticipating an occurrence of said semiperiodic change in said ongoing EEG signal.

3. A biofeedback apparatus as claimed in claim 2, wherein said anticipating means comprises means for determining a preferred frequency at which said brain produces said semiperiodic change over a predetermined period of time.

4. A biofeedback apparatus as claimed in claim 2, wherein said anticipating means comprises means for determining a period for a most recent preceding semiperiodic change.

5. A biofeedback apparatus as claimed in claim 2, further comprising means for modifying said delaying means to correspond to said anticipated occurrence of said semiperiodic change in said ongoing EEG signal.

6. A biofeedback apparatus as claimed in claim 2, wherein said means for generating said acoustical indication comprises means for generating sound selected from the group consisting of:

a tone chord that is frequency modulated with said ongoing EEG signal;

a punctate sound having a short attack time that is produced in response to a predetermined recurrent feature of said ongoing EEG signal; and

timbre modulation produced by modulating an overtone sweep with said ongoing EEG signal.

7. A biofeedback apparatus as claimed in claim 6, wherein the generated sound is a punctate sound and said means for generating said punctate sound comprises means for generating a sound selected from the group consisting of:

a bell;

a drum; and

a harp.

8. A biofeedback apparatus as claimed in claim 6, wherein the generated sound is a punctate sound and said means for generating said punctate sound comprises means for generating a bell sound in response to a local maxima in said ongoing EEG signal.

9. A biofeedback apparatus as claimed in claim 2, wherein:

said means for generating said acoustical indication comprises means for generating a tone chord; and

means for frequency modulating said tone chord with said ongoing EEG signal.

10. A biofeedback apparatus as claimed in claim 9, wherein said means for generating musical flavor further comprises means for modulating an overtone sweep with a low frequency, pseudorandom control signal.

11. A biofeedback apparatus as claimed in claim 9, wherein said means for generating musical flavor comprises:

means for generating a timbre modulated tone chord that is modulated with a low frequency, pseudorandom control signal; and means for generating a timbre modulated chord that is modulated with the voltage amplitude of said ongoing EEG signal.

12. A biofeedback apparatus as claimed in claim 9, wherein said means for generating musical flavor comprises means for generating a sound selected from the group consisting of:

a timbre modulated tone chord that is modulated with a low frequency, pseudorandom control signal;

a punctate sound having a short attack time that is produced in response to a predetermined recurrent feature of said ongoing EEG signal;

a timbre modulated tone chord that is modulated with said ongoing EEG signal; and

a sequence of musical notes.

13. A biofeedback apparatus as claimed in claim 12, wherein the generated sound is a punctate sound and said means for generating said punctate sound further comprises means for generating a sound selected from the group consisting of:

a bell;

a drum; and

a harp.

14. A biofeedback apparatus as claimed in claim 12, wherein the generated sound is a punctate sound and said means for generating said punctate sound comprises means for generating a bell sound in response to a local maxima in said ongoing EEG signal.

15. A biofeedback apparatus as claimed in claim 12, wherein the generated sound is a sequence of musical notes; and

said means for generating said sequence of notes comprises means for generating said notes at a predetermined rate; and

means for slowing said rate in proportion to the frequency of occurrence of high amplitude waves of said ongoing EEG signal.

16. A biofeedback apparatus as claimed in claim 15, further comprising means for triggering said slowing means only when the amplitude of said ongoing EEG signal exceeds a first predetermined threshold level.

17. A biofeedback apparatus as claimed in claim 16, further comprising means for

generating said sequence of notes over again when the amplitude of said ongoing EEG signal exceeds a second predetermined threshold level that is greater than said first predetermined threshold level.

18. A biofeedback apparatus as claimed in claim 15, further comprising means for generating said sequence of notes over again when the amplitude of said ongoing EEG signal exceeds a second predetermined threshold level that is greater than said first predetermined threshold level.

19. A biofeedback apparatus as claimed in claim 9, wherein said means for generating an acoustical indication of the semiperiodic change in said ongoing EEG signal produces a first musical voice.

20. A biofeedback apparatus as claimed in claim 19, wherein said musical flavor comprises:

means for generating a second musical voice indicative of a predetermined feature of said ongoing EEG signal;

means for generating a third musical voice indicative of the occurrence of a semiperiodic predetermined feature of the ongoing EEG signal; and

means for generating a fourth musical voice indicative of an average value of the ongoing EEG signal.

21. A biofeedback apparatus as claimed in claim 20, wherein:

said means for generating said first musical voice comprises means for generating a tone chord and means for frequency modulating said tone chord with said ongoing EEG signal;

said means for generating said second musical voice comprises means for generating a bell sound in response to a local maxima of said ongoing EEG signal;

said means for generating said third musical voice comprises means for generating an overtone sweep of a chord tone, said overtone sweep being modulated by the amplitude of said ongoing EEG signal at a local maxima; and

said means for generating said fourth musical voice comprises means for generating a series of notes in sequence at a rate determined by the amplitude of said ongoing EEG signal.

22. A biofeedback apparatus as claimed in claim 21, wherein:

said means for generating said second voice comprises means for not generating said second voice unless the amplitude of said ongoing EEG signal exceeds a first predetermined threshold level; and

said means for generating said fourth voice comprises means for not generating said sequence rate at a slower rate unless the amplitude of said ongoing EEG signal exceeds said first threshold level.

23. A biofeedback apparatus as claimed in claim 22, wherein:

said means for generating said third voice comprises means for not generating said third voice unless the amplitude of said ongoing EEG signal exceeds said first threshold level; and

said means for generating said sequence of notes comprises means for generating said sequence again whenever said ongoing EEG signal exceeds a second predetermined threshold level that is greater than said first predetermined threshold level.

24. A biofeedback apparatus as claimed in claim 23, wherein said means for generating said sequence of notes comprises means for generating a progressively more dissonant pattern.

25. A biofeedback apparatus as claimed in claim 23, wherein said means for generating said second voice comprises means for modulating the pitch of said bell sound around a center frequency in proportion to said amplitude of said ongoing EEG signal.

26. A biofeedback apparatus as claimed in claim 23, wherein said means for generating said fourth voice comprises an envelope generator means for amplitude modulating said fourth voice, said envelope generator means being triggered independently of said ongoing EEG signal.

27. A method of producing a biofeedback signal useful for creating music, comprising the steps of:

receiving an ongoing EEG signal from at least one region of the brain of a biological entity, said at least one region of the brain responding to acoustical stimulation, said ongoing EEG signal having a voltage amplitude exhibiting semiperiodic change; translating said ongoing EEG signal into music, including the steps of

generating an acoustical indication of the semiperiodic change in said ongoing EEG signal,

generating a musical flavor, and adding said

musical flavor to said acoustical indication;

directing said music so as to be received by the brain; and delaying said directing for a period of time determined so that the brain responds to said music with a predetermined phase relationship with respect to the ongoing EEG signal received from said region of the brain.

28. A method of producing a biofeedback signal as claimed in claim 27, further comprising the step of anticipating an occurrence of said semiperiodic change in said ongoing EEG signal.

29. A method of producing a biofeedback signal as claimed in claim 28, wherein said step of anticipating comprises the step of determining a preferred frequency at which said brain produces said semiperiodic change over a predetermined period of time.

30. A method of producing a biofeedback signal as claimed in claim 28, wherein said step of anticipating comprises the step of determining a period for a most recent preceding semiperiodic change.

31. A method of producing a biofeedback signal as claimed in claim 28, further comprising the step of modifying said delaying time period to correspond to anticipated occurrence of said semiperiodic change in said ongoing EEG signal.

32. A method of producing a biofeedback signal as claimed in claim 28, wherein said step of generating said acoustical indication comprises the step of generating a sound selected from the group consisting of:

a tone chord that is frequency modulated with said ongoing EEG signal;

a punctate sound having a short attack time that is produced in response to a predetermined recurrent feature of said ongoing EEG signal; and

timbre modulation produced by modulating an overtone sweep with said ongoing EEG signal.

33. A method of producing a biofeedback signal as claimed in claim 32, wherein the generated sound is punctate and said step of generating said punctate sound comprises generating a sound selected from the group consisting of:

a bell;

a drum and

a harp.

34. A method of producing biofeedback as claimed in claim 33 wherein said step of adding musical flavor to said acoustical indication comprises the step of modifying said musical flavor with said ongoing EEG signal.

35. A method of producing biofeedback as claimed in claim 34, wherein:

said step of generating said acoustical indication comprises generating a tone chord and the step of frequency modulating said tone chord with said ongoing EEG signal; and

said step of adding musical flavor comprises the step of timbre modulating said tone chord with the voltage amplitude of said ongoing EEG signal.

36. A method of producing biofeedback as claimed in claim 35, wherein said step of adding musical flavor further comprises the step of modulating said timbre of said tone chord with an independently produced signal that is independent of said ongoing EEG signal.

37. A method of producing biofeedback as claimed in claim 36, wherein said independently produced signal comprises a low frequency, pseudorandom signal.

38. A method of producing biofeedback as claimed in claim 34, wherein said step of generating said acoustical indication of the semiperiodic change in said ongoing EEG signal produces a first musical voice.

39. A method of producing biofeedback as claimed in claim 38, wherein said step of generating musical flavor comprises the steps of:

generating a second musical voice indicative of a predetermined feature of said ongoing EEG signal;

generating a third musical voice indicative of the recent amplitude of the ongoing EEG signal; and

generating a fourth musical voice indicative of an average value of the ongoing EEG signal,

40. A method of producing biofeedback as claimed in claim 39 wherein:

said step of generating said first musical voice comprises the step of generating a tone chord that is frequency modulated with said ongoing EEG signal;

said step of generating a second musical voice comprises the step of generating a bell sound in response to a local maxima of said ongoing EEG signal;

said step of generating said third musical voice comprises the step of generating an overtone sweep of a chord tone, said overtone sweep being modulated by the relative frequency of occurrence of an at least semiperiodic predetermined feature of said ongoing EEG signal; and

said step of generating said fourth musical voice comprises the step of generating a series of notes that are played in sequence at a rate determined by the amplitude of said ongoing EEG signal.

41. A method of producing biofeedback as claimed in claim 40, wherein:

said step of generating said second voice is performed only in response to the amplitude of said ongoing EEG signal exceeding a first predetermined threshold level; and

said step of generating said fourth voice comprises the step of slowing said sequence rate in proportion to the amplitude of said ongoing EEG signal only when said ongoing EEG signal exceeds said first threshold level.

42. A method of producing biofeedback as claimed in claim 41, wherein:

said step of generating said third voice comprises the step of modifying said third voice only when the amplitude of said ongoing EEG signal exceeds said first predetermined threshold level; and

said step of generating said fourth voice comprises the step of generating said sequence again whenever said ongoing EEG signal exceeds a second threshold level that is greater than said first threshold level.

43. A method of producing biofeedback as claimed in claim 42, wherein said sequence of notes comprises a progressively more dissonant pattern.

44. A method of producing biofeedback as claimed in claim 42, wherein said step of generating said second voice comprises the step of modulating the pitch of said bell sound around a center frequency in proportion to said amplitude of said ongoing EEG signal.

45. A method of producing biofeedback as claimed in claim 42, wherein said step of generating said fourth voice comprises the step of modifying the biofeedback signal with a signal that is independent of said ongoing EEG signal.

46. Music as derived by the process claimed in claim 39, wherein said steps of generating said acoustical indication and said musical flavor comprise generating a polyphonic hierarchy of musical voices that are mutually physiologically and psychoacoustically correct.

47. Music as derived by the process claimed in claim 46, wherein said first, second, third and fourth musical voices comprise sounds selected from the group consisting of:

a timbre modulated tone chord that is modulated with the ongoing EEG signal;

a punctate sound having a short attack time that is short relative to and produced in response to a predetermined recurrent feature of said ongoing EEG signal;

a timbre modulated tone chord that is modulated with said ongoing EEG signal; and

a sequence of dissonant musical notes.

48. A method of producing a biofeedback signal as claimed in claim 32, wherein the generated sound is punctate and said step of generating said punctate sound comprises the step of generating a bell sound in response to a local maxima in said ongoing EEG signal.

49. A method of producing a biofeedback signal as claimed in claim 28, wherein:

said step of generating said acoustical indication comprises the step of generating a tone chord and the step of frequency modulating said tone chord with said ongoing EEG signal.

50. A method of producing a biofeedback signal as claimed in claim 49, wherein said step of generating musical flavor further comprises the step of modulating an overtone sweep with a low frequency, pseudorandom control signal.

51. A method of producing a biofeedback signal as claimed in claim 49, wherein said step of generating musical flavor comprises the steps of:

generating a timbre modulated tone chord that is modulated with a low frequency, pseudorandom control signal; and

generating a timbre modulated chord that is modulated with the voltage amplitude of said ongoing EEG signal.

52. A method of producing a biofeedback signal as claimed in claim 49, wherein said step of generating musical flavor comprises the step of generating a sound selected from the group consisting of:

a timbre modulated tone chord that is modulated with a low frequency, pseudorandom control signal;

a punctate sound having a short attack time that is produced in response to a predetermined recurrent feature of said ongoing EEG signal;

a timbre modulated tone chord that is modulated with said ongoing EEG signal; and

a sequence of musical notes.

53. A method of producing a biofeedback signal as claimed in claim 52, wherein the generated sound is punctate and said step of generating said punctate sound further comprises the step of generating a sound selected from the group consisting of:

a bell;

a drum and

a harp.

54. A method of producing a biofeedback signal as claimed in claim 52, wherein the generated sound is a punctate sound and said step of generating said punctate sound further comprises the step of generating a bell sound in response to a local maxima in said ongoing EEG signal.

55. A method of producing a biofeedback signal as claimed in claim 52, wherein the sound is a sequence of musical notes, and

said step of generating said sequence of notes comprises the step of generating said notes at a predetermined rate; and

the step of slowing said rate in proportion to the frequency of occurrence of high amplitude waves of said ongoing EEG signal.

56. A method of producing a biofeedback signal as claimed in claim 55, further comprising the step of triggering said slowing step only when the amplitude of said ongoing EEG signal exceeds a first predetermined threshold level.

57. A method of producing a biofeedback signal as claimed in claim 56, further comprising the step of generating said sequence of notes over again when the amplitude of said ongoing EEG signal exceeds a second predetermined threshold level that is greater than said first predetermined threshold level.

58. A method of producing a biofeedback signal as claimed in claim 55, further comprising the step of generating said sequence of notes over again when the amplitude of said ongoing EEG signal exceeds a second predetermined threshold level that is greater than said first predetermined threshold level.

59. Music derived from brain waves by a process comprising the steps of:

receiving an ongoing EEG signal from at least one region of the brain of a biological entity, said at least one region of the brain responding to acoustical stimulation, said ongoing EEG signal exhibiting semiperiodic, moment-by-moment change;

generating an acoustical indication of the moment-by-moment change of said ongoing EEG signal;

adding musical flavor to said acoustical indication;

directing said acoustical indication so as to be received by the brain; and delaying said step of directing said acoustical indication for a period of time determined so that the brain responds to said acoustical indication with a predetermined phase relationship with respect to the ongoing EEG signal received from said region of the brain.

60. A brain wave driven cybernetic interface circuit adapted for cooperation with a nervous system, a brain, and an acoustical sensory organ, comprising:

means for selecting a predetermined form of electrical activity from the nervous system, said brain producing produce said electrical activity, said acoustical sensory organ adapted to respond to acoustical impulses, including

means for receiving an ongoing EEG signal from a region of the brain, and

means for filtering said ongoing EEG signal to select a particular type of neuroelectrical activity in the brain, said neuroelectrical activity exhibiting semiperiodic change;

means for reinforcing said neuroelectrical activity in the brain, including

means for generating an acoustical indication of said semiperiodic change,

means for adding musical flavor to said acoustical indication to form a musical feedback signal,

means for converting said musical feedback signal into acoustical impulses comprising feedback music,

means for directing said feedback music to be received by said acoustical sensory organ, and

means for delaying said directing means for a period of time determined so that the brain response to said feedback music occurs with a predetermined phase relationship with respect to the ongoing EEG signal received from said region of the brain; and

means for generating a control signal in response to a predetermined musical pattern in said feedback music.

61. A brain wave driven cybernetic interface circuit as claimed in claim 60, further comprising a musical instrument to receive said control signal and generate music in response thereto.

62. A method of forming a cybernetic interface, comprising the steps of:

selecting a predetermined form of electrical activity from a nervous system, said nervous system having a brain to produce said electrical activity and an acoustical sensory organ to respond to acoustical impulses, including the steps of

receiving an ongoing EEG signal from a region of the brain, and

filtering said ongoing EEG signal to select a particular type of neuroelectrical activity in the brain, said neuroelectrical activity exhibiting semiperiodic change;

reinforcing said neuroelectrical activity in the brain including the steps of

generating an acoustical indication of said semiperiodic change,

adding musical flavor to said acoustical indication to form a musical feedback signal,

converting said musical feedback signal into acoustical impulses comprising feedback music,

directing said feedback music to be received by said acoustical sensory organ, and

delaying said step of directing for a period of time determined so that the brain responds to said feedback music with a predetermined phase relationship with respect to the ongoing EEG signal received from said region of the brain; and

generating a control signal in response to a predetermined musical pattern in said feedback music.

63. A method of forming a cybernetic interface as claimed in claim 62, further comprising the step of directing said control signal to a musical instrument that generates music in response thereto.

64. A method of forming a cybernetic interface as claimed in claim 62, wherein said nervous system is a human nervous system.

65. A neural stimulation apparatus, comprising:

means for noninvasively extracting an ongoing EEG signal from a predetermined region of a brain;

means for converting said EEG signal into music, said music having physiological information and musical flavor;

means for directing said music to an auditory sensory organ of said brain; and

means for delaying said directing means for a period of time determined so that said response of said region of the brain said music occurs with a predetermined phase relationship with respect to the ongoing EEG signal extracted from said region of the brain.

66. A neural stimulation apparatus as claimed in claim 65, wherein said noninvasive extraction means comprises a magnetometer.

67. A neural stimulation apparatus as claimed in claim 66, wherein said magnetometer comprises means for triangulating EEG activity occurring within said brain.

68. A method of stimulating neural activity, comprising the steps of:

noninvasively extracting an ongoing EEG signal from a predetermined region of a brain;

converting said EEG signal into music, said music having physiological information and musical flavor;

directing said music to an auditory sensory organ of said brain; and

delaying said directing step for a period of time determined so that said region of the brain responds to said music with a predetermined phase relationship with respect to the ongoing EEG signal extracted from said region of the brain.

69. A method of stimulating neural activity as claimed in claim 68, wherein said step of extracting said ongoing EEG signal comprises the step of detecting semiperiodic changes in magnetic field indicative of said ongoing EEG activity.

70. A method of stimulating neural activity as claimed in claim 69, wherein said step of detecting semiperiodic changes in magnetic field comprises the step of triangulating said ongoing EEG activity so as to extract only ongoing EEG activity from a well defined region of said brain.

71. A method of stimulating neural activity as claimed in claim 70, wherein said brain is a human brain.

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## *Description*

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BACKGROUND OF THE INVENTION

1. Field of Invention

The present invention relates to the general field of psychoacoustics which is defined, for purposes of this application, as the neuropsychological response of the brain to music. Specifically, the invention relates to a method and apparatus for translating an electroencephalographic (EEG) signal into specifically engineered music, feeding back that music to a selected area of the brain, via the ear, from which the EEG signal was generated so as to induce and control a wide variety of psychological and physiological states. The invention uses a new type of biofeedback music. The principles controlling the generation of this biofeedback are henceforth known as neuroacoustics.

2. Description of related knowledge

The human brain exhibits periodic electrical activity, also known as brain waves, at the microvolt level in discrete frequency ranges. This brain wave activity has traditionally been classified by frequency as follows: alpha waves lie in the frequency range of 8 to 13 Hz, beta waves lie in the frequency range of 13 to 28 Hz, and theta waves lie in the frequency range of 4 to 8 Hz. The brain also exhibits delta waves during sleep which are characterized by a relatively high amplitude and very low frequency, typically less than one complete cycle per second. Beta waves have a relatively low amplitude and correspond to a high level of arousal or anxiety. The brain is known to produce primarily alpha waves when a person is in a state of rest and relaxation. Theta waves are often associated with pre-sleep, dream-like mentations and visual imagery.

It is also known that EEG activity, muscular activity and other physiological measures may be modified with "biofeedback". Conventional biofeedback involves converting some measurable physiological activity of an individual into a feedback signal comprising an auditory or visual stimulus. The feedback signal provides the individual with an indication of his or her physiological activity. One type of biofeedback apparatus converts alpha waves into an audible tone that has a volume or pitch corresponding to the average level of alpha wave activity. Some individuals can alter their internal emotional state and relax by learning to alter the feedback signal.

Conventional biofeedback, however, has well known limitations. Most individuals require multiple sessions with a trained therapist to learn to adjust their brain wave activity in response to the feedback signal. Biofeedback can be tiresome and boring when the feedback signal has no interesting or pleasing qualities. Some studies have found that conventional biofeedback is so mechanistically routine that the feedback signal does not induce an effect unless a therapist is present to add emotional content and direction to the experience.

The feedback signal normally indicates only a time average of the relevant physiological activity. As such, conventional biofeedback provides an information pathway by which the brain is made consciously aware of the physiological activity. The feedback signal, however, has no direct effect on ongoing physiological activity and therefore cannot produce a true real time cybernetic feedback loop. U.S. Pat. Nos. 3,978,847 and 4,031,884 to Fehmi et al disclose a multiple channel phase integrating biofeedback computer that generates a feedback signal having a tone whose volume rises and falls with the rise and fall of the voltage in subsequent cycles of a brain wave train such as an alpha burst. The therapist or individual using the biofeedback computer may adjust a phase shift network to shift the phase of the feedback signal relative to the user's brain wave activity in accord with personal experience or personal preference. This feedback signal, however, does not appear to actively promote brain wave activity, nor does the feedback tone have musical or emotional content. Hence, the exact phase relationship of the feedback signal to the brain wave activity is not specified and does not appear to be critical to the proper functioning of the biofeedback computer.

Various approaches have been proposed to overcome the inadequacies of conventional biofeedback. One method for promoting relaxation is to play prerecorded complex sounds or colors which are at least not annoying and perhaps even psychologically enjoyable. The prerecorded sounds or colors may or may not be controlled by some measured physiological quantity. The feedback, however, does not communicate current, ongoing physiological activity, nor does the feedback induce or reinforce a physiological response. Rather, the feedback signal remains only an aid to learning which permits a person to learn to adjust his or her physiological activity.

Composers such as David Rosenboom and Alvin Lucier have incorporated EEG signals into musical compositions. These efforts have produced music that is interesting from an aesthetic perspective. The EEG signals are obtained from electrodes that are placed on the scalp without regard the physiological significance of the area of the brain that is producing the EEG activity. It is not surprising, therefore, that these musical composers have neither attained a real time physiological feedback loop nor advanced a workable methodology for attaining such an end.

Thomas Mullholland and Benard Turskey have criticized conventional biofeedback because the biofeedback signal communicates exclusively learning information. They maintain that the biofeedback signal should incorporate principles of engineering and cybernetics. Specifically, the feedback signal should be multidimensional and contain information about many features of the physiological response of interest. Further, the return of the feedback signal to the biological system of origin should be controlled so as to directly encourage and reinforce a desired physiological response. This criticism of conventional biofeedback is well taken. However, no known biofeedback device can induce a physiological response consistent with the procedural objectives proposed by Mullholland and Turskey.

Neurophysiologists know how to induce neural activity in the human brain using external stimuli. Sound is particularly useful stimulus because much of the cerebral cortex is sensitive to acoustical stimulation. Large scale neural activity may be induced in response to a variety of sounds. For example, the cortical electroencephalogram is particularly responsive to punctate sounds such as those produced by a drum or bell. The "evoked potential" phenomenon uses punctate sounds to periodically stimulate the brain. The brain eventually responds to the stimulation by producing brain wave activity at the same frequency as the stimulus. The punctate sound "drives" the brain to produce brain wave activity at the frequency selected by the neurophysiologist. A flashing light is sometimes used as an alternate form of stimulation or as a supplement to the acoustical stimulation.

The physiological stimulation associated with the evoked potential becomes unpleasant if continued for a period of time. Indeed, an evoked potential session becomes particularly unpleasant when uninteresting, regularly occurring stimuli are used to synchronously drive the EEG at a particular frequency. This unfavorable psychological response appears to result, at least in part, from the inability of the brain to control the external stimulus.

Musicians know how to give sound a form, content and direction that is both interesting and emotionally moving to a listener. Such sounds are commonly known as music. The ability of music to produce an emotional response has been known for many centuries in cultures throughout the world. Only recently, however, have psychologists and musicians begun to codify the principles that govern the emotional response to music or to exploit this knowledge with newly developed methods of precise music synthesis.

Music typically has not been used to evoke controlled responses in the brain nor has the feedback signal produced by conventional biofeedback devices been specifically organized into musical form. This is surprising since musicians know how to make sound convey many levels of meaning. The art has yet to appreciate the utility of music to induce particular, selectable forms of neural activity. This failure stems, at least in part, from a perceived dissimilarity in goals between the fields of music and psychophysiology. Further, the basic principles governing the unique neurological, physiological and emotional effects which music can induce when used systematically in a real time cybernetic biofeedback loop have no precedence in the art.

SUMMARY OF THE INVENTION

The present invention relates to a method and apparatus for translating an ongoing EEG signal into a musical feedback signal and applying the musical feedback signal to the human brain, or any other brain, to induce controllable physiological and psychological responses. A signal processor converts an ongoing EEG signal from a selected position on the scalp into electrical signals that music synthesizers convert into music. The brain receives the musical feedback after it is delayed by a period of time that is calculated so that the music reinforces specific or desired EEG activity at a particular area of the brain determined by the site of the recording electrode. In addition, the music is engineered to have psychoacoustical and musical properties that induce the brain to preferentially produce a particular type of EEG activity. The physiological response of the brain to the feedback music actively drives the ongoing EEG activity into resonance with the music to form a real time physiological feedback loop. The musical qualities and encoded physiological information of the feedback signal selectively reinforce biologically produced brain wave activity. The type of brain wave activity that is reinforced, together with the musical program in which it is encoded, can be used to promote emotional states without additional stimuli such as the presence of a therapist. For example, alpha activity can be enhanced so as to induce relaxation solely by musically reinforcing the alpha activity that is sensed by an electrode located on the scalp at the positions on the scalp known as CZ or P3 in the nomenclature of clinical neurology. Both locations, but particularly CZ, are preferred.

The feedback music comprises at least one voice for recording cortical auditory activity that follows and reinforces the real time, moment-by-moment contour of the EEG. At least one or more additional musical voices provide musical flavor that conveys psychological as well as psychoacoustical content. The term musical flavor means some component of the amplitude envelope or harmonic spectrum of the feedback music that is discrete from and compliments the sound used to communicate the moment-by-moment contour of the EEG. The musical flavor enlivens the feedback and makes it enjoyable for extended periods of listening. The additional one or more voices are more derivative of the contours of the ongoing EEG signal but are still psychoacoustically correct with respect to the type of EEG activity being reinforced. The term psychoacoustically correct as applied to acoustical stimuli in this context means music that is formulated in accordance with the principles of psychoacoustics, music theory, musicology, and the emotional psychology of music to produce a desired physiological response in the resonance feedback loop. Thus formulated, the feedback music provides the emotional content normally supplied by a therapist in conventional biofeedback as well as learning information that enables a person undergoing resonance feedback to learn to control his brain wave patterns.

At its most basic level, the present invention is a biofeedback apparatus that conveys real time physiological information to the brain in a musical context. The resonance loop should comprise at least two levels of information. The first level comprises physiological information about the moment-by-moment oscillations of the ongoing EEG signal. The physiological information can be conveyed by frequency modulating a tone or chord with the ongoing EEG signal so that the pitch of the tone varies in proportion to the amplitude of the ongoing EEG signal. The fed back periodic changes in frequency make the brain aware of its ongoing brain wave activity and actively reinforce its continuance unless the goal is to discourage the activity by adjusting the phase relationship of the feedback signal to cause destructive interference. The second level of information is musical flavor. The musical flavor may comprise independently generated, pseudorandom timbre modulation. Preferably, however, the musical flavor is also a psychoacoustically correct sound that is derived from ongoing brain wave activity such as timbre modulation produced by modulating an overtone sweep with the ongoing EEG signal.

The preferred embodiment of the present invention uses musical feedback comprising four distinct musical voices that create and sustain the physiological feedback loop The four voices constitute a hierarchy of EEG analysis. A first musical voice is formed by frequency modulating a tone chord with the ongoing EEG signal to communicate to the brain the moment-by-moment contour of the EEG. A second musical voice extracts and reinforces specific features of the ongoing EEG activity. The second voice may comprise a punctate sound that is generated in response to a major feature of the EEG such as a crest (local amplitude maxima) in a brain wave. The punctate sound has an effect on the brain that is analogous to a conventional evoked potential response but differs in being directly controlled by the brain so as to reinforce only naturally occurring EEG activity. A third voice uses timbre modulation to indicate the relative frequency of occurrence of a particular feature of the ongoing EEG signal. The third voice provides more derivative physiological information by more slowly modulating the upper octaves of an independently generated tone chord signal with an overtone sweep. Each overtone sweep lasts for a period of time that is greater than the period of the brain wave activity in question so that the timbre modulation appears to get brighter during a burst of brain wave activity. The timbre modulation thus bears some resemblance to the naturally occurring EEG activity even while being more derivative of its moment-by-moment profile. A fourth voice conveys physiological information by slowing and retriggering a note sequence in response to the amplitude of the ongoing EEG signal exceeding predetermined levels and in phase with the timbre modulation.

The interplay of the first, second, third and fourth voices establish a polyphonic music in which the four voices dynamically interact with the changing physiological state of the person generating the ongoing EEG signal. The fourth voice comprises a sequence that cycles through a series of notes in rapid succession. The rate at which the sequencer cycles and the duration of a cycle decreases in relation to the amplitude of the ongoing EEG signal. The sequencer responds to predetermined threshold levels of the amplitude of the ongoing EEG signal. Thus, the sequencer does not begin to reduce its cycling rate until the amplitude of the ongoing EEG signal exceeds a first threshold level. The sequencer starts over its sequence whenever the amplitude of the ongoing EEG signal exceeds a second, higher threshold level. The third voice, the overtone sweep, sounds only in response to the ongoing EEG signal exceeding the first threshold level. The amplitude of the timbre modulation produced by the overtone sweep is related to the number of occurrences of a predetermined feature of interest in the ongoing EEG signal. The second voice, the punctate bell sound, sounds only when the amplitude of the ongoing EEG signal exceeds the first threshold level. The pitch of the bell is proportional to the amplitude of the ongoing EEG signal. The first voice is a continuously varying frequency modulated tone chord. The four voices thus combine to give the feedback signal musical flavor in the form of a rich, constantly changing musical pattern that is psychologically enjoyable and psychoacoustically correct with respect to the physiological phenomenon being driven by the resonance loop.

The feedback signal communicates psychoacoustic information to the brain through a musical "language" based on the four musical voices forming a polyphonic hierarchy of perceptual prominence. A voice which is readily apparent to a listener is said to be in the foreground of the music. A less apparent voice which is still readily perceptible is said to be a midground voice. A voice which is not readily apparent in the perceptual field is said to be a background voice. In the preferred embodiment, the sequencer is a foreground voice in the absence of significant EEG activity. However, once the amplitude of the ongoing EEG signal exceeds the first threshold level, the prominence of the sequencer declines into the midground region where it is joined by the sounds of bells and timbre modulation. The sequencer drops into the background and the bells move into the foreground as the amplitude of the ongoing EEG signal increases even further. The timbre modulation remains a midground voice and follows the bell sound as "ghost" sound that adds a natural harmonic content to the feedback music. The frequency modulated tone chord remains in the background of the perceptual field as a constantly changing, ever present voice. The frequency modulation, however, is phase locked with the bell sound so that both voices reinforce ongoing EEG activity in the brain.

The perceptual hierarchy is consistent with the elements of complex musical structure advanced by Shenker, Lerdahl and Jackendoff, and others. The music, however, has unique psychoacoustical properties. The brain responds to the music as an acoustical stimulus that reinforces particular physiological activity in a real time feedback loop. The musical attributes of the feed back signal keep the physiological information from becoming either boring or annoying and make the feedback psychologically emotionally acceptable for extended listing. It is to be appreciated that the four musical voices that comprise the preferred embodiment of the present invention represent a compromise between the often contradictory considerations governing the composition of music and the selection of adequate physiological stimuli that satisfy the necessary requirements for a real time feedback loop.

The character of the musical voices also may be adjusted to contain desirable psychological and musical information. For example, the notes generated by the sequencer may be tuned in a progressively more dissonant pattern. The musical quality of the acoustical feedback is then dissonant in the absence of the desired type of EEG activity but becomes musically consonant with the production of more of the desired type of EEG activity. The person undergoing resonance feedback is thus psychologically rewarded with consonant music for producing the preferred type of EEG activity. The base frequency of the first voice may be varied in accordance with individual taste to further enhance the therapeutic effect of the resonance feedback by making the music more attractive. For example, some researchers report that individuals prefer musical tunings that approximate the frequency range of their own voice. Also, the bell sound may be replaced by any number of other punctate sounds such as a drum or harp at the preference of the individual.

The four voices communicate a complex informational stimulus on the extent to which the person has entered into a desired brain state so that the person may learn to alter his physiological activity. The preferred embodiment conveys learning information about long term, time average physiological activity through the rate, retriggering, and perceived prominence of the note sequence. The other voices also contribute information to the learning process through their relative activity and perceptual prominence.

It is significant to the present invention that the learning information and psychological information need not interfere with the physiological content of the resonance feedback loop. The physiological resonance loop reinforces naturally occurring EEG activity so long as at least some of the musical voices are psychoacoustically correct and the remaining musical voices are not psychoacoustically incorrect in the sense of producing a physiological, psychological or psychoacoustical response that antagonizes the physiological resonance activity. The note sequencer is an example of a musical voice that provides only marginal direct physiological information by starting over when the ongoing EEG signal exceeds the second threshold. The note sequencer is nevertheless not inconsistent with physiological resonance since the production of each note is unrelated to the moment-by-moment activity of the ongoing EEG signal and the sequence as a whole does not interfere with the other voices. Arranging the sequence of notes in a dissonance pattern has the additional advantage of making the note sequencer a psychologically correct voice, in terms of incentive, as well as the primary conveyer of learning information.

The musical structure of the feedback signal enables a person to learn how to bring his EEG activity under volitional control. Experiments have shown that persons can learn to adjust their EEG activity in less than six minutes which is faster than commonly seen with conventional biofeedback. Indeed, it has been shown that individuals can modify their EEG activity to repeat musical patterns. These musical patterns are complex melodies which are unique to each individual. Nevertheless, the patterns constitute recognizable melodies that the individual producing the music can repeat at will. The learning information conveyed by the feedback signal permits people to literally produce music by cognitive control. Further, repeatable musical patterns could be used as control signals for instruments other than musical instruments. The present invention is therefore applicable to the field of man/machine interface.

It is to be appreciated that the feedback signal of the preferred embodiment of the present invention simultaneously conveys many levels of meaning through the real time resonance feedback loop. The hierarchical approach to forming the musical flavor provides a grammar which can be used to evoke an emotional response in accord with the principles of psychology and musicology. The feedback music provides emotional content such as normally supplied by the client-therapist interaction during conventional biofeedback.

Laboratory experiments have demonstrated that resonance feedback according to the present invention enhances the production of alpha wave activity in comparison to silence or the same feedback music played back so as not to be contingent on ongoing EEG activity. Further, increasing the intensity of resonance feedback music produces more EEG activity of the desired type once the level exceeds a threshold of approximately 86 decibels, at present signal to noise ratios. The words "signal" and "noise" in this context mean sound that is or is not directly correlated with ongoing physiological activity, respectively. Increasing the volume of noncontingent feedback music actually blocks production of the desired EEG activity. In addition, the time delay used in the feedback loop can maximize production of brain wave activity by precisely matching the frequency at which the brain of an individual is most inclined to generate the desired EEG activity.

The frequency modulation, bell sound, overtone sweep and note sequence comprise the only four voices that have been shown in laboratory experiments to promote physiological resonance while also maintaining the desired musical form, content and direction associated with psychoacoustically correct music. These four musical voices have been chosen for the purpose of increasing alpha activity so as to induce relaxation. It is believed that other sounds can be synthesized to obtain this result as well as other physiological and psychoacoustical objectives following the principles of neuroacoustics presented in this application.

The present invention can be practiced with music synthesizers that use analog components. It is considered preferable, however, to use digital EEG analysis and sound synthesis. Such implementation should have the advantages of increased reliability and precise adjustment of tone, pitch and gain parameters automatically, as well as automatic control over delay times and EEG feature extraction. These refinements should decrease the signal to noise ratio of the feedback music and thus lower the threshold for the onset of resonance feedback. Further, the task of creating psychoacoustically correct sounds should be greatly simplified with digital implementation due to the ease with which sounds and EEG analyses can be designed, stored and tested with digital synthesizers.

The present invention has many applications. For example, the musical feedback is itself an enjoyable form of music. Additional voices may be added to the music, inside or outside the feedback loop, to create interesting effects. For example, a white noise signal may be added to produce a thunder-like dramatic effect when the amplitude of the ongoing EEG signal exceeds a preselected threshold. The invention may be used by a clinical psychologist to facilitate various therapeutic procedures such as guided imagery by enhancing or retarding particular brain states. A neurologist may use the present invention as a musically pleasing test of brain functions by introducing a controlled punctate stimulus embedded within the music, to generate an evoked potential response. Yet another possible use for the invention is to create a form of interpersonal communication where music is generated in response to the collectively produced brain activity of several individuals. Numerous other applications are considered possible.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of the present invention as used in conjunction with a single individual;

FIG. 2 is a block diagram of a simplified circuit arrangement for practicing the present invention;

FIG. 3 is a flowchart showing the steps of signal processing used in a simplified embodiment of the invention such as the apparatus shown in FIG. 2;

FIG. 4 is a block diagram of a signal processing unit for the preferred embodiment of the present invention;

FIG. 5 is a block diagram of the frequency modulation unit shown in FIG. 4;

FIG. 6 is a block diagram of the bells unit shown in FIG. 4;

FIG. 7 is a block diagram of the overtone sweep unit shown in FIG. 4;

FIG. 8 is a block diagram of the sequencer unit shown in FIG. 4;

FIG. 9 is a flowchart of the signal processing according to the preferred embodiment of the present invention such as used in the signal processing unit shown in FIGS. 4-8;

FIG. 10 illustrates the ability of the present invention to induce relaxation in human beings;

FIG. 11 illustrates the ability of the musical feedback of the present invention to induce increased alpha activity using a physiological resonance feedback loop;

FIG. 12 illustrates the threshold at which alpha activity is induced by increasing the intensity of the acoustical feedback signal in resonance mode compared with the same type of music played so as not to be contingent on ongoing EEG activity; and

FIGS. 13 and 14 illustrate how the amount of alpha wave activity can be maximized by adjusting the delay time used in the resonance feedback loop to coincide with the frequency of the brain wave activity that the brain is predisposed to produce.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 is a block diagram of a simplified embodiment of the present invention. An electrode 3 is applied to the scalp of a person 1. The electrode may be a variety of clinically accepted electrodes, such as a Grass gold plated EEG cup electrode. The differential recording may be either monopolar or bipolar. Using the nomenclature which is conventionally used in clinical neurology, electrode 3 is preferably located at the CZ or P3 location for reinforcing alpha activity and producing relaxation. Other locations on the scalp might be used to induce other brain states. An electroencephalograph (EEG) channel conditioner 5, comprising a Tektronix.TM. 503 amplifier and a Krohn-Hite 3700 filter, amplifies the EEG 10,000 to 50,000 times and filters the electrical signal from electrode 3 to produce an ongoing EEG signal, in the range of 0.5 Hz to 35 Hz, corresponding to ongoing EEG activity in the brain of the person. The ongoing EEG signal is delayed in a delay line represented by delay line 7 and discussed in detail below. An EEG analysis unit 8 determines the most probable time to the next wave form of interest and adjusts delay line 7 accordingly. An EEG signal analysis processor 9 converts the ongoing EEG signal into electrical signals from which sound synthesizer 10 can produce music. The theory and functioning of the sound synthesizer is described in detail elsewhere in this application. Headphones 11 receive output signals from sound synthesizer 10 and direct an acoustical indication of the feedback signal to the ears of the person.

Delay line 7 shifts the phase of the periodic feedback signal so that the acoustical stimulus has a predetermined phase relationship to the ongoing EEG activity occurring in the brain of the person 1. Hence, delay could occur anywhere between sensor 3 and headphones 11 such as in a a Yamaha SPX 90 digital delay located between the sound synthesizer and the headphones. To produce an appropriate phase shift, delay line 7 must compensate for the time required for the brain to process sound, the time required to analyze the EEG, the time required for the sound synthesizer to actually produce the sound, the time required for the sound to propagate through the air to the listener, and the approximate period of time to the next EEG waveform of interest. The neural conduction time from ear to auditory cortex in humans is in the range of 35 milliseconds. Thus, for example, promoting alpha wave activity typically having a period of approximately 100 milliseconds requires an additional delay in delay line 7 of approximately 65 milliseconds so that the acoustical stimulation is approximately in phase with the next alpha wave and actively reinforces the biologically produced alpha activity. Conversely, a delay of only 15 milliseconds in delay line 7 produces a total delay of 50 milliseconds so that the acoustical stimulation is shifted 90 degrees out of phase with the production of alpha wave activity. In this last instance, the acoustical feedback presumably destructively interferes with the production of alpha wave activity and thereby allows the production of other types of EEG activity associated with other brain states. Other strategies for producing destructive interference, such as reversing electrode polarity, are available.

The degree of phase shift in delay line 7 changes with the type of EEG activity being measured, location of the EEG activity, and whether and to what extent the user desires the feedback to constructively or destructively interfere with the particular form of brain wave activity. The present invention selectively encourages or discourages EEG activity associated with various behavioral states and states of consciousness by varying the period of time by which the acoustical feedback is delayed.

The EEG analysis unit 8 may comprise an analog to digital converter to convert the EEG into a digital signal and an IBM PC programmed to perform a cross point analysis on the digitized EEG signal. The crosspoint analysis program may comprise counting the time required for each wave form in the ongoing EEG signal to cross a base line and then summing the number of wave forms that occur within discrete frequency ranges. The frequency range with the most occurrences is the preferred frequency of that subject. The delay line is adjusted with the inverse of the preferred frequency to approximate the period of time to the next EEG waveform. Other types of analysis other than cross point analysis such as FFT may be used. It is thought preferable to adjust the delay line on a moment-by-moment basis so that the anticipated arrival of the next brain wave corresponds to the period of the preceding brain wave.

A speaker 13, shown in FIG. 1, is connected to the output of sound synthesizer 10 by a switch 15. The speaker permits additional individuals to hear the acoustical output from the sound synthesizer. Speaker 13 may replace headphones 11 and supply feedback to person 1 if delay line 7 is adjusted to account for the longer period of time required for the sound to travel from the speaker to the person. Speaker 13 and headphones 11 should not, however, be used simultaneously unless provisions are made to prevent the acoustical output from the speaker and headphones from interfering with each other. Further, the output from sound synthesizer 10, or any other element, may be directed to additional signal processing equipment such as a recording device for subsequent editing, processing or playback.

It is to be appreciated that the present invention differs from other biofeedback or evoked potential devices by actively evoking a response with an acoustical feedback signal representing the brain's own ongoing EEG activity. The acoustical feedback actually makes the brain immediately follow its current EEG activity. Further, the physiological information encoded in the acoustical feedback signal is optimally suited to affect brain activity in desired ways because the response which the acoustical feedback induces in the brain is related to ongoing EEG activity produced by the brain itself. The utility of the present invention depends on giving the feedback sounds a form, content and direction sufficient to induce the desired response in the subject. Experiments have shown useful resonance feed back cannot be obtained without encoding the physiological information in a type of music designed in accordance with the principles of acoustics, music theory, musicology and the emotional psychology of music as explained in this application.

## ABBREVIATED MODEL

FIG. 2 is a functional block diagram of an abbreviated model for converting the ongoing EEG signal into a musical feedback signal in accordance with the present invention. The abbreviated apparatus establishes physiological resonance with a minimum of musical processing and is particularly useful for quick setup and limited experimentation. Delay line 7 is omitted for simplicity of the illustration. Tone generator 23 comprises three Moog 921 B voltage controlled oscillators (VCO's), 23a, 23b and 23c respectively, having base frequencies of 75 Hz, 115 Hz and 225 Hz, respectively. The 921 B oscillators individually produce a triangular wave output signal. A Moog 921 A oscillator controller 21 determines the frequency swings of the VCO's in the proportion of a one octave increase in frequency per volt increase in the amplitude of the ongoing EEG signal from signal conditioner 5. The sensitivity of the VCO's may be adjusted by placing a Moog CP3A voltage gain/attenuator at the input from the EEG signal conditioner 5. A Moog CP3A mixer 25 combines the output from the three VCO's in the proportion of 10:6:5, respectively, so that the output signal of mixer 25 can generate a chord tone.

The output signal from mixer 25 supplies an input signal to a Moog 904A high resonant voltage control low pass filter (VCLPF) 27. The value of the voltage from the ongoing EEG signal from signal conditioner 5 modulates VCLPF 27 so that it passes the higher frequencies of the VCO's from the oscillator of mixer 25 in proportion to the amplitude of the voltage signal. In other words, the VCLPF provides mixer 29 with more of the higher frequency signals in response to more intense EEG activity. A Moog CP3A mixer 29 combines the output signals from mixer 25 and VCLPF 27 in the ratio of 1:10. The output signal from mixer 29 is converted into the acoustical feedback signal and directed to the person through headphones, not shown in FIG. 2. The musical feedback thus consists primarily of the overtone sweep generated by VCLPF 27. It is to be appreciated that the moment-by-moment oscillations in the EEG are further accentuated by maintaining the phase relationship between VCO's 23 and VCLPF 27 so that the relative strength of the higher frequency tones increases as the oscillation frequencies of the VCO's increase.

A further refinement of the invention involves adding a pseudorandom, time varying signal to the VCLPF control line so as to offset the regularity of the electronically produced sound. As shown in FIG. 2, a Moog CP3A audio mixer 24 combines the output of three Moog 921 B voltage controlled oscillators to generate an output signal from pseudorandom signal generator 22. The VCO's are adjusted to have different, relatively low frequencies of oscillation on the order of 1Hz. The VCLPF 27 combines the control signals from mixer 24 and EEG signal conditioner 5 in the ratio of 1:1.

The VCLPF 27 adds musical flavor to the output pitch from the audio frequency generator 23 in the form of timbre modulation so that the musical feedback is more pleasing to listen to over time. Modulating the timbre in proportion to, and in phase with, the ongoing EEG signal provides physiological information to the listener and is therefore effective at inducing resonance feedback. The pseudorandom voltage signal acts on the timbre or "color" of the output sound in much the same way as vibrato on an instrument such as a violin. The pseudorandom signal adds an apparent gentle rhythmic randomness to the rapid moment-by-moment oscillations of the overtone sweep and frequency modulated chord tone so as to make the timbre modulation psychologically pleasant to the listener.

FIG. 3 is a flow chart of the signal processing steps performed by the apparatus shown in FIG. 2. The ongoing EEG signal, after being amplified and filtered, forms an input at step 5 that is delayed at step 7. The time delay may occur anywhere along the signal processing path and is illustrated as occurring to the input signal so as to be consistent with FIG. 1. Physiological information is generated at physiological content step 31 by converting the moment-by-moment oscillations of the ongoing EEG signal into a signal that an audio speaker can convert into a sound to which the brain of the listener is responsive. It is psychoacoustically preferable that the physiological content step comprise a frequency modulation of the pitch of a tone chord from signal generator 33 in response to the ongoing EEG signal because the human brain is more than 30 times more sensitive to changes in pitch than changes in amplitude (loudness). Part of the output from physiological content unit 31 supplies a flavor step 37 that adds a harmonic base to the music suitable for prolonged listening. Additional flavor may be supplied by a pseudorandom signal generator 32, or the pseudorandom signal may provide the only input signal at step 37. The output from flavor step 37 and physiological content step 31 are mixed at step 39 to form an output signal at step 40 suitable for conversion into a musical feedback signal.

It is to be appreciated that the functional attributes of the flow chart shown in FIG. 3 may be implemented in a number of ways using many different apparatus, including apparatuses using the techniques of digital sound synthesis, to function in accord with the teachings of the present invention.

ENHANCED MODEL

FIG. 4 is a block diagram for an analog implementation of the preferred embodiment of the present invention. A signal bus 6 receives the ongoing EEG signal from EEG signal conditioner 5. Delay line 7 has been omitted for simplicity of illustration. Frequency modulation unit 410, bells unit 420, overtone sweep unit 430 and sequencer unit 440 convert the ongoing EEG signal on bus 6 into four signals that are mixed and converted into four musical voices through means well known in the art such as a Tascam M512 mixer, not shown in FIG. 4.

Frequency modulation unit 410 generates a tone chord that is modulated by the amplitude variations of the ongoing EEG signal. The FM unit comprises three phase locked voltage controlled oscillators tied together to form a desired harmonic relationship with other voices. The frequency modulation unit provides physiological information in the form of moment-by-moment acoustical feedback corresponding to the amplitude contour of the ongoing EEG signal on line 6, as well as a harmonic background to the complex musical superstructure formed by the other three musical voices.

Bells unit 420 generates a second voice in the form of a punctate acoustical impulse such as the sound of a struck bell. The bell unit accepts two control signal inputs, 420a and 420b, for controlling the amplitude and pitch, respectively, of the bell sound into which its output signal is ultimately converted. The occurrence of the bell is determined in relationship to the amplitude of the voltage of the ongoing EEG signal. If the EEG signal exceeds a first threshold level, a first threshold detector 421, such as a Moog 912 Schmidt trigger, supplies a voltage control signal to sample and hold unit 422 at input 422a. The sample and hold unit responds to the voltage control signal by sampling the incoming EEG and tuning a tone generator in bells unit 420.

The voltage control signal from first threshold detector 421 to sample and hold unit 422 is delayed in delay line 424 for a period of time that approximates the time required for the ongoing EEG signal to crest at a local maxima. The value of the delay time is an experimentally determined parameter, calculated for each subject, that depends on the value of the threshold level as well as the the frequency and amplitude of the ongoing EEG signal. The frequency of the tone from the tone generator is proportional to the value of the voltage at control input 422b which corresponds to the relative moment-by-moment amplitude of the ongoing EEG signal at the time that the sample and hold unit is triggered. Thus, the pitch of the tone generator is proportional to the (approximate) amplitude of the ongoing EEG signal at the crest of a brain wave.

The output from an envelope generator 423 modulates the amplitude of the signal from the bell unit so that it assumes the amplitude envelope of a bell. If the EEG signal does not exceed the first threshold level, bells unit 420 does not generate an output signal and no bell sound is produced.

Overtone sweep unit 430 generates an output signal that forms a third musical voice for the musical feedback. The overtone sweep unit comprises a plurality of tone generators. A highly resonant voltage controlled low pass filter is modulated with respect to the ongoing EEG signal so as to pass more high frequency tones in response to a greater amplitude in the ongoing EEG signal. The overtone sweep is triggered only in response to the amplitude of the ongoing EEG signal exceeding the first threshold level as indicated by a signal from envelope generator 432. Envelope generator 432 is constructed with a slow attack so that the maximum timbre modulation occurs after the sound of the bell. The timbre modulation thus serves as a "ghost" sound to the bells which adds psychoacoustically correct flavor to the music of the feedback signal.

Further, the envelope generator preferably does not completely shut off immediately after the ongoing EEG signal drops below the first threshold level. This hysteresis causes the amplitude of the output of the envelope generator to increase with increasing frequency of occurrence of brain waves that have an amplitude greater than the first threshold level. Thus, the overtone sweep produces a feedback signal that is more derivative of the ongoing EEG signal while still maintaining some correspondence with the physiological information contained in the EEG.

The output signal from sequencer unit 440 forms a fourth musical voice for the musical feedback. The sequencer can generate twenty-four notes in sequence. The sequencer receives two control signals from the ongoing EEG signal. One control signal which controls the rate at which the sequencer cycles through its sequence corresponds to the negative of the output of envelope generator 432 by passing through inverter 431. The negative of the voltage of the signal from envelope generator 432 slows the cycling rate of sequencer 440 in proportion to the incidence of the ongoing EEG signal exceeding the first threshold. A second threshold detector 441, such as a Moog 912 Schmidt trigger, derives a second control signal directly from the ongoing EEG signal. The second threshold is preferably set at a greater voltage level than first threshold detector 421. The second control signal resets the sequencer to the beginning of its sequence of notes. Thus, the sequencer slows whenever the ongoing EEG signal exceeds the first threshold and starts over whenever the ongoing EEG signal exceeds the second threshold.

FIG. 5 is a more detailed functional block diagram of the frequency modulation unit 410 shown in FIG. 4. A Moog CP3A gain control unit 51 controls the amplitude of the ongoing EEG signal from line 6 that is supplied to a Moog 921A oscillation controller 53. The oscillator control 53 produces an output signal that controls the oscillation frequency of three Moog 921B voltage controlled oscillators, 55a, 55b and 55c, respectively, having base frequencies of 75 Hz, 158 Hz and 225 Hz, respectively. The output from the frequency oscillators comprise rich harmonic structures such as triangular wave forms. A Moog CP3A audio mixer 57 combines the output signals from the VCO's in the ratio of 10:6:5, respectively, as indicated by settings on the Moog mixer.

FIG. 6 shows a more detailed functional block diagram of the bells unit 420 and sample and hold unit 422 and envelope generator 423 shown in FIG. 4. A Moog 902 voltage controlled amplifier 621 directs the ongoing EEG signal from line 6 to a Moog 1528 sample and hold unit 422 from FIG. 4. The sample and hold unit is triggered by first threshold detector 421 to produce an output voltage that is proportional to the voltage of the ongoing EEG signal from signal bus 6. Once triggered, the sample and hold unit 422 determines the oscillation frequency of a Moog 921 voltage controlled oscillator 623 which has a center frequency of 10.7 KHz. A Moog 902 voltage controlled amplifier 625 receives an input signal from voltage oscillator 623 in the form of a triangular wave. A Moog 911 envelope generator 423 modulates the amplitude of the voltage output signal from VCA 625 so that the resulting audio output sounds like a bell and may therefore supply musical flavor to the resulting audio output. The envelope generator reaches maximum amplitude four milliseconds after being triggered by threshold detector 421. In order to bring the bell sound and FM sound into phase alignment, the FM sound should be delayed an additional 4 milliseconds, and this delay should be taken into account in calculating the delay time. The FM unit, however, is not shown as being so delayed. This relatively sharp rise time corresponds to a sharp attack time which is characteristic of a struck bell. The amplitude envelope then decays to 60% of maximum amplitude after 200 milliseconds. The generator shuts off after an additional 200 milliseconds so as to approximate the ringing of a bell.

FIG. 7 is a more detailed functional block diagram of overtone sweep unit 430 shown in FIG. 4. A Moog CP3A audio mixer 73 mixes, in the ratio of 10:3.5:5, the triangular wave output signals from Moog 921 voltage controlled oscillators 71a, 71b and 71c, having base frequencies of of 75 Hz, 144 Hz, and 257 Hz, respectively. A Moog 904 A voltage controlled low pass filter 75 directs the output signal of audio mixer 73 to the main mixer after its timbre spectral content is modulated by envelope generator 432 of FIG. 4. Envelope generator 432 produces an output signal that reaches maximum value 500 milliseconds after being triggered by threshold detector 421. The amplitude of the output envelope then falls 70% of peak value over the next 400 milliseconds and completely shuts off after an additional 500 milliseconds. The total conduction time of envelope generator 432 is therefore greater than the expected duration of an alpha wave. Hence, a subsequent alpha wave increases or maintains at maximum the amplitude of the control signal and maintains or increases the amplitude of the overtone sweep. The envelope generator eventually shuts off at the end of an alpha burst.

FIG. 8 is a more detailed block diagram of the sequencer unit 440 shown in FIG. 4. The output of envelope generator 432 is inverted by inverter 431, as shown in FIG. 4, to trigger a Moog 960 sequence clock controller 81 which supplies a clocking signal to sequence generator 82. The sequence generator has three rows of eight notes each for a total of 24 notes. The sequence generator cycles through the 24 notes at a fixed rate and modulates a Bode 1630 harmonic frequency shifter 84 which shifts the frequency of the square wave output signal from a Moog 901 B voltage controlled oscillator 83. The output signal from frequency shifter 84 passes through a Moog 902 voltage controlled amplifier 85 which is amplitude modulated by the output signal from a Moog 911 envelope generator 87 in response to a trigger signal from sequence clock controller 81.

The cycling rate of sequence generator 82 is reduced in proportion to the amplitude of a control signal from sequential controller 81 which is proportional to the voltage value of envelope generator control signal from first threshold detector 421. Sequence clock 81 also triggers envelope generator 87 through a Moog 961CP interface unit 86. The envelope generator adds musical flavor of the output signal from harmonic frequency shifter 84 by changing the output amplitude envelope to correspond to any desired instrument.

The sequential generator also comprises a control signal input for retriggering the sequence to the first row. Sequence generator 82 comprises a Moog 962 sequential switch which has three control ports for retriggering the sequential controller to any of the three columns. The output signal from threshold detector 441 uses a Moog 961CP interface to trigger the output switch to the first row and the sequence generator to the first column each time the ongoing EEG signal exceeds the second threshold level.

FIG. 9 is a flow chart of the signal processing steps such as performed by the apparatus disclosed in FIGS. 4-8. The ongoing EEG signal received at step 90 supplies a continuum of signal processing paths that ranges between following moment-by-moment change in the ongoing EEG signal to controlling independently generated sounds. Various intermediate signal processing paths respond to specific features or properties of the ongoing EEG signal in ways specifically engineered to incorporate multiple information pathways into the musical feedback signal. The music thus communicates a real time analysis of the ongoing EEG signal in a psychoacoustically correct form which can affect the biological activity of the brain when used in a real time resonance loop.

Referring to FIG. 9, the moment-by-moment change in the ongoing EEG signal is communicated at step 91. The preferred method for indicating moment-by-moment change is to frequency modulate a tone chord with ongoing EEG signal. Frequency modulation is preferred because the human auditory system is more than 30 times more sensitive to changes in frequency. The output signal from step 91 supplies an input signal to mixing step 92. This first level of signal processing provides the most immediate possible indication of current EEG activity.

Another level of EEG signal processing and analysis extracts major features of the EEG and reinforces them by sounding whenever the EEG signal generates the predetermined feature sensed at conditional test 94. No output is generated in the absence of the feature of interest. Any of several sounds might be generated to reinforce the particular features. However, no sound is absolutely physiologically correct if its attack time peak intensity exceeds the duration of the EEG feature that is being reinforced because a sound having a longer duration permits preceding features to obscure subsequent occurrences of the same feature. For example, reinforcing each peak for alpha activity having a frequency of approximately 10 Hz requires a sound having an attack time of less than 100 milliseconds. A bell, chime or harp sound is preferred because it has a sufficiently short attack time and is also psychologically musically pleasing to the listener and thus adds musical flavor to the feedback music.

Another level of signal analysis and processing of the ongoing EEG signal comprises generating an indication of the current flavor of the ongoing EEG signal. The current flavor may be indicated by generating an overtone sweep at step 97 in response to a feature such as a crest of the ongoing EEG signal. The ongoing EEG thus changes the musical flavor of the feedback music by increasing the harmonic content of the feedback as the ongoing EEG signal first exhibits the preferred activity and then continues to pass more harmonics with repeated instances of the preferred activity. The overtone sweep provides a more derivative indication of ongoing physiological activity since its production is not engineered to evoke an immediate response. Nevertheless, the overtone sweep is a relevant indication of ongoing EEG activity and the extent of the production of a particular type of EEG activity.

Yet another level of signal analysis and processing of the ongoing EEG signal comprises generating an indication of the time average of the musical flavor in a manner that is analogous to conventional biofeedback. The time average flavor can be indicated by modifying a sequence of notes at step 98 in response to some property of the ongoing

EEG signal such as its relative amplitude. Further, the sequence of notes can supply considerable musical flavor to the acoustical output independent of the ongoing EEG signal to make the feedback music psychologically pleasing for extended periods of time.

As shown in FIG. 9, the feature extraction, current flavor and average flavor signal processing levels all respond to a common feature of the ongoing EEG signal detected at conditional step 94. The multiple information pathways thus tend to reinforce the same physiological activity in different ways even while being derivative of moment-by-moment changes in the ongoing EEG signal. In addition, additional musical flavor may be triggered in response to other characteristics of the ongoing EEG signal as indicated by conditional test 99. It is to be appreciated that the musical flavor provides both current physiological information and more perceptually discernible time average learning information that enables a person to learn to control his EEG activity.

It has been found that particular utility can be obtained by organizing the information pathways in musical form. For example, the current musical flavor and feature extraction sounds, and long term flavor sound can be made to function as counter melodies of one another to add musical texture to the feedback. The relative perceptual prominence of each voice can be made to change so as to indicate the relative magnitude of a desired brain state as described in the summary of the invention section.

It is to be appreciated that the signal processing steps performed in the flow chart shown in FIG. 9 may be implemented with different apparatus, including preferably apparatus using the techniques of digital sound synthesis, to produce an apparatus that operates in accord with the teachings of the present invention. Numerous additional musical voices may be added to the output. Other musical relationships can be established between the musical voices, either permanently or through time-variant means.

ALTERNATE EMBODIMENTS

A modification to the embodiment of the invention shown in FIG. 1 involves measuring the ongoing EEG signal from additional locations on the scalp and modifying the acoustical feedback to simultaneously enhance the EEG at several locations, or to enhance it at one location while discouraging its production at another location. For example, it is thought to be preferable for reinforcing alpha wave activity with an electrode at the P3 location to direct physiological information, i.e. the frequency modulated tone chord and bell sound to the right ear and the overtone sweep and note sequence to the left ear. In terms of dichotic listening, the physiological stimulation thus is confined to the left side of the brain because sound heard with the right ear stimulates the left side of the brain. The right side of the brain is thus free to produce other types of EEG activity such as beta waves. The literature suggests that alpha activity at P3 with corresponding beta activity in the temporal lobe of right brain corresponds to a state of inwardly focused attention with positive emotional imagery. Further, right brain is better able to holistically process the learning information communicated by the note sequencer and overtone sweep, and respond to its changing musical structure.

It is to be appreciated that the signal processing steps shown in FIGS. 2 and 4 may be implemented with digital musical equipment. Indeed, digital sound synthesis techniques are thought to be preferable because a wide range of voices may be implemented in response to a wider range of phenomena present in the ongoing EEG signal. The particular EEG phenomena used to produce a voice and the musical structure of the voice may be selected, on an experimental basis, to produce a desired physiological response. Further, digital equipment permits more precise feature extraction as well as automatic scaling of the triggering thresholds during use so that the feedback music continues to induce the appropriate response in the person as his EEG parameters change throughout the session and he enters deeper into the desired state. Alternately or additionally, the musical voices may be organized by a composer based on purely aesthetic considerations. Digital analysis and synthesizing equipment greatly simplifies composing and implementing of the acoustical feedback by reducing the amount and time consumed in experimentally finding physiologically and psychoacoustically "correct" sounds.

Additional voices may be added to create interesting and physiologically relevant effects. Both the type of musical sound produced and the quality of that sound directly affect the ability of the present invention to enhance brain wave activity. The criteria used to select a proper sound have been described above. The musical quality of the feedback music must exceed an as of yet indefinite minimum threshold to allow the resonance feedback effect to proceed.

One unusual result obtained with the present invention is the production of synesthesic effects, or the observations of lights and colors, in response to the various musical voices in the resonance feedback. Specific colors or color patterns have been observed to follow particular voices in the music. Synesthesic effects have been experienced by approximately one third of individuals tested using the principles of the present invention. This result suggests that the addition of visual feedback may augment the effects obtained with acoustical feedback.

APPLICATIONS

The present invention is useful for producing enjoyable music. For example, the second voice can comprise a bell sound, chime or any other desired tone. Likewise, the sequencer may play twenty-four notes from any desired type of instrument to produce any type of melody. The invention may be used as a musical instrument on which a person may learn and play music by cognitive control without also having to physically perform a composition.

The invention may be used as a relaxation device that operates by resonantly reinforcing high amplitude, low frequency EEG activity such as alpha wave activity. Such biofeedback also permits an individual to monitor and change his brain wave patterns to obtain various internal states. A clinical psychologist may facilitate various therapeutic procedures, such as guided imagery, by enhancing or retarding a particular brain state. A neurologist may use the present invention as a musically pleasing test of brain functions by introducing a controlled signal, such as punctate sounds embedded within the feedback music, to generate an evoked potential response. Yet another application is as a clinical monitoring device which permits a physician or researcher, such as an anesthesiologist, to monitor the status of a patient's or subject's brain over a loudspeaker without having to maintain a constant vigil on the visual image formed on an oscilloscope.

Experiments have shown that the present invention provides an individual with a pleasant way to control his brain wave activity within a matter of a few minutes. Moreover, individuals who have experienced biofeedback resonance according to the present invention have shown a statistically significant reduction in anxiety. The present invention appears to actively promote alpha wave activity since the amount of alpha activity increases during feedback in contradistinction to no sound or a noncontingent, but in other respects similar, acoustical stimulus. In contrast, nonresonance biofeedback techniques may block alpha wave activity with an incongruent feedback signal.

The invention can be used to diagnose psychological and neurological conditions. The dramatic portrayal of the emotional and functional states of an individual contained in the feedback music provides a direct indication of the psychological state of a person. Empirical guidelines should be established to enable a practitioner to critically and analytically listen to the feedback music and form diagnostic opinions about the individual. Further, the invention could be used to create diagnostic methods for assessing hearing disorders after traumas such as stroke or head injury because the source of the EEG signal used to create the feedback music and the efficacy of the feedback can be precisely defined. The invention may also be useful for mapping brain activity in relation to the production or perception of music or language.

An additional application of the present invention is to the general field of man/machine interface such as between the human brain and a computer. Experiments have shown that the present invention enables individuals to control their EEG activity so as to repeat audible patterns. The human brain can easily remember and distinguish between a large number of musical patterns such as melodies. Individuals should be able to remember and reliably reproduce a large number of distinct control signals. Thus, referring to FIG. 1, speaker 13 may be replaced by a pattern recognition device which, after recognizing a desired musical pattern, generates the appropriate control signal to a device which is not necessarily a musical device.

The present invention also permits interpersonal communications. One skilled in the art may readily appreciate that various voices may be added to the feedback signal that indicate a particular synchronism or mental state among more than one individual. The musical feedback thus comprises a form of communication which is analogous to the type of communication which occurs between, for example, a violin and a cello playing a duet. In the present instance, however, the communication comprises a form of cognitive "group thought" and emotional communication not hitherto known.

EXAMPLE 1

The capabilities of the present invention to induce relaxation are illustrated by the experimental results presented in FIG. 10. A sample group of 15 subjects was selected. No subject was a clinical patient and none exhibited signs of psychopathology. Each subject experienced a ten minute control period of sitting quietly without sound, followed by a ten minute period of resonance feedback. The state of anxiety of each subject was measured before and after the ten minute periods using the Spielberger self report anxiety scale. The Spielberger scale is well known to those skilled in the art. The ordinate of FIG. 10 shows the relative anxiety scores as measured by the Spielberger scale. Scores in the range of 45 to 50 correspond to overt signs of anxiety. Scores in the mid 30's indicate moderately high levels of anxiety. The lowest possible score on the scale is 20.

As shown in FIG. 10, quiet did not significantly change the level the anxiety as seen by comparing the scores for blocks A and B obtained before and after the period of quiet, respectively. Measurements remained in the mid-30's. After resonance feedback, however, anxiety decreased markedly from the mid-30's to the mid-20's as shown by comparing blocks C and D corresponding to scores obtained before and after resonance feedback, respectively. The decrease in anxiety as a result of resonance feedback was significant at the $P<0.05$ level of statistical significance.

EXAMPLE 2

FIG. 11 exemplifies the increase in alpha activity in a single subject during resonance feedback. The ordinate corresponds to the number of alpha waves counted during a 30 second period at the CZ location on the scalp. FB corresponds to the wave count obtained from a single representative individual experiencing resonance feedback, In contrast, NS represents the alpha count for a control condition corresponding to a comparable period without sound. NC corresponds to the alpha count for the same individual listening to the music corresponding to his own brain wave activity but which has been delayed by a few minutes so as not to be contingent on the ongoing EEG signal. FIG. 11 clearly illustrates that the resonance feedback produces a greater number of alpha waves than obtained by mere silence. Further, the greater number of alpha waves obtained with resonance feedback as opposed to music that is not contingent upon the ongoing EEG signal shows the importance of resonance feedback at inducing the desired form of EEG activity.

EXAMPLE 3

FIG. 12 corresponds to a representative comparison of the effects of resonance feedback at various decibel intensity levels for a single subject for a single subject. The vertical scale corresponds to the relative power present in the alpha wave signal as measured by an electrode attached to the CZ location on the scalp (400 units=13.6 microvolts). The horizontal axis corresponds to the intensity of the feedback in decibels. Referring to FIG. 12, it is apparent that the amount of alpha activity present with resonance feedback, represented by curve 130, diverges substantially at approximately 86 decibels from that produced with the same type of music played as noncontingent sound as represented by curve 131. Further, the amount of alpha activity measured with resonance feedback and noncontingent feedback begins to converge as the intensity declines at approximately 82 decibels. It is to be appreciated that an intensity of 86 decibels corresponds to approximately the volume produced by a home stereo system operating at moderately high listening levels. Further, the amount of alpha activity generated with resonance feedback appears to increase with intensity after 86 decibels. In contrast, the amount of alpha wave activity produced by the noncontingent feedback decreases with increasing intensity as illustrated by the minimum in curve 131 at maximum intensity. Experiments conducted with several individuals have shown that the 86 decibel threshold, in the context of current signal to noise ratios, appears to be critical to the commencement of resonance feedback.

EXAMPLE 4

FIGS. 13 and 14 illustrate the importance of the delay period to maximize resonance feedback. FIG. 13a shows the distribution of alpha waves with frequency at the P3 location on the scalp of a representative individual. The ordinate corresponds to the number of EEG waves observed during a 30 second interval and the horizontal axis shows the range in frequencies obtained by using a cross point analysis. This particular individual exhibits maximum alpha Wave activity at 10 Hz. In FIG. 13b, the vertical axis represents the alpha wave count and the horizontal axis represents the total delay time in milliseconds obtained during resonance feedback using the present invention. The optimal amount of alpha wave activity was obtained with a delay time of 100 milliseconds which corresponds to a frequency of 10 Hz having a period of 100 milliseconds. Thus, the optimal delay time exactly corresponds to the preferred alpha frequency of this subject.

FIG. 14 shows similar results for a second representative individual. As shown in FIG. 14a, this individual has a preferred alpha frequency of 8 Hz which corresponds to a period of 125 milliseconds. FIG. 14b shows that the maximum amount of alpha wave activity obtained using the the present invention occurred with a total delay time of 125 milliseconds which, again, corresponds to the preferred EEG alpha frequency. Thus, for any particular individual the preferred frequency of the desired EEG activity determines the optimal delay time present in the resonance feedback loop. Resonance is maximized by matching the feedback time delay to the frequency at which the brain prefers to produce the EEG activity of interest.

SUGGESTIONS FOR FURTHER RESEARCH

Numerous possible applications of the present invention have been described above. A particularly promising application is the use of resonance feedback as an an alternative to conventional invasive brain stimulation techniques.

Current methods of brain stimulation involve surgically implanting an electrode into an region of the brain that is to be stimulated. The resulting effect on the brain depends on the location of the electrode and the frequency of the stimulation. For example, a region of the brain can be activated with high frequency stimulation, whereas inhibition and deactivation result from low frequency stimulation. The process of surgically implanting an electrode, however, is highly invasive and greatly limits the both research into brain stimulation and its utility as a diagnostic or therapeutic tool.

In contrast, resonance feedback uses noninvasive electrodes that are located on the scalp. The position of the electrodes determines the area of the brain that is "stimulated" by the feedback music. Further, the use of constructive and destructive interference, selective filtering and judicious manipulation of delay times may produce different frequencies of "stimulation". Resonance feedback thus offers the possibility of systematically stimulating selected areas of the brain.

One potential application for brain stimulation using resonance feedback involves neural exercise. Rehabilitation programs for persons who have suffered brain injuries are essentially designed around the concept of neural exercise, wherein the region of the brain that surrounds a region that has been damaged is systematically stimulated in the hope that it will assume the functions of the damaged brain cells. It is thought likely that resonance feedback is effective at stimulating neural activity in a selected region of the brain and should therefore serve as a form of neural exercise. Resonance feedback is thought to offer particular utility in cases involving music and language impairment.

Recent developments in superconductivity and research directed to recording brain waves with magnometers indicate that increased resolution and selectivity may soon be available to aid resonance stimulation of any region of the brain. Magnometers may replace the scalp electrode 3 shown in FIG. 1 to generate an input signal corresponding to the semiperiodic changes in amplitude of the magnetic field that are associated with ongoing EEG activity. Magnometers can triangulate the semiperiodic magnetic activity so as to generate a signal indicative of EEG activity occurring in a well defined region deep within the brain. The delay inserted into the feedback loop can be adjusted to obtain a desired phase relationship between the feedback signal and the ongoing EEG activity since magnometers can also be used to determine the response of the region of the brain to acoustic stimulation.

In addition, EEG computer analysis methods, such as BEAM developed by Frank Duffy, are providing extensive maps of the brain that indicate what EEG activity in which regions of the brain are associated with particular states of emotion, cognition and consciousness. This information can be used as a guide for designing resonance feedback protocols and in selecting regions of the brain for resonance stimulation.

The principles, preferred embodiments and modes of operation of the present invention have been described in the foregoing specification. The invention, which is intended to be protected herein, should not, however, be construed as limited to the particular forms described, or the particular examples given, as these are to be regarded as illustrative rather than restrictive. Variations and changes may be made by those skilled in the art without departing from the spirit of the invention. Accordingly, the foregoing detailed description should be considered exemplary in nature and as in no way limiting to the scope and pioneering spirit of the invention as set forth in the appended claims.

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**Monroe** **October 18, 1994**

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Method of and apparatus for inducing desired states of consciousness


### Abstract

Improved methods and apparatus for entraining human brain patterns, employing frequency following response (FFR) techniques, facilitate attainment of desired states of consciousness. In one embodiment, a plurality of electroencephalogram (EEG) waveforms, characteristic of a given state of consciousness, are combined to yield an EEG waveform to which subjects may be susceptible more readily. In another embodiment, sleep patterns are reproduced based on observed brain patterns during portions of a sleep cycle; entrainment principles are applied to induce sleep. In yet another embodiment, entrainment principles are applied in the work environment, to induce and maintain a desired level of consciousness. A portable device also is described.


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**References Cited** **[Referenced By]**

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**U.S. Patent Documents**

| | | | |
|---|---|---|---|
| 2466054 | Apr., 1949 | Siebel. | |
| 3160159 | Dec., 1964 | Hoody et al.. | |
| 3576185 | Apr., 1971 | Schulz et al.. | |
| 3712292 | Jan., 1973 | Zentmeyer, Jr.. | |
| 3753433 | Aug., 1973 | Bakerich et al.. | |
| 3826243 | Jul., 1974 | Anderson. | |
| 3837331 | Sep., 1974 | Ross. | |
| 3884218 | May., 1975 | Monroe. | |
| 4034741 | Jul., 1977 | Adams et al.. | |
| 4141344 | Feb., 1979 | Barbara. | |
| 4227516 | Oct., 1980 | Meland et al.. | |
| 4335710 | Jun., 1982 | Williamson. | |
| 4573449 | Mar., 1986 | Warnke. | |
| 4834701 | May., 1989 | Masaki. | |
| 4883067 | Nov., 1989 | Knispel et al. | 600/28. |
| 5036858 | Aug., 1991 | Carter et al.. | |
| 5101831 | Apr., 1992 | Koyama et al. | 600/26. |


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## *Claims*

1. A method of inducing desired states of consciousness in human beings, comprising the following steps:

combining a plurality of replicated electroencephalogram (EEG) waveforms, each indicative of a particular desired state of consciousness, to produce a combined EEG waveform;

superimposing said combined EEG waveform on two separate sets of carrier waves using stereo sound;

creating differential beat frequencies between said sets of carrier waves based on said superimposing step; and

providing the resulting signals in audio form to respective ears of a human being, to induce said state of consciousness.

2. A method as claimed in claim 1, wherein said combining step comprises mathematically averaging said EEG waveforms to produce said combined EEG waveform.

3. A method as claimed in claim 1, further comprising the step of repeating said combining, superimposing, and creating steps for each of a set of desired states of consciousness, and producing a cycle of sets of resulting audio signals, said providing step comprising providing said cycle of sets of resulting audio signals to respective ears of a human being, to induce each of said desired states of consciousness in cyclic fashion.

4. A method as claimed in claim 3, wherein said cycle corresponds to human sleep patterns, said desired states of consciousness comprising wakefulness, alpha sleep, delta sleep, and theta sleep.

5. A method as claimed in claim 3, wherein said cycle corresponds to human sleep patterns, said desired states of consciousness comprising alpha sleep, delta sleep, and theta sleep, said cycle being approximately 90 minutes long.

6. A method as claimed in claim 5, said method further comprising the steps of providing a plurality of repetitions of said cycle, followed by providing a set of audio signals containing a binaural beat at a frequency indicative of beta consciousness.

7. A method as claimed in claim 1, wherein said creating step includes the step of combining pink sound with said sets of carder waves by shifting of said pink sound with respect to said combined EEG waveform from one stereo audio channel to another, with cyclic changes in amplitude, frequency, and rate of panning.

8. Apparatus for facilitating sleep in a human subject, comprising:

means for setting a wake-up time to select a desired sleep duration;

means for generating a first sequence of signals in a cycle corresponding to a human sleep pattern, frequencies of said signals in said first sequence being substantially equal to frequencies of human brain patterns at different levels of sleep;

means for repeating said cycle a plurality of times based on the selected wake-up time; and

means for waking up said human subject at the selected wake-up time.

9. Apparatus as claimed in claim 8, wherein said means for waking up said human subject comprises means for generating a second sequence of signals a predetermined time before the selected wake-up time, frequencies of said signals in said second sequence being substantially equal to frequencies of human brain patterns at or near an awakened state.

10. Apparatus as claimed in claim 9, wherein said predetermined time is approximately five minutes.

11. Apparatus as claimed in claim 8, wherein said first sequence of frequencies comprises, in order, alpha frequencies, theta frequencies, delta frequencies, and theta frequencies.

12. Apparatus as claimed in claim 8, further comprising means for generating phased pink sound in conjunction with said first sequence of frequencies.

13. Apparatus as claimed in claim 8, wherein said first sequence of signals comprises a plurality of sets of combined brainwaves, each of said sets corresponding to a different level of sleep, said combined brainwaves within a given set being constituted by combined electroencephalogram (EEG) waveforms of a plurality of individuals, taken when said individuals had attained a different respective level of sleep.

14. Apparatus as claimed in claim 13, wherein said EEG waveforms are mathematically averaged.

15. Apparatus for awakening an individual using brain pattern entrainment, said apparatus comprising:

means for selecting a wake-up time;
means for keeping time; and

means, operative a predetermined period before said wake-up time as determined by said means for keeping time, for producing a first sequence of signals having frequencies in the theta-alpha range, followed by a second sequence of signals having frequencies in the beta-gamma range.

16. Apparatus as claimed in claim 15, wherein said means for producing said first and second sequences of signals comprises means for producing said second sequence of signals at a higher amplitude than said first sequence of signals.

17. Apparatus as claimed in claim 15, wherein said first sequence of signals comprises a plurality of sets of combined brainwaves, each of said sets corresponding to a different level of consciousness, said combined brainwaves within a given set being constituted by combined electroencephalogram (EEG) waveforms of a plurality of individuals, taken when said individuals had attained a different respective level of consciousness.

18. Apparatus as claimed in claim 16, wherein said EEG waveforms are mathematically averaged.

19. Apparatus for inducing a desired state of consciousness, said apparatus comprising:

means for detecting presence of a predetermined level of ambient noise;

means, responsive to said detecting means, for generating signals having frequencies substantially equal to frequencies of human brain patterns when said ambient noise is present; and

means for selecting said signals in accordance with desired human activity in said areas.

20. Apparatus as claimed in claim 19, further comprising timer means, connected to said generating means, for generating said signals for a predetermined time set by said timer means.

21. Apparatus as claimed in claim 19, wherein said timer means is connected to said selecting means to enable selection of different ones of said signals in accordance with desired human activity at different times of day.

22. Apparatus as claimed in claim 19, wherein said generating means comprises means, responsive to said detecting means, for increasing an amplitude of said signals in response to an increase in amplitude of said ambient noise, and for decreasing an amplitude of said signals in response to a decrease in amplitude of said ambient noise.

23. Apparatus as claimed in claim 22, wherein said generating means further comprises means for discontinuing said signals when said ambient noise falls below said predetermined level.

24. Apparatus as claimed in claim 19, wherein said generating means comprises a digital signal processor and a read-only memory (ROM) connected to said digital signal processor, said ROM storing a plurality of sets of signals, each of said sets of signals having frequencies substantially equal to human brain patterns at a desired state of consciousness.

25. Apparatus as claimed in claim 24, wherein each of said sets of signals comprises a plurality of sets of combined brainwaves, each of said sets corresponding to a different level of consciousness, said combined brainwaves within a given set being constituted by combined electroencephalogram (EEG) waveforms of a plurality of individuals, taken when said individuals had attained a different respective state of consciousness.

26. Apparatus as claimed in claim 25, wherein said EEG waveforms are mathematically averaged.

27. Apparatus for awakening an individual using brain pattern entrainment, said apparatus comprising:

means for selecting a wake-up time; and

means, operative a predetermined period before said wake-up time, for producing a first sequence of signals having frequencies in a first predetermined range corresponding to a first state of consciousness, followed by a second sequence of signals having frequencies in a second predetermined range corresponding to a second state of consciousness.

28. Apparatus as claimed in claim 27, wherein said first predetermined range is the theta-alpha range, and said second predetermined range is the beta-gamma range.

## ***Description***

CROSS-REFERENCE TO RELATED APPLICATION

The present application is related to copending application No. 07/514,460, filed Apr. 16, 1990 now U.S. Pat. No. 5,213,562.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an improved method of inducing desired states of consciousness, including different levels of sleep, in human beings, using a technique known as frequency following response (FFR), developed by the present inventor. The invention also relates to apparatus for performing the method. A number of areas of applicability of the invention are described, in accordance with different preferred embodiments.

2. Description of the Background Art

In a prior patent, U.S. Pat. No. 3,884,218, the present inventor described a method of inducing different levels of sleep, using the FFR technique, in which brain waves could be made to follow superimposed frequency patterns. These frequency patterns were provided as sine waves, at frequencies known to correspond to different levels of sleep, such as alpha (exhibiting brain wave activity in the range of 8-12 Hz), theta (6-8 Hz), and delta (1-4 Hz). EEGs exhibiting frequencies between 12 and 30 Hz (known as a beta range) are characteristic of awake individuals, though beta activity at even higher frequencies has been observed in different types of mental activities. Gamma activity has been characterized as all activity above 30 Hz; until recently, it has not been possible to monitor brain activity in the gamma range. (It should be noted that the boundaries between gamma and beta, beta and alpha, alpha and theta, and theta and delta are somewhat arbitrary; the foregoing delineations are intended to be exemplary and not limiting.)

The present inventor discovered that the human brain could be entrained to output brain wave patterns these different frequencies. While frequencies corresponding to these different levels of sleep are not audible, by superimposing those frequencies on some type of sound, such as music, it was determined to be possible to induce desired levels of sleep. The individual listening to the music would "hear" the low frequencies, with the desired effect on brain activity.

An improvement on the inventor's patented technique, to induce varied states of alertness, is the subject of copending Application No. 07/514,460, the contents of which are hereby incorporated herein by reference. This copending application describes a general FFR technique using what is known as a binaural beat phenomenon, details of which are provided in that application. Briefly, a binaural beat is produced by sending signals at different frequencies (some Hz apart, depending on the desired effect) to an individual's left and right ears. The difference between the frequencies defines the frequency of the binaural beat. Using this technique, the desired frequency can be introduced into the individual's brain activity, inducing the desired state of consciousness.

The induction of FFR in the human brain in this manner results in the synchronization of activity in the hemispheres of the brain. FIG. 1A shows brain activity without FFR, and FIG. 1B shows brain activity with FFR. The inventor has coined the term HEMI-SYNC (for Hemisphere Synchronization) to describe this phenomenon. The copending application describes a technique wherein, in one form, sine waves having a frequency corresponding to a consciousness state are superimposed on two different carrier frequencies to form two different signals to set up the binaural beat. In another form, an actual brain pattern, based on an electroencephalogram (EEG) waveform indicative of that consciousness state is superimposed on the different carrier frequencies to form two different signals. In use, each signal is provided to one ear of a subject. The difference in carrier frequencies sets up the binaural beat.

Another, more limited application of the binaural beat phenomenon is found in U.S. Pat. No. 4,834,701. In contrast to the narrow range of frequencies discussed in that patent, in the above-mentioned copending application, the applicability of the binaural beat phenomenon is investigated over a much wider range of frequencies, spanning the spectrum of brain activity.

Through additional investigation involving mapping of brain activities of different individuals, the present inventor has discovered some significance to the fact that, while brain waves at certain frequencies are characteristic of different levels of sleep, brain patterns of different individuals still vary. The inventor has investigated possible enhancements to the FFR effect by making it more generic among individuals, yet still more specific to brain activity than a simple sine wave, or an EEG of a particular individual.

Another area of investigation being performed by the present inventor relates to human sleep patterns. Based on current knowledge of human sleep patterns, it appears that sleep is composed of a series of 90-minute cycles. As stated earlier, the beta stage is one of alertness. The first sleep state is alpha, or mental and physical relaxation. The second is theta, or light sleep. Next is delta, or deep sleep. The inventor has investigated the possibility of providing FFR waveforms in cyclic patterns, replicating these human sleep patterns, to facilitate sleep. Another possibility is to take advantage of the cyclic nature of sleep patterns to provide a more gentle wake-up for a sleeper.

In considering the need for alertness during activities such as work, the inventor also considered how it might be possible to introduce FFR waveforms into ambient noise in one's surroundings to facilitate maintenance of desired states of consciousness. Particularly in environments such as factories, or in offices where office equipment puts out consistent types of noise, it would be desirable to be able to introduce a binaural beat into that noise at different frequencies, to enhance the degree of alertness of factory or office workers as desired.

## SUMMARY OF THE INVENTION

In view of the foregoing, according to one aspect of the invention, EEGs for a number of individuals in different states of consciousness are sampled, and EEG waveforms for the group of individuals, corresponding to each identifiable state of consciousness, are combined. A binaural beat then is generated using the combined EEGs.

According to this aspect of the invention, it has been determined that using groups of EEG waveforms from different individuals and combining them to obtain a representative waveform yields a waveform that a person's brain is more likely to replicate than an individual EEG waveform, or a sine wave representation of the EEG waveform. The combination may be simple averaging, though other combination techniques, such as weighted averaging, for combining different numbers of EEG waveforms as desired, are contemplated. Now that the inventor has discovered that combinations of EEG waveforms provide a particularly effective entrainment environment, it will be seen that various ways of combining these waveforms may yield greater or lesser effects.

In accordance with another aspect of the invention, a method for replicating cyclic sleep patterns for a desired sleep period is provided. In a preferred embodiment according to this aspect of the invention, a subject is led from beta, to alpha, to theta, to delta, then back to theta, then alpha, then a rapid-eye movement (REM) or light dreaming sleep, in a sequence of 90-minute cycles, during a sleep period of desired duration. After the expiration of the period, the subject may wake up voluntarily. Alternatively, the invention can provide a gentle external stimulus to lead the subject to a beta state.

With respect to this aspect of the invention, an apparatus is provided which automatically leads an individual through these cyclic sleep patterns, and enables the individual to set a desired sleep period. This device preferably takes advantage of the techniques to be described relative to the first-mentioned aspect of the invention, but is not so limited. The inventive contributions of this second aspect of the invention are considered to lie in the combination of hardware itself which generates the desired sequence of binaural beats, as opposed to the particular software which determines the nature of those binaural beats. In one form, the invention is constituted by an alarm clock which provides a fade-in theta-alpha signal followed by a strong beta-gamma signal shortly before a desired wake-up time.

According to yet another embodiment of the invention, selectable mind-affecting sound patterns are provided to supplement constant ambient noise in any environment. When the noise is not present, the patterns are not provided. The patterns vary in amplitude in accordance with changes in the environmental noise.

In accordance with still another embodiment of the invention, a portable system is provided to enable the wearer to introduce binaural beat signals of frequencies that are selectable in accordance with a desired level of awareness. Depending on the level of sophistication of the device, the binaural beat may be generated using the combined EEG waveforms of the first aspect of the invention, but this last aspect of the invention is not so limited.

## BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other aspects of the invention will be understood by those of working skill in this technological field by reference to the following detailed description of the preferred embodiments of the invention, read in conjunction with the accompanying drawings, wherein:

FIGS. 1A-1C and 1D-1F taken from the above-mentioned copending application, show one example of the results which can be achieved using the inventive techniques;

FIG. 2 is a block diagram of the hardware according to a second embodiment of the invention, and FIGS. 3-5 are more detailed schematics therefor;

FIGS. 6A-6J are drawings, similar to FIGS. 1A and 1B, but showing brain activity during various stages of a sleep cycle, using a technique in accordance with the second embodiment of the invention;

FIG. 7 is a block diagram of hardware in accordance with a third embodiment of the invention;

FIG. 8A is a block diagram of hardware in accordance with a fourth embodiment of the invention, and FIG. 8B a schematic of that hardware; and

FIGS. 9A-9M are graphs of different possible effects of the embodiment of FIGS. 8A and 8B, showing a baseline brain pattern, selected stimulus frequencies and corresponding stimulus waves, and associated response waves.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The method according to a first preferred embodiment of the invention, which has been developed through extensive experimentation, derives from the empirically-observed phenomenon that brain patterns of human subjects are entrained more readily to brain patterns which more closely match their own. In prior implementations of the FFR technique, such as in the inventor's prior patent, in which sine waves having frequencies corresponding to desired levels of sleep were superimposed upon a given frequency, entrainment did occur. Use of the binaural beat phenomenon yielded better results, through synchronization of the hemispheres of the brain.

However, simple repetitive frequencies, or even combinations of such frequencies within different ranges, do not represent brain patterns per se, but rather provide entrainment environments for the brain to follow. It has been determined that, the more closely the entrainment environment parallels normal brain function at different levels of consciousness, the more effective the entrainment effect. This phenomenon is what led to the improvement disclosed in the above-mentioned copending application.

As a further improvement on that technique, as mentioned above, the present inventor investigated the possibility of creating more generic models of brain function at different levels of consciousness. As a result of that investigation, it was determined that combinations of EEG waveforms from different individuals functioning at the same identifiable level of consciousness (e.g. alpha sleep, theta sleep, or delta sleep) provided a superior entrainment environment. In the inventive method according to this aspect of the invention, the brain patterns of 40 to 50 individuals were combined to yield the entrainment environment.

One area of applicability of the techniques of the present invention is in the area of sleep therapy. Many individuals suffer from sleep disorders to varying degrees. It is possible to provide a suitable entrainment environment, based on known sleep cycles prevalent in humans, to help individuals to regulate their sleep patterns, and thus help to solve their sleep disorders. One embodiment of the invention, shown in FIG. 2 and also in FIGS. 3-5, implements the inventive techniques in what the inventor calls a Sleep Processor to aid in the regulation of human sleep cycles.

In FIG. 2, a read-only memory (ROM) 10 stores frequency sequences corresponding to different parts of a human sleep cycle. The stored frequency sequences may be in accordance with a predetermined algorithm, or alternatively may provide a less complex entrainment environment, such as simple averaging. A digital signal processor (DSP) 20 selects different ones of these sequences based on the current time and the time to which an alarm is set. The time is displayed on display 30, and is set using time set 40. The alarm is set to a desired wake-up time using alarm set 50.

During operation, the DSP 20 accesses the ROM 10 and provides an output to a pulse code modulator unit (PCM) 60 accordingly. The PCM 60 provides an output to each of left and right channel speakers 70, 80 which are provided in close proximity to the ears of a human subject. Using headphones enhances the effect.

Some additional detail of operation of the DSP 20 in one aspect of this embodiment now will be provided. A serial port in the DSP 20 generates an interrupt at a 50 KHz rate. An interrupt handler in the DSP 20 computes the various sounds, in one form, by generating sine waves using a pair of integrators:

cosine=cosine+frequency.times.sine

sine=sine-frequency.times.cosine

The Sleep Processors needs ten frequencies, five for each channel, and all of these frequencies are generated at the same time. The results are multiplied by ten envelopes, most of which are zero at any moment.

Noise is generated by a well-known 16-bit shift-register algorithm. This algorithm generates a noise signal that repeats every 65535 samples, or about every five seconds. The noise is filtered to sound more like pink or red noise, and less like white noise, and is written into a delay line in RAM. For each channel, the filtered noise is averaged with an earlier sample from the delay line, thus imparting a comb filter response to it.

An additional low-frequency sine/cosine pair is generated, to sweep the comb filter delay. 32-bit arithmetic is used here. The approximate sweep rate is about 1/8 Hz. The low-frequency sine wave is used directly to sweep the delay on one channel. The delay on the other channel is controlled by some mix of the sine and cosine waves. By choosing these and other coefficients properly, any phase and amplitude relationship between the left and right sweep can be obtained. The comb filtered noise for each channel is multiplied by a noise envelope value.

The device is operated as follows. A desired wake-up time is set, much like an alarm clock, and the desired volume is selected. A start/stop button then is pressed to start the cycles for the selected sleep period. Throughout the sleep period, the device repeats a 90 minute cycle of sound that leads the subject through alpha, theta, delta, and back to dreaming sleep. Five minutes before the scheduled wake-up time, a beta signal is introduced to bring the subject back to complete physical wakefulness. When the subject wakes up, he/she hits the start/stop button again to stop the sound sequence.

**United States Patent** *5,309,411*
**Huang , et al.** **May 3, 1994**

# Transducer


**Abstract**

A transducer apparatus and method for generating sonic sound waves having a far field wavefront amplitude pattern in a Bessel or Gaussian distribution is disclosed. The transducer includes a piezoelectric element having uniformly poled dipoles formed therein. An unpoled backing body having the same dielecctric constant as the piezoelectric element contacts and is attached to the piezoelectric element. An indentation shaped to produce a beam amplitude distribution of a predetermined function is formed on the backing body.



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**References Cited [Referenced By]**

**U.S. Patent Documents**

| | | | |
|---|---|---|---|
| 4296349 | Oct., 1981 | Nakanishi et al. | 310/335. |
| 5212671 | May., 1993 | Fajii et al. | 367/151. |

**Other References**

Du et al., "The Ultrasonic Field of a Gaussian Transducer," J. Acoust. Soc. Am. 78 (6):2083-2086 (1985).
Aanonsen et al., "Distortion and Harmonic Generation in the Nearfielddl of a Finite Amplitude Sound Beam," J. Acoust. Soc. Am. 75 (3):749-768 (1984).
Du et al., "An Ultrasonic Gaussian Transducer With a Curved Back Electrode," J. Acoust., Soc. Am. 89 (3): 1443-1447 (1991).
Hsu et al., "Ultrasonic Beams with Bessel and Gaussian Profiles" Review of Progress in Quantiative Nondestructive Evaluation 9:799-806, Plenun Press, N.Y. (1990).
Martin et al., "A Simple Way to Eliminate Diffraction Lobes Emitted by Ultrasonic Transducers," J. Acoust. Soc. Am. 49:1668-1669 (1971).



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## *Claims*

We claim:

1. A transducer for generating sonic waves comprising:

a piezoelectric element having dipoles formed therein, and an external surface extending in a plane;

an unpoled backing element having a first surface contacting the piezoelectric element and a second surface opposite to the first surface having an indentation formed therein, the indentation shaped to produce a beam distribution of a predetermined function, the dielectric constant of the unpoled backing element being substantially the same as the dielectric constant of the piezoelectric element;

a first electrode contacting the external surface of the piezoelectric element; and

a second electrode contacting the indentation.

2. The transducer of claim 1 wherein the indentation is spherical in shape.

3. The transducer of claim 1 wherein the sonic waves generated have a Gaussian wavefront amplitude distribution.

4. The transducer of claim 1 further comprising a series of indentations formed in the first surface.

5. The transducer of claim 1 wherein the sound waves generated have a Bessel function amplitude distribution.

6. The transducer of claim 1 wherein the electrodes are formed by a silver coating on the external surface of the piezoelectric element and on the indentation.

7. The transducer of claim 1 wherein the sound waves generated are of low frequency.

8. The transducer of claim 7 wherein the low frequency sound waves generated are at frequencies below 2 MHz.

9. The transducer of claim 1 wherein the piezoelectric element is comprised of a ceramic.

10. The transducer of claim 1 wherein the dipoles of the piezoelectric element are uniformly poled.

11. A transducer for generating sound waves having a Gaussian function wavefront amplitude distribution comprising:

a piezoelectric element having dipoles formed therein, and an external surface extending in a plane;

an unpoled backing element having a first surface contacting the piezoelectric element and a second surface opposite to the first surface having a spherical indentation formed therein, the backing element having substantially the same dielectric constant as the dielectric constant of the piezoelectric element:

a first electrode formed on the external surface of the piezoelectric element;

a second electrode formed on the spherical indentation.

12. The transducer of claim 11 wherein the electrodes are formed by a silver coating on the external surface of the piezoelectric element and on the spherical indentation.

13. The transducer of claim 11 wherein the sound waves generated are of low frequency.

14. The transducer of claim 13 wherein the low frequency sound waves generated are at frequencies are below 2 MHz.

15. The transducer of claim 11 wherein the piezoelectric element is comprised of a ceramic.

16. The transducer of claim 11 wherein the dipoles of the piezoelectric element are uniformly poled.

17. A method for generating sound waves having a far field pattern shaped in accordance with a predetermined function comprising the steps of:

a) providing a planar piezoelectric element having uniformally poled dipoles formed therein;

b) attaching a planar backing body to the piezoelectric element in which the body has substantially the same dielectric constant as the piezoelectric element;

c) shaping an indentation into the backing body, the shape of the indentation being in accordance with the desired pattern;

d) generating an energizing voltage across the element and body to induce the element to vibrate and produce said shaped sound waves.

18. The method of claim 17 in which the sound waves produced are in a Gaussian function wavefront amplitude distribution.

19. The method of claim 17 in which the sound waves produced are in a Bessel function wavefront amplitude distribution.

20. The method of claim 17 in which the backing body is unpoled and the piezoelectric element is poled.

21. The method of claim 17 further comprising:

forming a first electrical contact on the piezoelectric element; and

forming a second electrical contact on the backing body.

22. The method of claim 17 in which the step of shaping comprises removing material from the backing body.

23. A method of generating sound waves comprising:

vibrating a planar piezoelectric element having dipoles formed therein by applying a voltage across a piezoelectric element and a backing element, the backing element having a first surface contacting the piezoelectric element and a second surface opposite to the first surface which as an indentation shaped to produce sound waves having a distribution of a predetermined function, the dielectric constant of the backing element being substantially the same as the piezoelectric element.

## ***Description***

BACKGROUND OF THE INVENTION

Electromagnetic beams having a Gaussian function wavefront amplitude distribution are advantageous for many reasons. One reason is that Gaussian beams are easy to model analytically. Another reason is that a circular Gaussian wavefront is free of near-field nulls and far-field sidelobes. In particular, sonic or ultrasonic beams having a Gaussian wavefront amplitude distribution are desirable in underwater acoustics, medical ultrasonics, nondestructive evaluation, acoustical microscopy, and nonlinear acoustics. A precise Gaussian beam reduces the possibility of waves reaching objects or areas where the beam is not directed. For example, in the acoustical field, background noise is substantially eliminated due to the reduction of stray sound waves.

Electromagnetic beams having a Bessel function wavefront distribution share some of the advantages of a Gaussian distribution but differ in that waves having a Bessel function distribution have the property that they do not spread and retain a narrow beam width.

Current transducers for generating Gaussian and Bessel function ultrasonic beams produce ultrasonic waves at relatively high frequencies but are unable to produce low frequency Gaussian function sound waves below 2 Hz. Low frequency sound waves are useful in applications such as sonar. Additionally, existing Gaussian function transducers generate sound wave amplitutude distributions having sidelobes with noise levels above -30 dB. Sidelobes are undesirable in that sidelobe sound waves can create signals reflected from objects other than the target.

Accordingly, there is a continuing need for an ultrasonic transducer which can generate ultrasonic sound waves in a Gaussian function amplitude distribution with low noise levels. Additionally there is a need for this transducer to be capable of generating these sound waves at low frequencies.

## SUMMARY OF THE INVENTION

The present invention provides an apparatus and method for generating sonic sound waves having a far field wavefront amplitude pattern or distribution in accordance with a predetermined beam function. The term "sonic" as used herein is meant to encompass the Infrasonic, (0-10 Hz) Sonic (10 Hz to 10 KHz) and Ultrasonic frequency ranges. The term "ultrasonic" covers the range from about 10 KHz to about 30 MHz. The transducer includes a piezoelectric element having uniformly poled dipoles formed therein. "Uniformly poled" means that the magnetic fields of the dipoles found in the piezoelectric element are all aligned in the same direction and one of the same polarity. The piezoelectric element has an external surface that extends in a plane. One planar surface of an unpoled backing element or body contacts and is attached to an internal surface of the piezoelectric element. The dielectric constant of the unpoled backing element is substantively the same as the dielectric constant of the piezoelectric element. A second surface of the backing element which is opposite and parallel to the first surface has an indentation or concave cavity formed therein. The indentation is shaped to produce a beam amplitude distribution of a predetermined function or pattern. A first conductive electrode is formed on the external surface of the piezoelectric element. A second conductive electrode is formed on the indentation in the backing element. Alternating electric power is coupled across the electrode to energize the transducer. The alternating energizing voltage across the piezoelectric element and backing element, induces the piezoelectric element to vibrate and produce sonic waves having a predetermined beam amplitude distribution or shape which is mainly predicated upon the shape of the indentation in the unpoled backing element.

The shape of the sound waves produced by the present invention can be in a Gaussian or Bessel distribution depending upon the shape of the indentation on the backing element. When generating a Gaussian pattern or distribution of sound waves, the shape of the indentation in the backing body is spherical. When generating a Bessel pattern of sound waves, a series of indentations are formed in the backing body. The resulting pattern of sound waves produced have sidelobes below -30 dB at low frequencies. Theoretically, there is no lower limit on the frequencies producible by the present invention but there are practical limits due to manufacturing limitations.

## BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features an advantageous of the invention will be apparent from the following more particular description of the preferred embodiment of the drawings in which like reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon the illustrating the principles of the invention.

FIG. 1 is a schematic sectional view of an sonic Gaussian function transducer in accordance with the invention.

FIG. 2 is a schematic drawing showing the coordinates for calculating the electric field of a Gaussian transducer.

FIG. 3 is a graph of the beam pattern of a four inch spherical button Gaussian transducer at 375 KHz.

FIG. 4 is a schematic sectional view of a sonic Bessel function transducer in accordance with an alternate embodiment of the invention.

FIG. 5 is a graph of the beam distribution of a Bessel transducer.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 spherical button Gaussian transducer 10 has a piezoelectric plate 12 with an external surface 42 in contact with surface 40 of backing element 14. Fluid, usually water, is in contact with surface 24. Piezoelectric plate 12 is a ceramic piezoelectric disk in which the dipoles have been poled by subjecting the element to a high D.C. voltage which uniformally aligns the dipoles in the direction of the arrows. An electrode 34 is formed on surface 24. In the preferred embodiment electrode 34 is a silver coating formed on surface 24. Alternatively, surface 24 can be coated with other suitable conductive metals such as, gold, platinum etc. to form electrode 34. An electrical lead 44 connects electrode 34 to ground 26, thereby grounding piezoelectric plate 12.

Backing element 14 is preferably made from unpoled i.e., unmagnetized piezoelectric material having the same dielectric constant as piezoelectric plate 12. In the preferred embodiment, backing element 14 is made of the same material as piezoelectric plate 12 but can alternatively be made of any other suitable piezoelectric material that has the same dielectric constant as piezoelectric plate 12.

A spherical indentation 18 having a radius R is formed in surface 38 of backing element 14, such as by grinding or etching away material. Alternatively, spherical indentation 18 can be formed by other suitable processes such as by a molding process. In the preferred embodiment, spherical indentation 18 has an axial angle .beta..sub.0 of about 43.6.degree.. .beta..sub.0 is the angle between the line drawn through the center of spherical indentation 18 perpendicular to the plane of plate 12 and a radius extending to one edge 18' of spherical indentation 18. Alternatively .beta..sub.0 can be of other suitable angles close to 43.6.degree.. In the preferred embodiment, the ratio between the radius R of spherical indentation 18 and minimum distance "T" between the two electrodes 16 and 34, (R/T) is about 3.73. R/T ratio of 3.73 provides the optimum distribution of sound waves for a Gaussian function and should be maintained regardless of the size of the transducer.

The spherical indentation 18 is coated with a conductive metal, which may also be silver, to form electrode 16. Alternatively, spherical indentation 18 can be coated with other suitable conductive metals, such as, gold, platinum, etc. Electrical lead 22 is connected to electrode 16 and provides electrical power across transducer 10 to ground. Alternatively, a brass electrode 20 (shown in dotted lines) can be disposed within spherical indentation 18 to serve as an electrode. In such a case, electrode 16 is not needed. In addition, electrode 20 can be made of other suitable conductive metals.

The piezoelectric plate 12 and backing element 14 are retained within bore 46 found in a retainer 30. Retainer 30 may be formed of a hollow electrically insulating tube formed of plexiglass or other suitable insulating material. Retainer 30 electrically isolates piezoelectric plate 12 and backing element 14 from housing 36. Housing 36 is made from metals, such as, aluminum or brass and provides environmental protection for piezoelectric plate 12 and backing element 14. Alternatively, housing 36 may be made of suitable high strength non-metallic materials. Housing 36 and retainer 30 form an airspace behind backing element 14.

An energizing A.C. voltage in the range of 100 volts to 1000 volts is generated across piezoelectric plate 12 and backing element 14 inducing piezoelectric plate 12 to vibrate and produce Gaussian shaped sound waves in the direction Z. Alternatively, lower or higher voltages can be used. The frequency of the sound waves generated depends on the size and thickness of piezoelectric plate 12. Smaller diameter transducers generate higher frequency sound waves while larger diameter transducers generate lower frequencies. Theoretically, there are no limits on the frequency range producible by the present invention. However, there are practical limits due to manufacturing limitations.

A theory as presently understood with respect to sound waves having a Gaussian amplitude distribution with transducer 10 is more fully discussed below although the invention is not to be limited to this theory.

The configuration of ultrasonic Gaussian transducer 10 can be described by spherical coordinates as shown in FIG. 2, where: Z.sub.1 =R and Z.sub.2 =R+T. Variable "all" is the radius of the piezoelectric disk 12, .beta. and .THETA. are axial angles with 0.ltoreq..beta..ltoreq..beta..sub.0 and 0.ltoreq..theta..ltoreq..theta..sub.0. Additionally, R is the radius of spherical indentation 18 (FIG. 1) and T is the minimum distance between electrodes 16 and 34. The plate 12 is assumed to be greater than the size of the spherical electrode 18 and the charge density .sigma. is assumed to be uniformly distributed on the surface of the spherical electrode 18 at time t. The electrode 34 (FIG. 1) in the plane Z=Z.sub.2 is electrically grounded and is in contact with fluid (for example, water).

By using the image charge method, the electrical potential produced by the differential element ds' on ds is given by ##EQU1## where dq=.sigma.'(t)ds' and where .sigma.'(t) is the image charge density at time t on the surface ds'. R is the vector from the origin to ds' and r is the vector from the origin to ds. The element ds is in the plane Z=Z.sub.2, where the Gaussian field distribution is desired.

For axial symmetry, the addition theorem for spherical harmonics allows one to write Eq. 1 in the form ##EQU2## where P.sub.l (cos .theta.) is the lth order Lengender polynomial. Integrating Eq. 2 gives ##EQU3## and Q(t)=.pi.R.sup.2 .sigma.'(t) The z component of the electric field is

E.sub.z =-.gradient.v.z. (4)

On the surface of the plate where Z=Z.sub.2, ##EQU4## By controlling the ratio of R/T, where the thickness T=Z.sub.2 -Z.sub.1, and the axial angle .beta..sub.0 for the spherical button, E.sub.z can approach a Gaussian distribution E.sub.z =E.sub.0z e.sup.B.rho..sup.2 with the Gaussian coefficient B needed.

A wave equation under a parabolic approximation, is given by ##EQU5## where .tau.=.omega.[t-(z/c.sub.0)],P=p/.rho..sub.o c.sub.o u.sub.o, .sigma.=z/r.sub.o and r.sub.o =a.sup.2 .omega./ 2c.sub.o are nondimensional variables. p, c.sub.o,.rho..sub.o are sound pressure, sound velocity and static density of the medium. The distance z is measured in the direction of propagation of the sound wave, variable "a" is the radius of the transducer plate, u.sub.o is the characteristic velocity amplitude and .alpha. is the absorption coefficient of the medium. .gradient..sup.2.sub..perp. denotes the nondimensional form of the transverse Laplacian operator. For the special case of a circular axisymmetric beam, we can substitute .gradient..sup.2.sub..perp.=( 1/.xi.)(.differential./.differential..xi.)[.xi.(.differential./.differentia l..xi.0] into Eq. (6), where .xi.=.rho./a and .rho. is the radial coordinate. The linearized solution for an axisymmetric source which oscillates sinusoidally in time is, in terms of nondimensional variables, p.sub.1 (.xi.,.sigma.,.tau.)=Re[iq.sub.1 (.xi.,.sigma.)exp(-i .tau.-.alpha.r.sub.o .sigma.0]. (7)

where ##EQU6##

Thus one can express the diffraction problem in nondimentional variables, .sigma.=z/r.sub.o, the axial distance from the source, and .xi.=.rho./a, the distance from the axis. At the source .sigma.=0, so the boundary condition becomes

p(.xi.,0,.tau.)=q.sub.1 (.xi.')exp(-i.tau.). (9)

The Gaussian amplitude distribution at the source can be expressed in normalized form by letting

q.sub.1 (.xi.')=exp(-B.xi.'2), (10)

where we will refer to B as the Gaussian coefficient. Substituting Eq. (10) into Eq. (8), we get ##EQU7## which can be integrated directly to give ##EQU8## where

.gamma.=[B.sup.2 .sigma./(1+(B.sigma.0.sup.2)].xi..sup.2 -tan.sup.-1 (B.sigma.)+.pi./2

is a phase shift.

Inserting Eq. (12) into Eq. (7), one finds that the amplitude of the sound field produced by a transducer with a Gaussian velocity distribution is described by ##EQU9## where A=B/[1+(B.sigma.).sup.2 ], is the Gaussian coefficient of the sound field .xi.=.rho./a, p.sub.o is the sound pressure amplitude in the fluid at the center of the transducer.

Two important observations about the sound field can be made by noting the form of Eq. (13). First, as the wave propagates, the sound pressure on axis reduces gradually with distance .sigma.. In the radiated beam, none of the maxima and minima typical of the Fresnel zone of a piston transducer appears. Second, the Gaussian coefficient of the sound field A=B/(1+B.sup.2 .sigma..sup.2) contains the source Gaussian coefficient B in a characteristic form and is a function of the distance .sigma. in the medium. This indicates that a transducer with a Gaussian amplitude distribution across its surface produces a sound field which is described by a Gaussian function both in the nearfield and the farfield. Furthermore, since the coefficient A gradually decreases with distance a from the source, the sound beam gradually spreads as it propagates, but does not develop the sidelobes characteristic of the farfield directivity pattern of a piston transducer.

The amplitude distribution in sound waves generated by transducer 10 (FIG. 1) according to the theory discussed above are depicted in FIG. 3. The graph shows the Gaussian beam pattern 110 produced by a 4 inch spherical button Gaussian transducer at a frequency of 375 KHz. The sound waves of sidelobes 112 and 114 are 31 dB down as compared with the central beam.

In FIG. 4, transducer 50 is another preferred embodiment of the present invention which generates sounds waves having a Bessel function amplitude distribution. Sound waves having in a Bessel function distribution do not spread.

Surface 88 of piezoelectric plate 54 is in contact with surface 90 of backing element 52. Piezoelectric plate 54 is a ceramic which is poled so that the dipoles are uniformly aligned in the direction of the arrows. A series of silver coatings on surface 86 form concentric circular electrodes 60, 62 and 64 on piezoelectric plate 54. Alternatively, surface 86 can be coated with other suitable conductive metals.

Backing element 52 is made of unpoled piezoelectric material having substantially the same dielectric constant as piezoelectric plate 54. Indentations 56, 70 and 74 are ground into surface 92 of backing element 52 by a grinder. The contours of indentations 56, 70 and 74 are shaped such that transducer 50 will generate a pattern of sound waves having a Bessel distribution. Alternatively, indentations 56, 70 and 74 can be formed by other suitable processes such as molding.

Indentation 74 encircles and is concentric about indentation 56. Indentation 70 encircles and is concentric about indentations 56 and 74. The radius R.sub.2 2 of indentation 74 is smaller than radius R.sub.3 of indentation 56 and the radius R.sub.1 is of indentation 70 is smaller than radius R.sub.2 of indentation 74. In the preferred embodiment, three indentations are employed. However, in the alternative, the number of indentations employed can vary. Indentations 56, 74 and 70 are coated with silver to form electrodes 58, 76 and 72 and are located below electrodes 60, 64 and 62, respectively.

Electrodes 60, 62 and 64 are connected to a ground by electrical leads (not shown) in a manner similar to that depicted in FIG. 1. Additionally electrodes 58, 76 and 72 are connected to electrical leads (not shown) which provide power to transducer 50. Electrical power is provided to transducer 50 in such a manner that electrode 58 is positively charged, electrode 76 is negatively charged, and electrode 72 is positively charged. corresponding electrodes 60, 64 and 62 are charged negatively, positively and negatively respectfully. These oppositely charged voltages across piezoelectric plate 54 and backing element 52 induce piezoelectric plate 54 to vibrate, generating sound waves having the Bessel distribution depicted in FIG. 5. The radius of piezoelectric plate 54 is designated by r.sub.p and J.sub.o designates the Bessel function of the sound waves generated.

While this invention has been particularly shown and described with references to preferred embodiments thereof, it will be under stood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

**United States Patent** *5,355,523*
**Ogawa , et al.** **October 11, 1994**

# Wireless transmission/reception system including transmitting terminal producing multiple frequency local oscillation signals and receiving terminal storing a local oscillation signal

**Abstract**

A wireless transmission system includes a plurality of terminal units, a specific one of which is provided with a transmission/receiving circuit that transmits a reference signal of a local oscillation frequency, while all others of which are provided respectively with a transmission/receiving circuit that prepares, on the basis of the reference signal received, a local oscillation frequency signal for frequency conversion of transmitting/receiving frequency signal and intermediate frequency signal, to thereby realize the system at lower costs even when a high local oscillation frequency is employed.

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**References Cited [Referenced By]**

**U.S. Patent Documents**

| | | | |
|---|---|---|---|
| 2227902 | Jan., 1941 | Hahnle | 455/201. |
| 3147437 | Sep., 1964 | Crafts et al. | 455/202. |
| 3182259 | May., 1965 | Holder | 455/203. |
| 3973203 | Aug., 1976 | Kahn | 455/202. |

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## *Claims*

What is claimed is:

1. A wireless transmission/reception system including a plurality of terminal units, a first of said terminal units including a transmitting/receiving circuit for transmitting a transmitted frequency signal resulting from mixing of an intermediate frequency signal with a local oscillation signal having a local oscillation frequency and for transmitting a reference signal at the local oscillation frequency, the other terminal units each including a transmitting/receiving circuit for receiving the transmitted frequency signal and the reference signal, for detecting the reference signal, and for generating from the detected reference signal the local oscillation frequency signal for frequency conversion of the transmitted frequency signal into the intermediate frequency signal, wherein a plurality of different local oscillation frequencies are generated in said first terminal unit, and one of the local oscillation frequencies is selected as the reference signal and for mixing with the intermediate frequency signal to produce the transmitted frequency signal in synchronism with a clock signal input to said first terminal unit for transmission of the transmitted frequency signal.

2. A wireless transmission/reception system including a plurality of terminal units a first of said terminal units including a transmitting/receiving circuit for transmitting a transmitted frequency signal resulting from mixing of an intermediate frequency signal with a local oscillation signal having a local oscillation frequency and for transmitting a reference signal at the local oscillation frequency, the other terminal units each including a transmitting/receiving circuit for receiving the transmitted frequency signal and the reference signal, for detecting the reference signal, and for generating from the detected reference signal the local oscillation frequency signal for frequency conversion of the transmitted frequency signal into the intermediate frequency signal, wherein each of said transmitting/receiving circuits of said other terminal units comprises means for storing the local oscillation frequency signal generated from the detected reference signal and providing the stored local oscillation frequency signal for the frequency conversion when the reference signal is not received from said first terminal unit.

## *Description*

BACKGROUND OF THE INVENTION

This invention relates to a wireless transmission system for transmitting and receiving signals between a plurality of terminal units in wireless manner.

The wireless transmission system of the kind referred to should find its utility when used in transmitting data signals, voice signals and so on between the respective terminal units.

DESCRIPTION OF RELATED ART

Generally, in the wireless transmission system, a transmission circuit is so arranged that an intermediate frequency signal is received as an input at a frequency converting circuit and mixed with a local oscillation frequency signal from a local oscillator, and a conversion into a radio frequency transmitting/receiving signal is performed, and a signal of a required frequency is amplified at an amplification circuit and transmitted through an output circuit and an antenna. While a receiving circuit is so arranged that, among signals received through an antenna and an input circuit, the signal of the required frequency is amplified at an amplification circuit, mixed with a local oscillation signal from a local oscillator, and converted at a frequency converting circuit into an intermediate frequency signal to be provided as an output.

Basic technologies of the wireless transmission system of this kind have been disclosed in, for example, U.S. Pat. No. 3,641,433 to R. W. Mifflin et al, U.S. Pat. No. 5,099,495 to N. Mikoshiba et al, and a technical bulletin titled "Spread Spectrum System" by R. C. Dixon of 1977.

However, these known wireless transmission systems are mostly of the type that a plurality of terminal units between which data signals, voice signals or the like are transmitted and received are respectively provided with both of transmission and receiving circuits, and every one of these circuits comprises a local oscillator, so that there has arisen a problem that, specifically when a local oscillator of a high local oscillation frequency is employed, the system has to be made expensive, and the transmission and receiving circuits provided to the respective terminal units have to be made high in manufacturing costs.

SUMMARY OF THE INVENTION

A object of the present invention is, therefore, to provide a wireless transmission system in which the transmission and receiving circuits in the terminal units can be maintained inexpensive even when the circuits providing a high local oscillation frequency are employed.

Another object of the present invention is to provide a wireless transmission system capable of enhancing the security by subjecting a reference signal of the local oscillation frequency to a scramble or a modulation.

Still another object of the present invention is to provide a wireless transmission system which allows administration of transmitted and received signals to be easier by means of an allocation of a plurality of scrambling or modulation systems respectively to every terminal unit or every group of the terminal units.

A further object of the present invention is to provide a wireless transmission system which less suffers any multipath distortion even in the case where the data transmitting velocity is high.

Yet another object of the present invention is to provide a wireless transmission system which is capable of being improved in the resistance to multipath problem.

Other objects and advantages of the present invention shall become clear as following description of the invention advances as detailed with reference to preferred embodiments of the invention shown in accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows in a block diagram a transmission circuit employed in an embodiment of the wireless transmission system according to the present invention;

FIG. 2 shows also is a block diagram a receiving circuit employed in the embodiment in FIG. 1;

FIG. 3 is an explanatory diagram for the operation of the embodiment in FIG. 1;

FIG. 4 shows in a block diagram a transmission circuit employed in another embodiment of the wireless transmission system according to the present invention;

FIG. 5 shows in a block diagram a transmission circuit employed in further another embodiment of the wireless transmission system according to the present invention;

FIG. 6 shows in a schematic explanatory diagram a working aspect of the wireless transmission system according to the present invention;

FIG. 7 shows in a block diagram a transmission circuit employed in still another embodiment of the wireless transmission system according to the present invention;

FIG. 8 shows in a block diagram a receiving circuit employed in the embodiment in FIG. 7; and

FIG. 9 is a block diagram a transmission/receiving circuit in further other embodiment of the wireless transmission system according to the present invention.

While the present invention is to be explained in the followings with reference to the embodiments shown, it will be appreciated that the intention is not to limit the invention only to these embodiment shown but rather to include all alterations, modifications and equivalent arrangements possible within the scope of appended claims.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, there is shown a transmission circuit 10 of a specific one of a plurality of terminal units in an embodiment of the wireless transmission system according to the present invention. In this transmission circuit 10, an intermediate frequency signal is provided to a frequency converting circuit 11, where the input is mixed with a local oscillation signal from a local oscillator 12 to be converted into a transmitting frequency signal, and this signal is amplified at an amplification circuit 13. A reference signal of the local oscillation frequency is also provided from the local oscillator 12 to a further amplification circuit 14 to be amplified and is then mixed at a mixing circuit 15 with the amplified transmitting frequency signal, and the thus mixed signals are transmitted simultaneously through an output circuit 16 and out of an antenna 17.

In a receiving circuit 20 as shown in FIG. 2 of one of other terminal units in the system, on the other hand, the mixed signals received are provided through an input circuit 22 to first and second filters 23 and 24 to be separated into the reference signal and a received signal of the receiving signal, the reference signal is amplified at an amplification circuit 25 so that a local oscillation frequency signal is prepared, while the received signal is amplified at a further amplification circuit 26, the local oscillation frequency signal and the received signal are both provided to a frequency converting circuit 27 to be mixed with each other, and an intermediate frequency signal is provided out of this circuit 27.

Referring more concretely to the system in conjunction with FIG. 3, the transmission circuit 10 of the specific terminal unit Ts provides from the local oscillator 12 a plurality of the reference signals of different frequencies f.sub.0, f.sub.1, . . . f.sub.n, for example, which are mixed respectively with the intermediate frequency signal to be converted into a plurality of the transmitting/receiving frequency signals, and these signals are transmitted from the specific terminal unit Ts towards all other terminal units T.sub.0, T.sub.1, . . . T.sub.n. At the receiving circuit 20 in each of the terminal units T.sub.0, T.sub.1, . . . T.sub.n, the local oscillation frequency signal is prepared with the reference signal from the specific terminal unit Ts, and a conversion of the transmitting frequency signal and intermediate frequency signal is carried out with the local oscillation frequency signal utilized. In this case, the frequencies F.sub.0, F.sub.1, . . . f.sub.n of the reference signal may be allotted respectively to each of the terminal units or, alternately, to every group of the terminal units as shown in FIG. 3.

Here, it will be readily appreciated that, according to the wireless transmission system of the present invention, the receiving circuit in the respective other terminal units is not required to be provided with any local oscillator, so as to be manufacturable at lower costs.

In FIG. 4, there is shown a transmission circuit 30 employed in another embodiment of the wireless transmission system according to the present invention, in which circuit 30 a scramble circuit 38 is connected to the local oscillator 32 in contrast to the transmission circuit 10 of FIG. 1, and an output of this scramble circuit 38 is provided to the frequency converting circuit 31 and amplification circuit 34, whereby the local oscillation signal provided from the local oscillator 32 is subjected to a scramble as passed through the scramble circuit 38. The thus scrambled local oscillation signal is provided to the frequency converting circuit 31 to be mixed with the intermediate frequency signal and converted into the transmitting frequency signal, which signal is then amplified at the amplification circuit 33 and mixed at the mixing circuit 35 with the reference signal directly amplified through the amplification circuit 34, and the mixed signals are simultaneously transmitted through the output circuit 36 and out of the antenna 37.

For the receiving circuit used in correspondence to the above transmission circuit 30, substantially the same circuit as the receiving circuit 20 of FIG. 2 is employable, wherein the signals received through the antenna 21 are separated into the scrambled reference signal and received signal through the input circuit 22 and first and second filters 23 and 24, the scrambled reference signal separated is amplified at the amplification circuit 25, the local oscillation frequency signal is thereby prepared and provided to the frequency converting circuit 27 together with the received signal provided as amplified at the amplification circuit 26, and both of these signals provided to the circuit 27 are mixed with each other to be converted into the intermediate frequency signal. In this event, the foregoing scramble may be varied with respect to every terminal unit or every group of the terminal units.

In the embodiment of FIG. 4, all other arrangements and functions are the same as those in the first embodiment shown in FIGS. 1-3, and the same constituent elements as those in the embodiment of FIGS. 1-3 are denoted in FIG. 4 by the same reference numerals but with "20" added thereto.

In a transmission circuit 50 employed in further another embodiment of the wireless transmission system according to the present invention, as shown in FIG. 5, a modulation circuit 58 is provided instead of the scramble circuit 38 in the foregoing embodiment of FIG. 4. In this case, the reference signal of a modulated local oscillation frequency is transmitted from the transmission circuit 50 of the specific terminal unit together with the transmitting frequency signal, while in the same receiving circuit as that of FIG. 2 in the respective terminal units, the local oscillation frequency signal is prepared from the modulated reference signal received, the prepared signal is mixed with the receiving signal, and the conversion into the intermediate frequency signal is performed. For the modulation system to be executed at the modulation circuit 58, it may be possible to employ any optional one of AM system, FM system, PM system and so on.

In the circuit 50 of FIG. 5, all other arrangements and functions are the same as those in the embodiment of FIGS. 1-3 and, in FIG. 5, the same constituent elements as those in the embodiment of FIGS. 1-3 are denoted by the same reference numeral but with "40" added.

In FIG. 6, there is shown an aspect in which the wireless transmission system of the present invention is practically worked. In this aspect, the system is arranged in the form of a local area network which executes the wireless transmission with microwaves. In this case, the transmission signal from a control unit U installed at a control room R is transmitted by means of the microwaves through waveguides G which are provided along floors F, walls W or ceilings C of respective working areas A in which a plurality of the terminal units T are dispersedly installed. These terminal units T are respectively provided with a transmission/receiving circuit S, while the waveguides G have apertures or slits opened towards the respective working areas A, so that the microwaves from the apertures of the waveguides G will propagate through space to be received by the transmission/receiving circuit S of the terminal units T. Reversely, the transmission signals from the transmission/receiving circuit S are made to be propagated by means of microwaves through the space wirelessly to reach the apertures of the waveguides G so as to be guided to the control unit U. Further, the control unit U is arranged at another place without the control room R.

In this local area network shown in FIG. 6, microwaves are employed for the transmission signal, and the local oscillator is apt to become expensive. In the present invention, however, the local oscillator may be provided only in the control unit U acting as the specific terminal unit, while the transmission/receiving circuits S of the terminal units T are made to utilize the local oscillation frequency signal transmitted as the reference signal from the local oscillator for the specific terminal unit, and the system of an inexpensive arrangement can be realized. When such scramble circuit or modulation circuit as in the transmission circuit of FIG. 4 or 5 is added to the transmission/receiving circuit S in the foregoing manner, it is possible to render the transmission signal difficult to be intercepted, and the entire system to be high in the security.

In still another embodiment shown in FIG. 7 of the wireless transmission system according to the present invention, the transmission circuit 70 in the specific terminal unit comprises a plurality of the local oscillators 72 and a change-over circuit 78 connected to the respective local oscillators 72. In this case, the respective local oscillators 72 are oscillating at different local oscillation frequencies as f.sub.11, f.sub.12, . . . f.sub.ln, which are input to the change-over circuit 78, so that any one of these local oscillation frequency signals will be provided to the frequency converting circuit 71 in synchronism with a clock signal provided to the change-over circuit 78. The local oscillation frequency signal thus selected at the change-over circuit 78 is amplified at the amplification circuit 74 and is then mixed, at the mixing circuit 75, with the transmitting frequency signal provided thereto as amplified at the amplification circuit 73, so that both of these signals will be concurrently transmitted through the output circuit 76 and out of the antenna 77.

In a receiving circuit 80 as shown in FIG. 8 of the other terminal units, the received signal passed through the first filter 83 is amplified at the amplification circuit 86 and provided to the frequency converting circuit 87, while the reference signal shifted in frequency as passed through the second filter 84 is amplified at the amplification circuit 85 to form the local oscillation frequency signal which is also provided to the frequency converting circuit 87, and both of these signals provided to the frequency converting circuit 87 are mixed to be converted into the intermediate frequency signal which is provided as an output. At the same time, the output of the amplification circuit 85 is also provided to a clock detecting circuit 88, and a clock signal is detected at the circuit 88 from the timing of the frequency shift and is provided as a clock signal, whereby a preparation of the clock signal for a Manchester coding or decoding can be easily attained without any provision of a clock signal oscillator. With such arrangement as disclosed, it is possible to prevent any multipath distortion from occurring even in the case where the data transmission velocity is high.

In the circuits of FIGS. 7 and 8, all other arrangements and functions are the same as those in the embodiment of FIGS. 1-3, and the same constituent elements as those in the embodiment of FIGS. 1-3 are denoted in FIGS. 7 and 8 by the same reference numerals with "60" added thereto.

In FIG. 9, there is shown a transmission/receiving circuit in still another embodiment of the wireless transmission system according to the present invention, which circuit is to be provided in the other terminal units which receive the signal transmitted from the specific terminal unit. In this circuit, the input signal from a receiving antenna 91 is provided through the input circuit 92 to the first filter 93, the received signal passed through that filter is amplified at the amplification circuit 96 and provided as an input to the frequency converting circuit 97, while the reference signal passed through the second filter 94 is once stored in a wave-form memory circuit 98 so that, in an event where the reference signal from the specific terminal unit is absent, the reference signal wave-form is output from the wave-form memory circuit 98 to the amplification circuit 95 where the local oscillation frequency signal is thereby prepared, this local oscillation frequency signal is provided into the frequency converting circuit 97, in which both of the signals are mixed and converted into the intermediate frequency signal as an output.

The transmission/receiving circuit 90 of this embodiment further comprises a further frequency converting circuit 97A to which the local oscillation frequency signal from the amplification circuit 95 and the intermediate frequency signal are provided, so that transmitting frequency signal will be transmitted, through the amplification circuit 99, an output circuit 100 and a transmission antenna 91A.

According to the above described embodiment, the local oscillation frequency signal can be stably provided even in the case when the other terminal units cannot receive the reference signal of a local oscillation frequency signal due to a fading or the like caused by multipath transmission, and the system can be effectively improved in the resistance to multipath distortion, as will be readily appreciated.

**United States Patent** **5,561,689**
**Fleek , et al.** **October 1, 1996**

# Method and apparatus for digital carrier detection in a wireless lan

**Abstract**

The oscillator at the sending node of a wireless digital network, generates a carrier signal, starting at a first instant. A modulator coupled to the oscillator performs phase shift modulating of the carrier signal with an input signal. A spoiler signal generator is coupled to the modulator, for providing a spoiler signal as the input signal, starting at the first instant and continuing for a first duration which is longer than a period needed for the oscillator to achieve stable characteristics. A transmitter is coupled to the modulator at the sending node, for transmitting a wireless radio signal representation of the carrier signal phase shift modulated with the spoiler signal to a receiver at a receiving node. The spoiler signal in the modulated carrier signal interrupts the periodic characteristic of the pulses, and thereby prevents the carrier sensor from detecting the carrier signal. Further, the spoiler signal ceases to modulate the carrier signal after the first duration when the oscillator has achieved stable characteristics, thereby enabling the carrier sensor to detect the carrier signal.

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| **Field of Search:** | 375/279,284,344,308,329,338 329/304 332/103 455/71,42 |

**References Cited [Referenced By]**

**U.S. Patent Documents**

| | | | |
|---|---|---|---|
| 3999005 | Dec., 1976 | Dickinson | 455/42. |
| 5159703 | Oct., 1992 | Lowery | 455/42. |
| 5355523 | Oct., 1994 | Ogawa et al. | 455/71. |

*Primary Examiner:* Safourek; Benedict V.
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*Attorney, Agent or Firm:* Keohane; Stephen T., Hoel; John E.

## *Claims*

What is claimed is:

1. A wireless digital network, comprising:

an oscillator means at a sending node of a wireless digital network, for generating a carrier signal, starting at a first instant;

a modulator means coupled to said oscillator means, for phase shift modulating said carrier signal with an input signal;

a spoiler signal generator means coupled to said modulator means, for providing a spoiler signal as said input signal, starting at said first instant and continuing for a first duration which is longer than a period needed for said oscillator means to achieve stable characteristics;

a transmitting means coupled to said modulator means at the sending node, for transmitting a wireless radio signal representation of said carrier signal phase shift modulated with said spoiler signal;

a receiving means at a receiving node of the wireless digital network, for receiving the wireless radio signal representation of the carrier signal;

an amplifier means, coupled to the receiving means, for forming from said carrier signal a received signal of square wave pulses having rising and falling edges separated by spacings;

carrier sensing means coupled to said amplifier means, for detecting said carrier signal by counting a predetermined number of said pulses having a periodic characteristic;

said spoiler signal in said modulated carrier signal interrupting said periodic characteristic of said pulses, and thereby preventing said carrier sensing means from detecting said carrier signal;

said spoiler signal ceasing to modulate said carrier signal after said first duration when said oscillator means has achieved stable characteristics, thereby enabling said carrier sensing means to detect said carrier signal.

2. The wireless digital network of claim 1, which further comprises:

a first computer means at said sending node, for providing a binary data signal as said input signal, starting after said first duration when said oscillator means has achieved stable characteristics;

demodulator means at said receiving node, coupled to said amplifier means, for detecting when the spacing between the edges of the square wave pulses changes in response to the phase shift modulation;

said demodulator means measuring first intervals between consecutive rising edges of said received signal, by counting clock pulses for a second selected interval whose duration is determined by a second selected count value;

said demodulator means measuring second intervals between consecutive falling edges of said received signal by counting clock pulses for a third selected interval whose duration is determined by a third selected count value; and

compensating means coupled to said carrier sensing means and to said demodulator means, for compensating for frequency drift in said carrier signal by adjusting said second selected count value and said third selected count value, using said first duration;

said demodulator means combining results of said measuring first intervals and measuring second intervals to provide a composite representation of the binary signal at the receiver; and

a second computer means coupled to said demodulator means at the receiving node of the wireless digital network, for processing said binary signal output from said demodulator means.

3. The wireless digital network of claim 1, which further comprises: said oscillator means at said sending node starting said generating of said carrier signal in response to a communication mode change from a receive mode at a receive frequency to transmit mode at a transmit frequency.

4. The wireless digital network of claim 1, which further comprises:

said oscillator means at said sending node starting said generating of said carrier signal in response to a frequency hop protocol change from a first frequency to a second frequency.

5. An improved method to detect a digital carrier in a wireless digital network, comprising:

generating a carrier signal with an oscillator means at a sending node of a wireless digital network, starting at a first instant;

phase shift modulating said carrier signal with an input signal;

providing a spoiler signal as said input signal, starting at said first instant and continuing for a first duration which is longer than a period needed for said oscillator means to achieve stable characteristics;

transmitting a wireless radio signal representation of said carrier signal phase shift modulated with said spoiler signal;

receiving the wireless radio signal representation of the carrier signal at a receiving node of the wireless digital network;

forming from said carrier signal a received signal of square wave pulses having rising and falling edges separated by spacings;

detecting said carrier signal by counting a predetermined number of said pulses having a periodic characteristic;

said spoiler signal in said modulated carrier signal interrupting said periodic characteristic of said pulses, and thereby preventing detecting said carrier signal;

said spoiler signal ceasing to modulate said carrier signal after said first duration when said oscillator means has achieved stable characteristics, thereby enabling detection of said carrier signal.

6. The method to detect a digital carrier of claim 5, which further comprises:

providing a binary data signal as said input signal, starting after said first duration when said oscillator means has achieved stable characteristics;

detecting when the spacing between the edges of the square wave pulses changes in response to the phase shift modulation;

measuring first intervals between consecutive rising edges of said received signal, by counting clock pulses for a second selected interval whose duration is determined by a second selected count value;

measuring second intervals between consecutive falling edges of said received signal by counting clock pulses for a third selected interval whose duration is determined by a third selected count value;

compensating for frequency drift in said carrier signal by adjusting said second selected count value and said third selected count value, using said first duration;

combining results of said measuring first intervals and measuring second intervals to provide a composite representation of the binary signal at the receiver;, and

processing said binary signal resulting from said combining.

7. The method to detect a digital carrier of claim 5, which further comprises:

starting said generating of said carrier signal in response to a communication mode change from a receive mode at a receive frequency to transmit mode at a transmit frequency.

8. The method to detect a digital carrier of claim 5, which further comprises:

starting said generating of said carrier signal in response to a frequency hop protocol change from a first frequency to a second frequency.

***Description***

FIELD OF THE INVENTION

The invention disclosed broadly relates to data processing systems, and more particularly relates to digital input/output systems for communication over a radio medium.

BACKGROUND OF THE INVENTION

Phase shift key (PSK) modulation of radio signals has been used in the past to transmit digital information between data processing systems. One example is shown in U.S. Pat. No. 5,150,070, entitled "Demodulator for biphase, suppressed-carrier PSK signals" by P. Rinaldi. The phase modulation technique uses a 180 degree phase shift to distinguish between a binary one and a binary zero. This forces the carrier to be zeroed out during modulation. To demodulate the modulated signal, the prior art requires complex circuitry to reliably reconstitute the binary information at the receiver. The demodulators of the prior art must reconstruct the carrier. They require coherent demodulation to create a signal that is phase locked with the incoming signal, and they then must combine the two in a multiplier to detect the data. The IF signal must be made synchronous with the demodulated signal off the carrier. Stated otherwise, the carrier and the local oscillator must be made synchronous to demodulate the PSK signal in the prior art. What is needed in the prior an is a simple radio demodulation method and apparatus, that can detect phase changes in PSK modulated signals at very low intermediate frequencies.

In phase shift key modulation, a carrier signal, for example a 2.4 gHz carrier signal, is selectedly applied to a phase shift delay circuit, depending upon the binary state of control input to the delay circuit. For example, when there is a binary zero data state for the control input, no phase shift delay is applied to the carrier signal. Alternately, when there is a binary one data state, a phase shift delay is applied to the carrier signal. The carrier signal is then transmitted to the receiver. At the receiver, there is a local oscillator that oscillates at a slightly different frequency, for example 2.4 gHz plus 2 mHz. At the receiver, these two frequencies are mixed and a corresponding beat note signal or intermediate frequency (IF) signal is produced. Phase shift information which has been imposed on the carrier signal is then manifested in the IF signal at the receiver. A significant problem in such phase shift key modulation communication techniques is created by the drift in the frequency of the oscillator at the transmitter, which generates the 2.4 gHz carrier signal, and the drift of the local oscillator at the receiver, which generates the 2.4 gHz plus 2 mHz signal. The relative drift in the frequencies of these two oscillators will result in unstable characteristics in the intermediate frequency produced at the receiver and therefore unreliable detection of the binary data being transmitted.

OBJECTS OF THE INVENTION

It is an object of the invention to provide a wireless local area network that has a more reliable and accurate reception of digital transmissions from a sending node, than has been available in the prior art.

It is another object of the invention to provide a wireless local area network that has a better carrier signal detection than has been available in the prior art.

SUMMARY OF THE INVENTION

These and other objects, features and advantages are accomplished by the invention disclosed herein. The invention provides an improved digital carrier detection for a carrier signal of a wireless local area network. The network includes a first computer at a sending node of the network, which originates the binary signal. A transmitter is coupled to the first computer at the sending node, for forming a phase shift modulated carrier signal from the binary signal, which is transmitted as a wireless radio signal. When the carrier signal frequency is changed because of a change from receive mode to transmit mode, or because of a frequency hop protocol, the carrier oscillator requires a period for stabilizing its new frequency. During this period, receivers in the vicinity might erroneously lock onto the new frequency before it has reached stability. The invention prevents this from occurring.

The oscillator at the sending node of a wireless digital network, generates a carrier signal, starting at a first instant. A modulator coupled to the oscillator performs phase shift modulating of the carrier signal with an input signal.

In accordance with the invention, a spoiler signal generator is coupled to the modulator, for providing a spoiler signal as the input signal, starting at the first instant and continuing for a first duration which is longer than a period needed for the oscillator to achieve stable characteristics. A transmitter is coupled to the modulator at the sending node, for transmitting a wireless radio signal representation of the carrier signal phase shift modulated with the spoiler signal. A receiver at a receiving node of the wireless digital network, receives the wireless radio signal representation of the carrier signal. An amplifier is coupled to the receiver, for forming from the carrier signal a received signal of square wave pulses having rising and falling edges separated by spacings. A carrier sensor is coupled to the amplifier, for detecting the carrier signal by counting a predetermined number of the pulses having a periodic characteristic.

In accordance with the invention, the spoiler signal in the modulated carrier signal interrupts the periodic characteristic of the pulses, and thereby prevents the carrier sensor from detecting the carrier signal. Further in accordance with the invention, the spoiler signal ceases to modulate the carrier signal after the first duration when the oscillator has achieved stable characteristics, thereby enabling the carrier sensor to detect the carrier signal.

DESCRIPTION OF THE FIGURES

These and other objects, features and advantages will be more fully appreciated with reference to the accompanying figures.

FIG. 1A is a waveform diagram of the intermediate frequency (IF) demodulation.

FIG. 1B is a waveform diagram illustrating the digital filtering in the demodulator of the invention.

FIG. 2A shows the preferred embodiment of the modulator 106, which uses an adjustable phase shift value which is set at 122.degree. phase shift.

FIG. 2B shows an alternate embodiment of the modulator 106, with a fixed phase shift value of 90.degree..

FIG. 3 is a functional block diagram of the demodulator 122 in the receiver, in accordance with the invention.

FIG. 4 is a logic block diagram of the carrier sense circuit, in accordance with the invention.

FIG. 5 is a logic block diagram of the frequency compensation circuit, in accordance with the invention.

FIG. 6 is a logic block diagram of the digital filter and intermediate frequency edge detector, in accordance with the invention.

FIG. 7 is a logic block diagram of the positive edge data demodulator circuit, in accordance with the invention.

FIG. 8 is a logic block diagram of the negative edge data demodulator circuit, in accordance with the invention.

FIG. 9 is a logic block diagram of the digital filter and data output circuit, in accordance with the invention.

FIG. 10 is a timing diagram of the carrier sense operation.

FIG. 11 is a timing diagram of the data demodulation operation of the invention.

FIG. 12 is a logic block diagram of the clock pulse generation circuit.

FIG. 13 is a functional block diagram of the local area network, showing the carrier detection spoiler signal generator 170 at the transmitter.

FIG. 14 is a schematic diagram of the carrier detection spoiler signal generator circuit 170.

FIG. 15A is a waveform diagram of the intermediate frequency signal D which is modulated by the spoiler signal SP.

FIG. 15B is a waveform diagram of signal D for the intermediate frequency after the spoiler signal SP no longer modulates the carrier signal.

FIG. 16 is a functional block diagram of a complete transmitter/receiver note in the local area network of FIG. 18.

FIG. 17 is an illustration of the message 180 which is transmitted over the radial link 115, and which includes the trailer portion 186 with a specified frequency hopping sequence.

FIG. 18 is a functional block diagram of the local area network, including the sending node and the receiving node, in accordance with the invention.

DISCUSSION OF THE PREFERRED EMBODIMENT

The waveform diagram of FIG. 1A illustrates a 0.5 megabit per second data rate waveform A showing a binary 1 A=1 interval which ends at the time T1 with a transition from a binary 1 to a binary 0 state. The time in nanoseconds is shown along the abscissa of the waveform and it is seen that at 2000 nanoseconds, the T1 event occurs. After time T1 and before time T2, the data waveform is in a binary 0 state A=0. At the instant T2, a transition from binary 0 to binary 1 occurs with A=1.

Reference can be made to the system block diagram of FIG. 18 which illustrates how the transmitter at the local area network sending node 110 transmits the information in the data waveform A. A source computer 102 outputs binary digital information to the local area network interface adapter 104, which outputs a 500 Kbps binary data stream A. The data rate for the binary data stream A can have other values up to 1/2 of the IF frequency D in FIG. 1A. Thus, if the IF frequency is higher, for example at 20 mHz, then the data rate can have any value up to 10 megabits per second, for example. A 2.4 gHz oscillator 100 generates the carrier signal B. The carrier signal B is applied to the phase shift key (PSK) modulator 106. The control signal which is the binary signal A is applied to the modulator 106. Modulation occurs when the waveform A transitions from the binary A=1 to binary A=0 at the time T1; a phase shift delay is applied to the carrier signal B. Alternately, when the data waveform A transitions from a binary value A=0 to a binary value A=1 at time T2, the phase shift delay is removed from the carrier signal B. This modulated carrier signal is then applied as signal C to the radio transmitter 108 at the local area network sending node 110. An electromagnetic radio wave 115 is transmitted from the transmitter 108 to the radio receiver 116 at the local area network receiving node 130 in FIG. 18. The receiver 116 then outputs the waveform C to the input of the signal mixer 120. The local oscillator 118 at the receiving node 130, has a frequency of 2.4 gHz+2 mHz. The local oscillator at the receiving node could also have a frequency of 2.4 gHz-2 mHz, for example. The local oscillator signal B' is applied to the other input to the mixer 120, resulting in a heterodyned beat signal C' which is the 2 mHz intermediate frequency signal. The 2 mHz intermediate frequency signal at C' is applied to a low pass filter 150 whose output 121 is then applied to the PSK demodulator 122. The demodulator 122 is shown in greater detail in FIG. 3. The output of the demodulator 122 is a binary data stream A' which is the reconstructed data stream A which was applied to the input of the modulator 106 at the sending node 110. The output of the demodulator 122 on line 123 is applied to the local area network interface adapter 124 and then to the destination computer 126 at the local area network receiving node 130.

FIG. 2A shows the preferred embodiment for the modulator 106, and the best mode of the invention, with the phase angle for the phase shift having a value of 122.degree., applied over an interval less than but approximately equal to the period of the intermediate frequency of 500 nanoseconds.

FIG. 2B shows an alternate embodiment for the modulator 106, wherein a 90.degree. phase shift is applied. When the binary signal A transitions from a binary value of one to a binary value of zero. Alternately when the data waveform A transitions from a binary value of zero to a binary value of one, the phase shift delay is removed from the carrier signal B. Inspection of the waveform diagram A in FIG. 1A will show that the transition from the binary one to the binary zero is substantially instantaneous. When a 90.degree. phase shift is applied to the carrier signal B during an extremely small interval, undesirable harmonic frequencies are generated which make the design difficult to comply with the Federal Communications Commission Part 15 spectral requirements. Thus, the preferred embodiment and best mode of the invention is for the modulator 106 as shown in FIG. 2A.

In FIG. 2A, the modulator 106 is designed to apply the phase shift over a duration which is less than and approximately equal to the intermediate frequency period of 500 nanoseconds. In order to increase the detectability of the phase shift signal at the receiver, the magnitude of the phase shift angle was increased from 90.degree. up to 130.degree.. Phase shift magnitudes from 90.degree. to 130.degree. are found to work well. The best mode for the phase shift angle is found to be 122.degree.. The modulator 106 of FIG. 2A accomplishes the phase modulation as follows. The binary signal A is applied to the input of the filter 140, which is a low pass filter. The filter 140 includes a notch filter at 0.75 mHz, to suppress undesirable harmonics. The output of the filter 140, is applied on line 144 to the input of the vector modulator 142. The wave form V for the output on line 144 from the filter 140, is shown in the waveform 145. It is seen in the waveform 145, that the duration over which the binary value of the signal A changes from a binary one to binary zero, is approximately 500 nanoseconds, which is the intermediate frequency. This is compared with the waveform 141 shown in FIG. 2A for the binary waveform A input to filter 140. The vector modulator 142 has an adjustable input 146 which allows the setting of the maximum value for the phase angle to be applied by the vector modulator 142 to the carrier signal B. Settings for the maximum value phase angle 146 can be fixed from 90.degree. to 130.degree. and a satisfactory modulated carrier signal C can be obtained. In the best mode of the invention, the setting for the maximum value phase angle 146 is found to be a value of 122 degrees.

Returning to FIG. 1A, it can be seen that the intermediate frequency signal C' output from the mixer 120 in FIG. 18 is an approximately 2 mHz sinewave signal whose phase is modulated by the 500 Kbps digital signal A. The modulation shown for FIGS. 1A and 1B is instantaneous 90.degree. phase shift when the binary data A transitions from a binary one to a binary zero. This is done to simplify the illustration of the invention.

In FIG. 3, the demodulator 122 has its input 121 connected to the limit amplifier 200, for amplifying the filtered intermediate frequency signal C' to form the square wave, limit amplified signal D shown in FIG. 1A. The square wave signal D will have its zero crossings at the same instant as the zero crossings of the sinewave signal C'. It can be seen by inspection of FIG. 1A, that the duration of each period for the waveform D remains approximately 500 nanoseconds long for normal intervals when there is no phase change applied to the carrier signal B at the transmitter. However, at time T1, when there is a 1-to-0 transition in the data waveform A, there is a corresponding lengthening of the duration of the intermediate frequency signal D to approximately 625 nanoseconds. Further, by inspection it can be seen that at the instant T2 when the data waveform A transitions from a binary 0 to a binary 1, the intermediate frequency waveform D has the duration of its period reduced to approximately 375 nanoseconds. In accordance with the invention, the demodulator circuit 122 of FIG. 3 will detect the occurrence of changes in the duration of the intermediate frequency signal D and will correctly reconstruct the data waveform as the output signal A'. The modulation could be done in the opposite manner, for example, by applying a phase shift delay when the binary input waveform A rises from a 0 value to a 10 and removing the phase shift delay when the binary value transitions from a 1 to a 0, for example.

It is seen that the circuit of FIG. 3 monitors the time intervals between consecutive positive going edges of the D waveform and, in addition, it also monitors the time intervals between consecutive falling edges of the D waveform. In accordance with the invention, this dual monitoring of both the positive going edges of the D waveform and the negative going edges of the D waveform accommodates the asynchronous character between the data waveform A and the intermediate frequency waveform D. For example, if a binary 1-to-0 transition occurred in the data waveform A at an instant close to the transition of the intermediate frequency waveform D, then the modulated character of the waveform might be missed for the PSK measurement of the occurrence of that data transition, however, it would be correctly reflected in the corresponding negative edges of the intermediate frequency waveform. Thus, by monitoring both positive edges and negative edges, it is certain that the asynchronous transitions of the binary waveform A will have their modulated manifestation detectable in the intermediate frequency waveform D.

The demodulator circuit 122 of FIG. 3 takes the output D from limit amplifier 200 and applies it to the carrier sense circuit 400 which is shown in greater detail in FIG. 4. The carrier sense circuit 400 correctly detects the presence of the carrier signal bearing a 2 mHz modulated intermediate frequency signal, and outputs a signal F32CRS representing a successful detection of the carrier signal. This is output to the frequency compensation circuit 500 shown in FIG. 5. The output D from the limit amplifier 200 in FIG. 3 is also applied to the digital filter and intermediate frequency edge detector 600 shown in FIG. 6. The circuit of FIG. 6 correctly detects a positive going edge of the intermediate frequency waveform. This signal is applied as POSED as the positive edge detection signal to the positive edge data demodulator 700 shown in FIG. 7. The digital filter and intermediate frequency edge detector circuit 600 of FIG. 6 also correctly detects a negative going edge of the intermediate frequency waveform. This recognition is output as the signal NEG ED to the negative edge data demodulator circuit 800 of FIG. 8.

The positive edge data demodulator circuit 700 of FIG. 7 correctly identifies a short duration interval between consecutive positive edges of the intermediate frequency waveform D, which represents a transition from a binary 0 to a binary 1 for the data waveform A. This information is output as the signal POS T1 to the digital filter and data output circuit 900 of FIG. 9. The positive edge data demodulator circuit 700 of FIG. 7 also correctly detects a long duration interval between consecutive positive intermediate frequency edges for the waveform D, and outputs this recognition as the signal NEG T1 to the digital filter and data output circuit 900 of FIG. 9. The frequency compensation circuit of FIG. 5 outputs signals FC0, FC1, and FC2 to the positive edge data demodulator circuit 700 of FIG. 7, for the purpose of applying a digital offset to the circuit 700 to compensate for changes in the frequency of the nominally 2 mHz frequency for the intermediate frequency signal D.

The negative edge data demodulator circuit 800 correctly detects the short duration between consecutive negative edges of the intermediate frequency signal D and outputs a recognition signal POS T2 to the digital filter and data output circuit 900 of FIG. 9. The negative edge data demodulator circuit 800 of FIG. 8 also correctly detects the occurrence of long duration intervals between consecutive negative edges of the intermediate frequency signal D, outputting the recognition signal NEG T2 to the digital filter and data output circuit 900 of FIG. 9. The frequency compensation circuit of FIG. 5 outputs the signals FC0, FC1, and FC2 to the negative edge data demodulator circuit 800 of FIG. 8 to apply a digital offset to the circuit 800 to compensate for variations in the nominal 2 mHz frequency of the intermediate frequency signal D.

The digital filter and data output circuit 900 of FIG. 9 correctly outputs the reconstructed binary value A' of the digital data waveform A. The circuit 900 of FIG. 9 applies a digital filter to prevent ringing of the input signal from being misinterpreted as data for the output signal. The reconstructed signal A' is output on line 123 from the demodulator 122 to the local area network interface adapter 124. The digital filtering function performed by the circuit of FIG. 9 monitors binary 0 to binary 1 transitions, and binary 1 to binary 0 transitions of the data waveform A, and blocks the recognition of any further binary data transitions in waveform A for a subsequent 800-nanosecond interval. This is done to prevent spurious ringing signals from confusing the circuitry during the 800-nanosecond interval following a valid data transition in waveform A.

In this manner, the invention successfully accomplishes the detection of the intermediate frequency signal on the 2.4 gHz carrier, it successfully applies frequency compensation to overcome a carrier frequency drift, and it successfully demodulates the intermediate frequency signal to reconstruct the binary digital waveform.

Reference to FIG. 1A will show the intervals between consecutive rising edges of the waveform D, represented as R, and the intervals between consecutive falling edges of the waveform D, represented as F. It can be seen that the intervals between rising edges R are four consecutive periods of 500 nanoseconds for normal intervals, followed by a long interval of 625 nanoseconds at the time T1 when the transition from a binary 1 to a binary 0 occurs for the data waveform A. This is followed by two 500 nanosecond periods which are normal, followed by a short period of 375 nanoseconds, the duration of which is cut short by the occurrence at time T2 of the transition from a binary 0 to a binary 1 for the data waveform A. T2 is then followed by two more normal intervals R of 500 nanoseconds between the rising edges of D. Correspondingly, the falling edge of the waveform D represented by the intervals F in FIG. 1A, shows three consecutive intervals of 500 nanoseconds for the normal intervals, followed by a long interval of 625 nanoseconds which spans the instant of time T1. This is followed by three consecutive normal intervals of 500 nanoseconds and then a short interval of 375 nanoseconds which spans the instant of T2. This is then followed by a normal interval of 500 nanoseconds. The invention is able to identify these normal, long and short intervals for both the rising edge and falling edge of the waveform D, and to correctly infer and reconstruct the data waveform A, as the reconstructed waveform A'.

FIG. 4 is a more detailed illustration of the logic for the carrier sense circuit 400. The 2 mHz intermediate frequency signal D is input on line 201 to the latch 402. The latch 402 is connected to the latch 404. The outputs of the latches 402 and 404 are applied to the AND gate 406 along with the signal TX indicating that there is no transmission currently at the receiving node. The AND gate 406 outputs a signal for every positive edge detected for the input waveform D. The output of AND gate 406 is PP26 and this signal is applied as the reset signal for the counter 408, which counts 27 mHz clock pulses. The counter 408 has five output decodes set to go high after the respective durations that are shown in the figure. The outputs CS=0 and CS=10 are applied to the AND-OR gate 410 and the outputs CS=15 and CS=20 are applied to the AND-OR gate 412. The AND-OR gate 410 has an output connected to the set input of the window latch 414 and the output of the AND-OR gate 412 is applied to the reset input of the window latch 414. The N output of latch 4 14 is applied to one input of the AND gate 416, the other input being the signal PP26. The F output of the latch 414 is applied as one input to the AND portion of the AND-OR 418, the other input to the AND gate being PP26. The output of the AND is then ORed with the CS=22 output of the counter 408. The CS=22 output for the counter 408 represents an overrun condition above a duration of 778 nanoseconds. If no IF cycle has been detected within a duration of approximately 800 nanoseconds, this signal, CS=22, has the effect of resetting the good latch 420 in FIG. 4. The output of the AND gate 416 is applied to the set input of the good latch 420 and the output of the AND-OR gate 418 is applied to the reset input of the latch 420. The latch 420 is clocked with a 27 mHz clock. The N output of the good latch 420 is applied to the AND gate 422, which also has applied to it the signal PP26 and an inverted signal output from the counter 424. The inverted output "=0" from the counter 424 represents the state of the counter not being at 0. The F or off state output of the good latch 420 is applied to the AL=33 input of the counter 424, setting a value of 33 in the counter. The counter then counts the consecutive occurrences of intermediate frequency waveform signals and if it successfully counts above 63 consecutive good IF signals, it applies that recognition as the output signal F32CRS. Once the counter is stopped, it is returned to a 0 state and will not have a value of 33 loaded into it until the good latch 420 goes into its off state. The counter 424 will count all the way up to 127 and then will wrap to 0, or to be more precise, the counter counts from 0 to 127 and then wraps to 0. The counter 424 is the carrier sense filter counter, which is a 7-bit counter which is clocked with 27 mHz clock pulses. The output of the AND gate 422 is applied as the enable signal to the counter 424. The counter 424 counts up from 33 to 64, indicating that if 31 consecutive waveforms for the intermediate frequency signal D, are successfully detected, then it can be inferred that a true carrier signal is being received at the receiving node. This indication is output as a signal F32CRS. This signal is applied to the frequency compensation circuit of FIG. 5. The output F32CRS at a count greater than 63 goes to the frequency compensation circuit 500. For the duration represented by the next 64 IF cycles, from 63 to 127, during that interval the frequency compensation circuit 500 monitors the actual frequency of the IF signal D that is received and generates the values FC0, FC1 and FC2, which are correction factors applied in accordance with the invention to compensate for any deviations from the nominal value of the frequency of 2 mHz. The counter 424 in FIG. 4 will count up to a value of 127 counts, for 95 good IF cycles, and then it will wrap to 0. When it wraps to 0, the "=0" output represents a stop count and that signal is applied to the D input of the latch 428. The latch 428 will then output the CRS signal on output N, representing that a valid carrier sense condition has been detected. The signal CRS is then applied to the LAN interface adapter 124 of FIG. 18, to signal the receiving node to begin looking at the data content of the demodulated output waveform A'.

The frequency compensation circuit 500 of FIG. 5 includes the counter 502, which is an 8-bit counter that counts down. The counter counts the 27 mHz clock pulse and is enabled by the signal F32CRS. The counter 502 counts how long it takes to successfully detect 64 consecutive intermediate frequency cycles of the D waveform. If the intermediate frequency D waveform is exactly 2 mHz in frequency, then the outputs from the counter 502 will be FC0=0, FC1 =0, and FC2=0. If it takes a longer time than nominal to count 64 consecutive IF cycles, then the actual frequency of the intermediate frequency waveform D is less than 2 mHz and the values of FC0, FC1 and FC2 will apply a negative offset to the counters 702 and 802 in FIGS. 7 and 8. Conversely, if it takes less than the nominal duration of time to count 64 consecutive IF signals in the counter 502 of FIG. 5, then the values of FC0, FC1 and FC2 will provide a positive offset, reflecting that the actual frequency of the intermediate frequency waveform D is higher than the nominal 2 mHz. This positive offset is then applied to the counter 702 in FIG. 7 and counter 802 in FIG. 8. The counter 502 in FIG. 5 has as one input the not good input and that is the output F from the good latch 420 in FIG. 4. When the not good input is active at the counter 502, the counter has pre-loaded a hex value of 70 hex or a decimal value of 112 into the counter. If the nominal 2 mHz frequency currently exists for the IF waveform D, then the counter 502 will count down for 64 cycles of the IF waveform, and this will take 32 microseconds. This would correspond to 564 counts of the 27 mHz clock applied to the counter 502. Since the counter 502 is an 8-bit counter, it will wrap three times in counting down from the preloaded value of 112 and the resulting value in the 8-bit counter will be a value of 16. Since FC0, FC1 and FC2 are the high order bits of the 8-bit counter, their values will be 0, 0, and 0, respectively, for this condition. Alternately, if the IF frequency is low, then the counter 502 will count more than the nominal 564 counts and as the counter counts down, the next 17 counts of the 27 mHz clock it will wrap. As the counter counts down, the next 17 counts it will wrap and all binary 1's will exist in the 8 bits of the counter. This corresponds to a binary value of -1. Thus, the values of FC0, FC1 and FC2, when they are all 1's, corresponds to a value of -1. This negative value is then applied as a negative offset to the counters 702 in FIG. 7 and 802 in FIG. 8. Alternately, if the IF frequency is higher than the nominal 2 mHz, then the counter 502 will not completely count the 564 counts corresponding to a nominal frequency. There will thus be a corresponding positive binary value for FC0, FC1 and FC2, and this will be applied as a positive offset to the counter 702 in FIG. 7 and the counter 802 in FIG. 8.

FIG. 6 is a detailed logic block diagram of the digital filter and intermediate frequency edge detector circuit 600. The waveform D is input on line 201 to the D input of the latch 602 and the 54 mHz clock pulse is applied to the C input. The N output is connected to the D input of the latch 604 and the 54 mHz clock signal is applied to the C input of the latch 604. The N output of the first latch 602 is applied to one input of the AND gate 606 and the F output of the second latch 604 is applied to the second input of the AND gate 606. When both inputs to the AND gate 606 are high, that indicates that a positive going edge has been detected. The third input to the AND gate 606 is pan of the digital filter which avoids the detection of false positive data transitions. If the actual data waveform A is a binary 1, and if another positive edge is detected before 422 nanoseconds, then the circuit ignores a rising edge detection. The AND gate 608 has as one input the signal RCV DTA which is output from the latch 918 in FIG. 9. This signal is the main output of the demodulator 122 and is high when the data waveform A' is high and is 0 when the data output for A' is 0. The other input to the AND gate 608 is LPOS ED which is the output of the latch 616 in FIG. 6. If both of these signals are high, the AND gate 608 sets the latch 612 and the corresponding output from the N terminal of latch 612 is applied through the inverter 614 to a third input of the AND gate 606. This disables the AND gate 606 and prevents a signal being applied to the D input of the output latch 616. This digital filtering operation avoids the recognition of false positive data. Correspondingly, the OR gate 610 has the signal LPOS 15 applied to one input, which comes from the register 706 of FIG. 7. The other input to the OR gate 610 is LPOS ED which is the output of the latch 616 of FIG. 6. The output of the OR gate 610 is applied to the reset of the latch 612.

One aspect of the digital filter and IF edge detector 600 of FIG. 6 is the digital filtering feature which prevents a false detection of a data signal for waveform A. In FIG. 6, the AND gate 608 has as one of its inputs the RCV DTA input which is the reconstructed waveform A' output from the circuit of FIG. 9. When the reconstructed waveform A' has a binary 1 value, it is the object of the digital filter in FIG. 6 to block any indication that a transition from a binary 0 to a binary 1 is taking place with the waveform A. This transition would not take place if there is a valid current binary 1 state for the waveform A and its corresponding reconstructed waveform A'. Thus, once a latched positive signal is output from the latch 616 in FIG. 6, it is applied as one input to the AND gate 608 and the received data signal, which is high, is applied to the other input of the AND gate 608. This sets the S input for the latch 612. The latch 612 is thus set on every positive edge of the IF signal for as long as there is a binary 1 state for the value A' waveform. The output of the latch 612 is inverted through the inverter 614 and applied to one of the three inputs of the AND gate 606. Thus, if the latches 602 and 604 apply positive inputs to the AND gate 606 indicating that a positive edge has been detected for the IF waveform D, the AND gate 606 will only be enabled if the received data value is low. If the received data value is high, then the input to the AND gate 606 is not enabled until the latch 612 is reset. The latch 612 is not reset until the latched positive 15 signal from counter 702 is applied through the OR gate 610 to the reset input of the latch 612. The LPOS 15 signal from the counter 702 does not go high until 422 nanoseconds after the occurrence of the positive edge LPOS ED output from the latch 616. Thus, it is seen that for an interval of 422 nanoseconds following the occurrence of LPOS ED that the LPOS ED output will be disabled. This in effect blocks the recognition of any short interval between consecutive rising edges of the IF waveform D, which would erroneously correspond to an erroneous indication of a rising data waveform signal from A0 to A1. A similar operation takes place for the circuit driving the AND gate 628 into the latch 630 for the negative edge detection circuitry of FIG. 6. Turning to FIG. 1A, the diagram of the IF signal waveform D shows at the beginning of time T1 that the IF waveform is phase delayed by 90.degree.. The design of the receiver 116 includes a low pass filter to minimize overlapping cross-talk from nearby channels. A low pass filter 150 filters the IF output from the mixer 120 before it is applied to the demodulator 122 in FIG. 18. The purpose of the low pass filter is to block out nearby IF channels in a frequency multiplexed application. In particular, where frequency hopping is performed between nearby IF bands, each of which is 1 mHz wide, it is important to eliminate cross-talk from such nearby channels. As a consequence of such low pass filtration, when a 90.degree. phase delay is applied, such as at time T1, if there were no low pass filter the waveform immediately following T1 for waveform D would be relatively flat. However, because of the low pass filter and the elimination of high frequency components in the waveform D, the waveform appears to have a small peak above 0 and a small valley below 0 immediately following the time T1. When the limit amplifier in FIG. 3 is applied to the waveform C', it amplifies the small peak and the small valley in the waveform C' to get a distinct spurious square wave following the time T1. This square wave must be blocked from being interpreted as an indication of a valid transition of either a rising edge or a falling edge for the IF waveform. This is done by the digital filtering circuitry of FIG. 6. Attention is directed to the latch 612 waveform shown in FIG. 1A, which indicates the binary state of the latch 612 in the digital filter of FIG. 6. The latch 612 is seen to stay on in an on state for a period of 422 nanoseconds. The 422 nanosecond duration of the on state for the latch 612 prevents the circuit of FIG. 6 from recognizing the negative edge and following positive edge immediately after T1 as being valid edges for the IF waveform. In this manner, the digital filter compensates for the necessity of applying low pass filtering to the IF waveform to avoid overlapping adjacent channels in a frequency hopping application. Note that after latch 918 falls, as is shown in the waveform of FIG. 1A, latch 612 no longer is set and this is reflected in the waveform for latch 612 also shown in FIG. 1A. Not until the waveform A rises again at time T2 will latch 918 become set and correspondingly latch 612 periodically set to once again apply the digital filtration to the IF waveform to ignore the spurious pulses due to the low pass filtration of the IF waveform.

A similar operation occurs for the negative edge detection portion of the circuit 600 of FIG. 6. AND gate 620 has the signals RCV DTA and LNEG ED.

The output of the AND gate 620 is applied to the set input of the latch 624. The latch is clocked with a 54 mHz clock. The other input to the latch at the reset input is from the OR gate 622 which has the input LNEG 15 which comes from the counter 806 in FIG. 8.

The other input to the OR gate 622 is LNEG ED. The output of the latch 624 is applied through an inverter 626 to one input of the AND gate 628. The F output of latch 602 is applied to a second input of the AND gate 628 and the N output of the latch 604 is applied to the third input of the AND gate 628. The AND gate 628 is enabled whenever a falling edge is detected for the intermediate frequency waveform D. This is output to the D input of the latch 630 which is clocked at 54 mHz and provides the output signal LNEG ED representing the falling edge having been detected. The signal LPOS ED is applied the counter 702 of FIG. 7 for positive edge data demodulation and the signal LNEG ED is applied to the counter 802 of FIG. 8 for negative edge data demodulation.

FIG. 7 shows a logic block diagram for the positive edge detection data demodulation circuit 700. The counter 702 counts up the 54 mHz clock pulses applied to it at input C. The POSED signal representing a positive edge detection for the IF waveform D is applied to the counter and digital offset values FC0, FC1 and FC2 are applied from the frequency compensation circuit of FIG. 5. The counter 702 has four outputs, the first output 8 represents a 200 nanosecond duration, the output 15 represents a 426 nanosecond duration, the output 1B represents a 574 nanosecond duration, and the output 29 represents a 796 nanosecond duration. These decoded signals from the counter 702 are applied through the staging logic 704. The AND gate 704 is for two input AND gates, with one of the inputs being the not positive edge signal and the other input of the AND gate being from each of the respective decoded outputs shown for the counter 702. The output of the AND gate 704 is applied to the input of the staging register 706. The net effect of the AND gate 704 and the staging register 706 is to properly stage the outputs of the counter 702 so that they can be appropriately applied to the following logic circuitry in FIG. 7. Similar comments can be made for the AND gate 804 and staging register 806 of FIG. 8.

The output of the gate 704 is then applied to the register 706 which is clocked at 54 mHz and provides a staging operation for the decoded signal lines output from the counter 702. The decoded signal lines are then output from the register 706 and applied as follows. The 204 nanosecond output decode 8 is applied to the set input of the latch 712. The 426 nanosecond output 15 from counter 702 is applied through the OR gate 708 to the reset input of the latch 712. The other input to the OR gate 708 is the LPOS ED signal. The output of the latch 712 is the window latch and it is applied to the D input of latch 716. The output of latch 716 is POS T1 and represents the detection of a short interval between consecutive positive edges of the waveform D, corresponding to a 0-to-1 transition of the data waveform A. The 1B output which is the 574 nanosecond decode output from counter 702 is applied through register 706 to the set input of the latch 714 and the 796 nanosecond decoded output 29 from the counter 702 is applied through the register 706 and the OR gate 710 to the reset input of the latch 714. The other input to the OR gate is LPOS ED. The output of the latch 714 is applied to the D input of the latch 718 whose output is NEG T1. This signal represents the detection of a long duration between consecutive positive edges of the input waveform D, which corresponds to a 1-to-0 transition for the binary data waveform A. The POS T1 output from latch 716 represents a short duration of between 200-422 nanoseconds. The output NEG T1 from latch 718 represents a long duration of from 568 to 800 nanoseconds. These signals are applied to the digital filter and data output circuit of FIG. 9.

FIG. 8 is organized in a manner similar to that shown for FIG. 7. Counter 802 receives NEG ED signal, the FC0, FC1 and FC2 signals, and counts a 54 mHz clock. It outputs 200, 422, 568 and 800 nanosecond decoded signals which are applied through the logic 804 and the register 806 to the latch 812, the OR gate 808, the latch 814 and the OR gate 810. The output of the latch 812 is applied to the D input of the latch 816, whose output is POS T2 which represents the detection of a short duration between consecutive negative edges of the input waveform D. The output of latch 814 is applied to the D input of the latch 818 which outputs the signal NEG T2. This signal represents detection of a long duration between consecutive negative edges of the input waveform D. A short duration for POS T2 indicates a transition of the data waveform A from binary 0 to binary 1. A long duration represented by NEG T2 represents a binary transition from a binary 1 to a binary 0 for the data A. These signals are applied to the digital filter and data output circuit 900 of FIG. 9.

FIG. 9 shows the register 902 which receives these signals and outputs them through the OR circuit 904 and 906. The latch 908 is connected to the AND gate 912 which is satisfied when a short transition signal is received, of the waveform D. The output of the AND gate 912 sets the output latch 918 for RCV DTA, indicating that a transition from binary 0 to binary 1 has been detected. OR 906 is output to latch 910 and AND gate 914. AND gate 914 is satisfied when a long duration signal is received. The output of the AND gate 914 is to the reset input of the latch 918.

The register 902 in FIG. 9 has the long duration signals NEG T1 and NEG T2 applied through the register 902 and OR gate 906 to the AND gate 914 and the latch 910. When a negative edge is detected, either for the negative edge detector or for the positive edge detector, then the AND gate 914 is satisfied and resets the latch 918. The output RCV DTA then goes from 1 to 0, which reconstructs the binary 1 to binary 0 transition of the data waveform A.

The latch 910 has an output from its N terminal labelled LNTRAN.

The AND gate 912 in FIG. 9 has an output applied to the AND-OR gate 920, which has another output to its AND gate applied from the enable data signal EN DTA. This signal comes from the output latch 924 in FIG. 9, and is used in the digital filter feature of this circuit which prevents ringing signals from being detected. The other input to the OR gate of the gate 920 is a signal 26 output from the counter 922.

The output of the gate 920 is applied to the reset terminal of the counter 922. The counter 922 counts up and counts 13.5 mHz clock pulses. It has a 14-15 output which is applied to the set input of the latch 924.

The latch 924 has a clock input from the 13.5 mHz clock. It has a reset input RSTRC from AND gate 920.

The output of the latch 924 is EN DTA which represents the period following a 1.11 millisecond interval, after which valid signals may be detected.

FIG. 10 is a timing diagram for the carrier sense decode. The window waveform pertains to the window latch 414. In FIG. 10, the L1 waveform corresponds to latch 402 and the L2 waveform corresponds to the latch 404. The window waveform corresponds to the latch 414 in FIG. 4.

FIG. 11 is a timing diagram of the data demodulation. The NEG window waveform pertains to the latch 714. The POS window waveform pertains to the latch 712. In FIG. 11, the L waveform corresponds to the latch 602 and the L2 waveform corresponds to the latch 604 in FIG. 6. The NEG window waveform corresponds to the latch 714 in FIG. 7 and the POS window waveform corresponds to the latch 712 in FIG. 7.

FIG. 12 is a logic diagram illustrating how the 54 mHz local clock pulse is counted down to provide 27 mHz and 13.5 mHz clock pulses which are used in the logic circuits.

Table 1 shows the frequency compensation count values for the counter 502 in FIG. 5. The counter 502 counts the 27 mHz clock pulses for 16 consecutive cycles of the IF waveform in order to measure the actual frequency of the IF waveform. Table 1 shows several columns, the first column is the number of 27 mHz clock pulses that have been counted from the beginning of the counting interval for the counter 502. The table goes from 1 count all the way up to 254 counts. This is based upon local crystal oscillators at the transmitter and the receiver, each having a frequency of 2.4 gHz for the transmitter .+-.50 parts per million and 2.4 gHz 30 2 mHz .+-.50 parts per million. In the worst case, the transmitting crystal oscillator could have its tolerance in the opposite direction from the crystal oscillator at the receiving node and this would result in their being a .+-.240 kHz tolerance in the difference between the frequencies for the transmitting oscillator and the receiving oscillator. This then would correspond to a counting range of from 754 clock counts for 64 IF cycles, corresponding to a 27.89 microsecond duration for 64 IF cycles, up to 1009 clock counts for 37.33 microseconds required to count the 64 IF cycles. The first column of Table 1 is the number of counts of the counter, the second column is the initially-set count applied as the AL count in FIG. 5. If the counter were a 10-bit counter, then 880 counts would correspond to the hexadecimal number 370 hex. For an 8-bit counter, the hexadecimal representation is 70 hex. Since the counter 502 is an 8-bit counter, the value of 70 hex is loaded into the counter 502 at the beginning of the counting period. Taking the top three bits in an 8-bit counter as FC0, FC1 and FC2, they would represent a binary value of 3 for a starting count of 880 for the first pulse counted of the 27 mHz clock. The third column of Table 1 shows the hexadecimal value for a 10-bit counter, the fourth column shows the hexadecimal representation in an 8-bit counter. The fifth column the value of the binary representation for FC0, FC1 and FC2 and the sixth column represents the time in nanoseconds which is the duration from the beginning of the clock pulse counting. Table 1 shows the progression of the values for these six columns as the number of 27 mHz clock pulses increases from 1 up through 754. At the level of the 753 counted clock pulse, the remaining count in the counter 502 is 128 and this corresponds to a hexadecimal representation of 80 for both a 10-bit counter and an 8-bit counter. The corresponding binary value for FC0, FC1 and FC2 would be a value of 4 and this would be at the 27852 nanosecond duration since the beginning of the clock counting period. At this point, the IF frequency is 2.295 mHz and this corresponds to a 27889 nanosecond interval since the beginning of the clocking. Table 1 shows some additional columns. The POS window start value and stop value refer to the latches 712 and 812 in FIGS. 7 and 8. The NEG window start and stop values refer to the latches 714 and 814 in FIGS. 7 and 8. Table 1 shows that the binary value for FC0, FC1 and FC2 will slowly decrease from a value of 4 at 27740 nanoseconds or an IF frequency of 2.2989 mHz to 0 at a value of 2.000 mHz. This is the normal or nominal value for the IF frequency. As the IF frequency continues to decrease, at a value of 1.961 mHz, it is seen that the binary value of FC0, FC1 and FC2 goes negative. The negative value continues to negatively increase up to a value of 4 at the lower range for the IF frequency of 1.714 mHz. The values for FC0, FC1 and FC2 are applied as offset values to the counters 702 and 802 in FIGS. 7 and 8, as previously discussed. Thus it is seen that frequency compensation is accurately imposed by the invention.

A problem occurs with carrier detection when the transmitter is stabilizing its frequency at the beginning of a transmission interval. The transmitter will change its transmission frequency each time there is a frequency hopping event in the network. In addition, the frequency of transmission is different from the local oscillator receiving frequency, and therefore every time a note in the local area network changes from the receiving mode to the transmitting mode, the oscillator frequency must stabilize at the transmitting frequency. During the interval of stabilization of the transmitting frequency, any receiver in the network that detects the presence of the carrier signal being transmitted by the transmitter, risks performing a carrier detection on an unstable signal. This problem is solved by the intentional introduction of a spoiler signal at a transmitter during an initial period when the transmitter is attempting to stabilize a new transmission frequency. Thus, during that initial period of attempted stabilization by the transmitter, any receiver detecting the transmitted carrier signal will not have a successful carrier detection operation. It is only after the transmitter has stabilized its signal that the spoiler signal is removed from modulating the carrier from the transmitter so as to permit receivers to successfully detect the stabilized transmitted carrier signal.

FIG. 13 illustrates the local area network shown in FIG. 18, but with the addition of the carrier detection spoiler signal generator 170 at the transmitter sending node 110. The source computer 102 outputs on line 171 the information as to whether the node is in a transmitting mode or a receiving mode. When the source computer 102 in FIG. 13 begins the transmitting mode, a signal is applied on line 171 to the oscillator 100 to begin stabilizing the attempt to stabilize the new transmitting frequency. The signal 171 is also applied to the carrier detection spoiler signal generator 170, to start the spoiler signal SP which is applied to the modulator 106.

FIG. 14 shows a more detailed view of the carrier detection spoiler signal generator 170. The start transmission signal 171 is applied to a 100 microsecond timer 172 which turns on the enabling line 173. Also included in the carrier detection spoiler signal generator 170 is a 250 kHz signal generator 174. A 250 Kbps pulse train is output on line 175. Lines 173 and 175 are applied to the AND gate 176, the output of which is the spoiler signal SP. At the instant that the signal on line 171 is applied to the timer 172, the enabling signal 173 is applied to the AND gate 176. For a duration of 100 microseconds, the AND gate 176 is enabled, and passes the 250 kHz pulse train on line 175 out as the spoiler signal SP. The duration of 100 microseconds for the timer 172 was determined from the maximum normal time required for a transmitter oscillator 100 to stabilize at a new transmission frequency. Other values could be chosen for the 100 microsecond timer 172. The 250 kHz signal output on line 175 and passed as the spoiler signal SP to the modulator 106, produces a modulation phase change in the carrier signal C output from the modulator 106. The occurrence of the modulated phase change is once every four IF intermediate frequency intervals which are each 500 nanoseconds long.

Reference to FIG. 15A will show a sequence of the intermediate frequency pulses D which also were shown in FIG. 1A. At the receiver, the mixer 120 mixes the local oscillator 118 signal B' with the received carrier signal C, producing the D waveform. The D waveform shown in FIG. 15A is seen to have a phase modulation occur at every fourth intermediate frequency pulses. As was discussed above, the carrier sensing circuit 400 counts 32 consecutive IF pulses on the waveform D before it outputs the signal F32CRS indicating that a successful detection of the carrier has been made. In accordance with the invention, by intentionally spoiling the carrier signal C through the intentional introduction of a phase change in one out of eight IF pulses on the waveform D, by using the carrier detection spoiler signal generator 170 at the transmitter, the carrier sense circuit 400 at the receiver is not capable of successfully identifying the presence of a carrier. In accordance with the invention, it will not be until 100 microseconds after the beginning of the transmission interval at the transmitter, that the spoiler signal SP will stop modulating the carrier signal being sent to the transmitter to the receiver. Thus, the receiver is prevented from successfully performing a carrier detection operation on the signal transmitted from the transmitter, until 100 microseconds after the transmitter begins its transmission interval, which is sufficient time to enable the transmitter's oscillator 100 to stabilize at the new transmission frequency.

FIG. 15B shows the state of the waveform D after the transmitter has successfully passed its 100 microsecond duration and its transmitting frequency has stabilized. The uniform IF pulses in the waveform D of FIG. 15B will enable the carrier sensing circuit 400 of the receiver to successfully identify the presence of the carrier and output the signal F32CRS, as described above.

Reference is now made to FIG. 16 which shows a consolidate node in the local area network of FIG. 13, which includes both a transmitter and receiver portion. It is seen in FIG. 16 that a single oscillator 100 is used to generate both the transmission frequency as well as the receiving frequency for the mixer 120. The oscillator frequency from the oscillator 100 is increased by 2 mHz before it is applied to the mixer 120 for receiver operations. A node computer 102' will apply a transmission control signal TX to the gate 177 to apply the 2.4 gHz transmission signal from oscillator 100 to the modulator 106. If the computer 102' is in a receive mode, then it applies a receive control signal RCV to the gate 178 which applies the 2.4 gHz signal plus 2 mHz to the input of the mixer 120.

It is seen in FIG. 16 that the transmit signal TX is applied as a signal on line 171 to the spoiler circuit 170.

FIG. 16 also shows a 200 millisecond timer 188 which serves to identify the frequency hopping interval for the network of FIG. 13. In the network of FIG. 13, each sending node and receiving node will cooperatively change its frequency for transmission and reception every 200 milliseconds, in a operation known as frequency hopping. The 200 millisecond timer 188 notifies the computer 102 prime of each new frequency hopping interval.

FIG. 17 shows the format of the message 180 which is transmitted over the radio link 115 in the network shown in FIG. 13. The message 180 includes the header portion 182, the data portion 184, and the trailer portion 186. The message 180 trailer portion 186 includes a frequency hopping sequence F1, F2, F3 and F4. The various communicating nodes in the network of FIG. 13 will broadcast to each other every 200 millisecond frequency hopping interval, a new message 180 which identifies the next 4 consecutive frequency hopping frequencies for each of the next 4 frequency hopping intervals 200 milliseconds each.

Each time a transmitter at a communicating node in the network shown in FIG. 13, either changes its status from receiving to transmitting so that the transmitter must stabilize a new transmission frequency, it will undergo the carrier detection spoiler signal generation operation described above. In addition, every time a communicating node performs a frequency hopping transition at the beginning of a new frequency hopping interval, then the transmitter will begin transmitting at a new frequency which requires stabilization, and therefore the transmitter once again, will undergo the carrier detection spoiler signal generation operation described above. In this manner, receivers in the network of FIG. 13 are prevented from erroneously identifying carrier signals whose frequencies have not yet stabilized.

Table 1 is attached which consists of four pages labeled Table 1(1), Table 1(2), Table 1(3) and Table 1(4).

Although a specific embodiment of the invention has been disclosed, it would be understood by those having skill in the art that changes can be made to that specific embodiment without departing from the spirit and the scope of the invention.

**United States Patent** | ***4,343,301***
**Indech** | **August 10, 1982**

# Subcutaneous neural stimulation or local tissue destruction


**Abstract**

A method of generating a high energy density at any point in the body, noninvasively, by two high frequency sonic beams creating a low frequency beating pattern at their intersection locus. One method provides for two transducers at different angular positions. Each transducer produces a beam pattern of high frequency. One transducer produces a high frequency which is higher by a predetermined quantity than the other. At their point of intersection, the sonic oscillations add and subtract, producing a low frequency beat equal to the predetermined quantity. This high energy low frequency beat can be used to stimulate neural points in the skull or other parts of the body or for tissue destruction. In a related method, the high frequency beams are set in axial alignment so that the frequency generating output is fixed between the transducers. A master modulator can then be used to electronically vary the position of the intersecting locus along the axial line connecting the transducers.



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|---|---|
| **Current U.S. Class:** | **601/3** |
| **Intern'l Class:** | A61H 023/00; A61H 039/00 |
| **Field of Search:** | 128/420 A,24 A,24 R,663,660,32,33,24 A |



**References Cited [Referenced By]**

**U.S. Patent Documents**

| | | | |
|---|---|---|---|
| 2968302 | Jan., 1961 | Fry et al. | 128/24. |
| 3499437 | Mar., 1970 | Balamuth | 128/24. |
| 3987673 | Oct., 1976 | Hansen | 128/663. |
| 4023574 | May., 1977 | Nemec | 128/420. |
| 4105024 | Aug., 1978 | Raffel | 128/33. |
| 4153061 | May., 1979 | Nemec | 128/420. |

**Foreign Patent Documents**

| | | | |
|---|---|---|---|
| 2801796 | Jul., 1979 | DE | 128/804. |
| 624626 | Sep., 1978 | SU | 128/24. |
| 628914 | Oct., 1978 | SU | 128/24. |

**Other References**

Fry et al.; The Use of Ultrasound in Neurosurgery; 3rd International Conference on Medical Electronics, London, 1960.


*Primary Examiner:* Pellegrino; Stephen C.
*Assistant Examiner:* Hanley; John C.

## ***Claims***

I claim:

1. A method of noninvasively stimulating a neuron within a body via a mechanical resonance produced by a low frequency sonic beat comprising the steps of positioning a pair of transducers on the body so that the sonic waves emanating therefrom will intersect, sending a high frequency sonic wave from one transducer, sending a high frequency sonic wave from the other transducer, one of said sonic waves having a slightly higher frequency than the other, whereby a low frequency beat is produced at the intersection of said waves equal to the difference in frequency between said waves, whereby said low frequency beat is sufficient in amplitude to produce an action potential at a neuron situated at said intersection point, and directing said intersection to a predetermined point within the body.

2. The method as in claim 1, wherein the frequency of one of said sonic waves is 1000 Hertz or more and the frequency of the second of said waves is the same as the first plus 100 Hertz or less.

3. The method as in claim 1, wherein said transducers are positioned to direct their sonic waves at an angle of less than 180.degree. to intersect within the body.

4. The method as in claim 3, wherein the frequency of one of said sonic waves is 1000 Hertz or more and the frequency of the second of said waves is the same as the first plus 100 Hertz or less.

5. The method as in claim 1, wherein the point of positioning of the low frequency beat may be varied within the body.

6. The method as in claim 5, wherein said transducers are in opposed position to produce sonic beams along an axial line between them, the position of said low frequency beat being variable along said axial line.

7. The method as in claim 6, wherein the frequency of one of said sonic waves is 1000 Hertz or more and the frequency of the second of said waves is the same as the first plus 100 Hertz or less.

## ***Description***

### BACKGROUND OF THE INVENTION

It has been determined that high frequency sound waves can be used to affect human tissue and stimulate nerves. Further, a high energy low frequency wave produces a more positive marked effect by periodic pressure changes, particle acceleration, etc. If it is possible to pinpoint and aim such a high energy low frequency wave to a single point in the body, many advantages would flow. Such a method will allow for a form of noninvasive neurosurgery, or stimulation of the spinal cord for pain elimination or message transmission noninvasively. It can stimulate regional centres of the brain for artificial vision, artificial hearing, or pleasure responses. It can also be used to destroy tumors, clots, etc. through local heating.

### SUMMARY OF THE INVENTION

The present invention provides a method and means for producing the desired low frequency high energy beam at a point within the body without invasion of the body. One method provides for two transducers at different angular points outside of the body. Each produces a high frequency beam, one being slightly higher than the other by a predetermined quantity. At their point of intersection, the sonic oscillations add and subtract producing a low frequency high energy beat equal to the predetermined quantity. In a related method, the high frequencies are set in axial alignment so that the frequency generating output is fixed between the transducers. A modulator can then be used to electronically vary the timing so that the position of the intersecting locus along the axial line can be varied.

## DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a diagrammatic view of a single locus, dual cell device of the present invention; and

FIG. 2 is a diagrammatic view of a multi-locus, dual cell device.

## DESCRIPTION OF THE INVENTION

The basic method of applying a high energy low frequency beat to a predetermined point within the body is illustrated in FIG. 1. A pair of transducers 10 and 12 are positioned about a human skull 14 to produce high frequency beams which intersect at the point 16 within the skull 14.

The transducer 10 is actuated by a frequency generator 18 which is in turn controlled by the amplitude modulator 20. The transducer 12 is actuated by a frequency generator 22 also controlled through the amplitude modulator 20. The transducer 10 produces a high frequency beam f1, which, for example, can be in the range of 1000 Hertz or more. The transducer 12 provides a high frequency beam f1+.DELTA.f in which the value of .DELTA.f may equal 100 Hertz or less.

With the above arrangement and values, it will be found that a high energy low frequency beat, equivalent to the value of .DELTA.f, is produced at the point of intersection 16, the high frequencies f1 continuing in diverging lines through the skull. In effect, the sonic oscillations are of themselves of sufficiently high frequency to pass through without affecting the body while producing the low frequency high energy beat at the point of intersection 16. The transducer output may be mechanically coupled to the scalp by any conventional gel coupling agent 23.

The advantages of this method are many. It will allow a form of noninvasive surgery. It will stimulate the spinal cord for pain elimination or message transmission noninvasively. It can stimulate regional centres of the brain to produce artificial vision or hearing or for pleasure responses. It can be used to destroy tumors, blood clots, etc. through local heating.

The method used in FIG. 1 pinpoints the locus at a predetermined point of intersection. FIG. 2 illustrates a method of varying the locus within the body. In this form, the transducers are positioned on opposite sides of the skull 24. The transducers 26 and 28 face each other in axial alignment to produce high frequency beams 30.

Where the transducer 26 produces a high frequency wave f1+.DELTA.f, and the transducer 28 produces a high frequency wave f1, a high energy low frequency beat equal to .DELTA.f is produced along the beams 30 at a time-space intersection 32, as well as a high frequency beat f1+f1+.DELTA.f. The position of the point 32 along the axis of the beam 30 can be varied by varying the timing of the wave lengths of the transducers. This allows the low frequency beat to be moved along the beam 30.

The electronic connections are simple. The transducer 26 is actuated through an amplifier 34 and amplitude modulator 36. The modulator 36 is connected to an oscillator 38 for the f1+.DELTA.f frequency which passes through an analog switch 40 to the amplifier 34. A master timer 42 controls the switch 40.

At the transducer 28, the oscillator 44 is connected to the analog switch 46 which is also controlled by the master timer 42. The analog switch 46 connects to the amplifier 48 controlled by the modulator 36 and connected to the transducer 28. Thus, by varying the master timer, the locus of the low frequency beat can be varied along the axis of the beam 30. Further, the locus of the low frequency beat may be varied to transfer information to the brain by external information input 52 to the master modulator 36.

In both methods, a pair of high frequency sound waves are caused to intersect at the point of operation to produce a low frequency high energy beat. In both cases this is accomplished by allowing the high frequencies to internally heterodyne and leave the low frequency which has been added to one of the waves. In one case the phenomenon is directed to a single fixed point. In the second method, the point of operation can be moved along a fixed line.

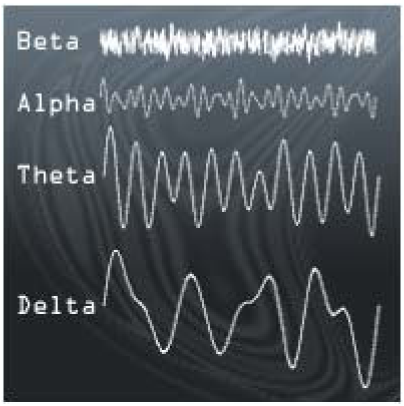
Thus, the present method allows for the internal imposition of a low frequency high energy beat without the invasion of the corpus. The technique is simple and easy and should result in a great deal of accuracy regarding the positioning of the beat. This method can also be applied to any device in which it is desired to produce a low frequency high energy beat or heat at a predetermined point in the device without invasion. Other advantages of the present invention will be readily apparent to a person skilled in the art.

## Light and Sound Stimulation

### The Brain Waves

Brain research took a big step forward when "brain waves" were discovered in 1929 by the German doctor Hans Berger. Brain waves are measured via an electroenzephalogram (EEG) at the scalp. Each of the countless electrochemical discharges of the nerve cells inside the brain produce a minute electromagnetic field with a frequency between 1 and 30 hz (oscillations per second). The sum of these electrical activities results in so-called brain waves.

One differentiates between four groups of brain waves, the Beta, Alpha, Theta and Delta waves. Different brain waves may occur in different brain areas simultaneously, thus changing the wave pattern second by second.




**Beta (30-13 Hz)**
Attentive and alert state of mind. A high concentration of Beta waves is related to an increased production of stress hormones. Attention is focused outwardly. In extreme cases they mark anxiety, worry and sudden fear.

**Alpha (12-8 Hz)**
These waves are dominant during relaxation, quietly flowing thoughts, a positive attitude (Alpha state). It is the preferred state for "Superlearning".

**Theta (7-4 Hz)**
These waves occur during sleep and deep meditation. They mark the ability for vivid visual imagination, sudden creativity, as well as an increased ability to learn and memorize.

**Delta (1-3 Hz)**
They accompany a dreamless, deep sleep. These waves are of great importance for the healing process and the functioning of the immune system.

# Opti-Acoustic Systems

Smythies, J. R. (1959). "The Stroboscopic Patterns." Brit. J. Psychol., (1959), 50, 106-116 (a) 305-324 (b) und Brit. J. Psychol. (1960), 51, 3, 247-255 (c)
Oster, G. (1973) "Auditory beats in the brain." Scientific American, 229, 94-102
Atwater, F. H. (1988): "The Monroe Institute´s Hemisync process: A Theoretical Perspective." Faber, Va: Monroe Institute
Hobson, J. A. (1990) "Schlaf: Gehirnaktivität im Ruhezustand" Spektrum der Wissenschaft" Heidelberg S. 90-91; Eine Aktivierungstheorie der Hirnentwicklung
Brauchli, Peter (1993). "Vergleichsuntersuhung der psychophysiologischen Entspannungseffekte einer optisch-akustischen Mind Machine mit einer Entspannungsmusik" In Zeitschrift für experimentelle und angewandte Psychologie 1993, Band XL, Heft 2, S. 179-193
Brauchli, Peter (1994). "Electrocortical, autonomic, and subjective responses to rhytmic audio-visual stimulation" In International Journal of Psychophysiology 19 (1995) 53-66
Landeck, Klaus-Jürgen (1994). "Einschalten zum Abschalten" In RAABE Fachverlag für Wissenschaftsinformation (Hrsg.): Handbuch Hochschullehre, Bonn 1996
Schenk, Christoph (1989) "Biofeedback. Grundlagen zum Verständnis, zur Indikation, Durchfürung und Wirkungsweise der Biofeedbacktherapie" Perimed Band 12
Zeier, Hans (1997) "Biofeedback. Physiologishe Grundlagen - Anwendungen in der Psychotherapie" Verlag Hans-Huber

# Scientific Method :

A **scientific method** or **process** is considered fundamental to the scientific investigation and acquisition of new knowledge based upon physical evidence. Scientists use observations, hypotheses and deductions to propose explanations for natural phenomena in the form of theories. Predictions from these theories are tested by experiment. If a prediction turns out to be correct, the theory survives. Any theory which is cogent enough to make predictions can then be tested reproducibly in this way. The method is commonly taken as the underlying logic of scientific practice. A scientific method is essentially an extremely cautious means of building a supportable, evidence-based understanding of our natural world.

# A Review of B. F. Skinner's Verbal Behavior

by Noam Chomsky
"A Review of B. F. Skinner's *Verbal Behavior*" in Language, 35, No. 1 (1959), 26-58.

## Preface

Preface to the 1967 reprint of "A Review of Skinner's *Verbal Behavior*"
Appeared in *Readings in the Psychology of Language*, ed. Leon A. Jakobovits and Murray S. Miron (Prentice-Hall, Inc., 1967), pp.142-143
by Noam Chomsky

Rereading this review after eight years, I find little of substance that I would change if I were to write it today. I am not aware of any theoretical or experimental work that challenges its conclusions; nor, so far as I know, has there been any attempt to meet the criticisms that are raised in the review or to show that they are erroneous or ill-founded.

I had intended this review not specifically as a criticism of Skinner's speculations regarding language, but rather as a more general critique of behaviorist (I would now prefer to say "empiricist") speculation as to the nature of higher mental processes. My reason for discussing Skinner's book in such detail was that it was the most careful and thoroughgoing presentation of such speculations, an evaluation that I feel is still accurate. Therefore, if the conclusions I attempted to substantiate in the review are correct, as I believe they are, then Skinner's work can be regarded as, in effect, a *reductio ad absurdum* of behaviorist assumptions. My personal view is that it is a definite merit, not a defect, of Skinner's work that it can be used for this purpose, and it was for this reason that I tried to deal with it fairly exhaustively. I do not see how his proposals can be improved upon, aside from occasional details and oversights, within the framework of the general assumptions that he accepts. I do not, in other words, see any way in which his proposals can be substantially improved within the general framework of behaviorist or neobehaviorist, or, more generally, empiricist ideas that has dominated much of modern linguistics, psychology, and philosophy. The conclusion that I hoped to establish in the review, by discussing these speculations in their most explicit and detailed form, was that the general point of view was largely mythology, and that its widespread acceptance is not the result of empirical support, persuasive reasoning, or the absence of a plausible alternative.

If I were writing today on the same topic, I would try to make it more clear than I did that I was discussing Skinner's proposals as a paradigm example of a futile tendency in modern speculation about language and mind. I would also be somewhat less apologetic and hesitant about proposing the alternative view sketched in Sections 5 and 11 -- and also less ahistorical in proposing this alternative, since in fact it embodies assumptions that are not only plausible and relatively well-confirmed, so it appears to me, but also deeply rooted in a rich and largely forgotten tradition of rationalist psychology and linguistics. I have tried to correct this imbalance in later publications (Chomsky, 1962, 1964, 1966; see also Miller *et al.*, 1960; Katz and Postal, 1964; Fodor, 1965; Lenneberg, 1966).

I think it would also have been valuable to try to sketch some of the reasons -- and there were many -- that have made the view I was criticizing seem plausible over a long period, and also to discuss the reasons for the decline of the alternative rationalist conception which, I was suggesting, should be rehabilitated. Such a discussion would, perhaps, have helped to place the specific critique of Skinner in a more meaningful context.

# References in the Preface

Chomsky, N., "Explanatory Models in Linguistics," in *Logic, Methodology and Philosophy of Science*, ed. E. Nagel, P. Suppes, and A. Tarski. Stanford; Calif.: Stanford University Press, 1962.
----------, Current Issues in Linguistic Theory. The Hague: Mouton and Co., 1964.
----------, Cartesian Linguistics. New York: Harper and Row, Publishers, 1966.
Fodor, J., "Could Meaning Be an 'rm'," Journal of Verbal Learning and Verbal Behavior, 4 (1965), 73-81.
Katz, J. and P. Postal, An Integrated Theory of Linguistic Description. Cambridge, Mass: M.I.T. Press, 1964.
Lenneberg, E., Biological Bases of Language. (In press.)
Miller, G. A., E. Galanter, and K. H. Pribram, Plans and the Structure of Behavior. New York: Holt, Rhinehart, and Winston, Inc., 1960.

## 1959 review:

I

A great many linguists and philosophers concerned with language have expressed the hope that their studies might ultimately be embedded in a framework provided by behaviorist psychology, and that refractory areas of investigation, particularly those in which meaning is involved, will in this way be opened up to fruitful exploration. Since this volume is the first large-scale attempt to incorporate the major aspects of linguistic behavior within a behaviorist framework, it merits and will undoubtedly receive careful attention. Skinner is noted for his contributions to the study of animal behavior. The book under review is the product of study of linguistic behavior extending over more than twenty years. Earlier versions of it have been fairly widely circulated, and there are quite a few references in the psychological literature to its major ideas.

The problem to which this book is addressed is that of giving a "functional analysis" of verbal behavior. By functional analysis, Skinner means identification of the variables that control this behavior and specification of how they interact to determine a particular verbal response. Furthermore, the controlling variables are to be described completely in terms of such notions as *stimulus*, *reinforcement*, *deprivation*, which have been given a reasonably clear meaning in animal experimentation. In other words, the goal of the book is to provide a way to predict and control verbal behavior by observing and manipulating the physical environment of the speaker.

Skinner feels that recent advances in the laboratory study of animal behavior permit us to approach this problem with a certain optimism, since "the basic processes and relations which give verbal behavior its special characteristics are now fairly well understood ... the results [of this experimental work] have been surprisingly free of species restrictions. Recent work has shown that the methods can be extended to human behavior without serious modification" (3).1

It is important to see clearly just what it is in Skinner's program and claims that makes them appear so bold and remarkable, It is not primarily the fact that he has set functional analysis as his problem, or that he limits himself to study of *observables*, i.e., input-output relations. What is so surprising is the particular limitations he has imposed on the way in which the observables of behavior are to be studied, and, above all, the particularly simple nature of the *function* which, he claims, describes the causation of behavior. One would naturally expect that prediction of the behavior of a complex organism (or machine) would require, in addition to information about external stimulation, knowledge of the internal structure of the organism, the ways in which it processes input information and organizes its own behavior. These characteristics of the organism are in general a complicated product of inborn structure, the genetically determined course of maturation, and past experience. Insofar as independent neurophysiological evidence is not available, it is obvious that inferences concerning the structure of the organism are based on observation of behavior and outside events. Nevertheless, one's estimate of the relative importance of external factors and internal structure in the determination of behavior will have an important effect on the direction of research on linguistic (or any other) behavior, and on the kinds of analogies from animal behavior studies that will be considered relevant or suggestive.

Putting it differently, anyone who sets himself the problem of analyzing the causation of behavior will (in the absence of independent neurophysiological evidence) concern himself with the only data available, namely the record of inputs to the organism and the organism's present response, and will try to describe the function specifying the response in terms of the history of inputs. This is nothing more than the definition of his problem. There are no possible grounds for argument here, if one accepts the problem as legitimate, though Skinner has often advanced and defended this definition of a problem as if it were a thesis which other investigators reject. The differences that arise between those who affirm and those who deny the importance of the specific "contribution of the organism" to learning and performance concern the particular character and complexity of this function, and the kinds of observations and research necessary for arriving at a precise specification of it. If the contribution of the organism is complex, the only hope of predicting behavior even in a gross way will be through a very indirect program of research that begins by studying the detailed character of the behavior itself and the particular capacities of the organism involved.

Skinner's thesis is that external factors consisting of present stimulation and the history of reinforcement (in particular, the frequency, arrangement, and withholding of reinforcing stimuli) are of overwhelming importance, and that the general principles revealed in laboratory studies of these phenomena provide the basis for understanding the complexities of verbal behavior. He confidently and repeatedly voices his claim to have demonstrated that the contribution of the speaker is quite trivial and elementary, and that precise prediction of verbal behavior involves only specification of the few external factors that he has isolated experimentally with lower organisms.

Careful study of this book (and of the research on which it draws) reveals, however, that these astonishing claims are far from justified. It indicates, furthermore, that the insights that have been achieved in the laboratories of the reinforcement theorist, though quite genuine, can be applied to complex human behavior only in the most gross and superficial way, and that speculative attempts to discuss linguistic behavior in these terms alone omit from consideration factors of fundamental importance that are, no doubt, amenable to scientific study, although their specific character cannot at present be precisely formulated. Since Skinner's work is the most extensive attempt to accommodate human behavior involving higher mental faculties within a strict behaviorist schema of the type that has attracted many linguists and philosophers, as well as psychologists, a detailed documentation is of independent interest. The magnitude of the failure of this attempt to account for verbal behavior serves as a kind of measure of the importance of the factors omitted from consideration, and an indication of how little is really known about this remarkably complex phenomenon.

The force of Skinner's argument lies in the enormous wealth and range of examples for which he proposes a functional analysis. The only way to evaluate the success of his program and the correctness of his basic assumptions about verbal behavior is to review these examples in detail and to determine the precise character of the concepts in terms of which the functional analysis is presented. Section 2 of this review describes the experimental context with respect to which these concepts are originally defined. Sections 3 and 4 deal with the basic concepts -- *stimulus*, *response*, and *reinforcement*, Sections 6 to 10 with the new descriptive machinery developed specifically for the description of verbal behavior. In Section 5 we consider the status of the fundamental claim, drawn from the laboratory, which serves as the basis for the analogic guesses about human behavior that have been proposed by many psychologists. The final section (Section 11) will consider some ways in which further linguistic work may play a part in clarifying some of these problems.

II

Although this book makes no direct reference to experimental work, it can be understood only in terms of the general framework that Skinner has developed for the description of behavior. Skinner divides the responses of the animal into two main categories. *Respondents* are purely reflex responses elicited by particular stimuli. *Operants* are emitted responses, for which no obvious stimulus can be discovered. Skinner has been concerned primarily with operant behavior. The experimental arrangement that he introduced consists basically of a box with a bar attached to one wall in such a way that when the bar is pressed, a food pellet is dropped into a tray (and the bar press is recorded). A rat placed in the box will soon press the bar, releasing a pellet into the tray. This state of affairs, resulting from the bar press, increases the *strength* of the bar-pressing operant. The food pellet is called a *reinforcer*; the event, a *reinforcing event*. The strength of an operant is defined by Skinner in terms of the rate of response during extinction (i.e, after the last reinforcement and before return to the pre-conditioning rate).

Suppose that release of the pellet is conditional on the flashing of a light. Then the rat will come to press the bar only when the light flashes. This is called *stimulus discrimination*. The response is called a *discriminated operant* and the light is called the *occasion* for its emission: this is to be distinguished from elicitation of a response by a stimulus in the case of the respondent.[2] Suppose that the apparatus is so arranged that bar-pressing of only a certain character (e.g., duration) will release the pellet. The rat will then come to press the bar in the required way. This process is called *response differentiation*. By successive slight changes in the conditions under which the response will be reinforced, it is possible to shape the response of a rat or a pigeon in very surprising ways in a very short time, so that rather complex behavior can be produced by a process of successive approximation.

A stimulus can become reinforcing by repeated association with an already reinforcing stimulus. Such a stimulus is called a *secondary reinforcer*. Like many contemporary behaviorists, Skinner considers money, approval, and the like to be secondary reinforcers which have become reinforcing because of their association with food, etc.3 Secondary reinforcers can be *generalized* by associating them with a variety of different primary reinforcers.

Another variable that can affect the rate of the bar-pressing operant is *drive*, which Skinner defines operationally in terms of hours of deprivation. His major scientific book, *Behavior of Organisms*, is a study of the effects of food-deprivation and conditioning on the strength of the bar-pressing response of healthy mature rats. Probably Skinner's most original contribution to animal behavior studies has been his investigation of the effects of intermittent reinforcement, arranged in various different ways, presented in *Behavior of Organisms* and extended (with pecking of pigeons as the operant under investigation) in the recent *Schedules of Reinforcement* by Ferster and Skinner (1957). It is apparently these studies that Skinner has in mind when he refers to the recent advances in the study of animal behavior.4

The notions *stimulus*, *response*, *reinforcement* are relatively well defined with respect to the bar-pressing experiments and others similarly restricted. Before we can extend them to real-life behavior, however, certain difficulties must be faced. We must decide, first of all, whether any physical event to which the organism is capable of reacting is to be called a stimulus on a given occasion, or only one to which the organism in fact reacts; and correspondingly, we must decide whether any part of behavior is to be called a response, or only one connected with stimuli in lawful ways. Questions of this sort pose something of a dilemma for the experimental psychologist. If he accepts the broad definitions, characterizing any physical event impinging on the organism as a stimulus and any part of the organism's behavior as a response, he must conclude that behavior has not been demonstrated to be lawful. In the present state of our knowledge, we must attribute an overwhelming influence on actual behavior to ill-defined factors of attention, set, volition, and caprice. If we accept the narrower definitions, then behavior is lawful by definition (if it consists of responses); but this fact is of limited significance, since most of what the animal does will simply not be considered behavior. Hence, the psychologist either must admit that behavior is not lawful (or that he cannot at present show that it is -- not at all a damaging admission for a developing science), or must restrict his attention to those highly limited areas in which it is lawful (e.g., with adequate controls, bar-pressing in rats; lawfulness of the observed behavior provides, for Skinner, an implicit definition of a good experiment).

Skinner does not consistently adopt either course. He utilizes the experimental results as evidence for the scientific character of his system of behavior, and analogic guesses (formulated in terms of a metaphoric extension of the technical vocabulary of the laboratory) as evidence for its scope. This creates the illusion of a rigorous scientific theory with a very broad scope, although in fact the terms used in the description of real-life and of laboratory behavior may be mere homonyms, with at most a vague similarity of meaning. To substantiate this evaluation, a critical account of his book must show that with a literal reading (where the terms of the descriptive system have something like the technical meanings given in Skinner's definitions) the book covers almost no aspect of linguistic behavior, and that with a metaphoric reading, it is no more scientific than the traditional approaches to this subject matter, and rarely as clear and careful.5

III

Consider first Skinner's use of the notions *stimulus* and *response*. In *Behavior of Organisms* (9) he commits himself to the narrow definitions for these terms. A part of the environment and a part of behavior are called *stimulus* (eliciting, discriminated, or reinforcing) and *response*, respectively, only if they are lawfully related; that is, if the *dynamic laws* relating them show smooth and reproducible curves. Evidently, stimuli and responses, so defined, have not been shown to figure very widely in ordinary human behavior.6 We can, in the face of presently available evidence, continue to maintain the lawfulness of the relation between stimulus and response only by depriving them of their objective character. A typical example of *stimulus control* for Skinner would be the response to a piece of music with the utterance *Mozart* or to a painting with the response *Dutch*. These responses are asserted to be "under the control of extremely subtle properties" of the physical object or event (108). Suppose instead of saying *Dutch* we had said *Clashes with the wallpaper, I thought you liked abstract work, Never saw it before, Tilted, Hanging too low, Beautiful, Hideous, Remember our camping trip last summer?*, or whatever else might come into our minds when looking at a picture (in Skinnerian translation, whatever other responses exist in sufficient strength). Skinner could only say that each of these responses is under the control of some other stimulus property of the physical object. If we look at a red chair and say *red*, the response is under the control of the stimulus *redness*; if we say *chair*, it is under the control of the collection of properties (for Skinner, the object) *chairness* (110), and similarly for any other response. This device is as simple as it is empty. Since properties are free for the asking (we have as many of them as we have nonsynonymous descriptive expressions in our language, whatever this means exactly), we can account for a wide class of responses in terms of Skinnerian functional analysis by identifying the *controlling stimuli*. But the word *stimulus* has lost all objectivity in this usage. Stimuli are no longer part of the outside physical world; they are driven back into the organism. We identify the stimulus when we hear the response. It is clear from such examples, which abound, that the talk of *stimulus control* simply disguises a complete retreat to mentalistic psychology. We cannot predict verbal behavior in terms of the stimuli in the speaker's environment, since we do not know what the current stimuli are until he responds. Furthermore, since we cannot control the property of a physical object to which an individual will respond, except in highly artificial cases, Skinner's claim that his system, as opposed to the traditional one, permits the practical control of verbal behavior7 is quite false.

Other examples of *stimulus control* merely add to the general mystification. Thus, a proper noun is held to be a response "under the control of a specific person or thing" (as controlling stimulus, 113). I have often used the words *Eisenhower* and *Moscow*, which I presume are proper nouns if anything is, but have never been *stimulated* by the corresponding objects. How can this fact be made compatible with this definition? Suppose that I use the name of a friend who is not present. Is this an instance of a proper noun under the control of the friend as stimulus? Elsewhere it is asserted that a stimulus controls a response in the sense that presence of the stimulus increases the probability of the response. But it is obviously untrue that the probability that a speaker will produce a full name is increased when its bearer faces the speaker. Furthermore, how can one's own name be a proper noun in this sense?

A multitude of similar questions arise immediately. It appears that the word *control* here is merely a misleading paraphrase for the traditional *denote* or *refer*. The assertion (115) that so far as the speaker is concerned, the relation of reference is "simply the probability that the speaker will emit a response of a given form in the presence of a stimulus having specified properties" is surely incorrect if we take the words *presence*, *stimulus*, and *probability* in their literal sense. That they are not intended to be taken literally is indicated by many examples, as when a response is said to be "controlled" by a situation or state of affairs as "stimulus." Thus, the expression *a needle in a haystack* "may be controlled as a unit by a particular type of situation" (116); the words in a single part of speech, e.g., all adjectives, are under the control of a single set of subtle properties of stimuli (121); "the sentence *The boy runs a store* is under the control of an extremely complex stimulus situation" (335) "*He is not at all well* may function as a standard response under the control of a state of affairs which might also control *He is ailing*" (325); when an envoy observes events in a foreign country and reports upon his return, his report is under "remote stimulus control" (416); the statement *This is war* may be a response to a "confusing international situation" (441); the suffix *-ed* is controlled by that "subtle property of stimuli which we speak of as action-in-the-past" (121) just as the *-s* in *The boy runs* is under the control of such specific features of the situation as its "currency" (332). No characterization of the notion *stimulus control* that is remotely related to the bar-pressing experiment (or that preserves the faintest objectivity) can be made to cover a set of examples like these, in which, for example, the controlling stimulus need not even impinge on the responding organism.

Consider now Skinner's use of the notion *response*. The problem of identifying units in verbal behavior has of course been a primary concern of linguists, and it seems very likely that experimental psychologists should be able to provide much-needed assistance in clearing up the many remaining difficulties in systematic identification. Skinner recognizes (20) the fundamental character of the problem of identification of a unit of verbal behavior, but is satisfied with an answer so vague and subjective that it does not really contribute to its solution. The unit of verbal behavior -- the verbal operant -- is defined as a class of responses of identifiable form functionally related to one or more controlling variables. No method is suggested for determining in a particular instance what are the controlling variables, how many such units have occurred, or where their boundaries are in the total response. Nor is any attempt made to specify how much or what kind of similarity in form or control is required for two physical events to be considered instances of the same operant. In short, no answers are suggested for the most elementary questions that must be asked of anyone proposing a method for description of behavior. Skinner is content with what he calls an *extrapolation* of the concept of operant developed in the laboratory to the verbal field. In the typical Skinnerian experiment, the problem of identifying the unit of behavior is not too crucial. It is defined, by fiat, as a recorded peck or bar-press, and systematic variations in the rate of this operant and its resistance to extinction are studied as a function of deprivation and scheduling of reinforcement (pellets). The operant is thus defined with respect to a particular experimental procedure. This is perfectly reasonable and has led to many interesting results. It is, however, completely meaningless to speak of extrapolating this concept of operant to ordinary verbal behavior. Such "extrapolation" leaves us with no way of justifying one or another decision about the units in the "verbal repertoire."

Skinner specifies "response strength" as the basic datum, the basic dependent variable in his functional analysis. In the bar-pressing experiment, response strength is defined in terms of rate of emission during extinction. Skinner has argued8 that this is "the only datum that varies significantly and in the expected direction under conditions which are relevant to the 'learning process.'" In the book under review, response strength is defined as "probability of emission" (22). This definition provides a comforting impression of objectivity, which, however, is quickly dispelled when we look into the matter more closely. The term *probability* has some rather obscure meaning for Skinner in this book.9 We are told, on the one hand, that "our evidence for the contribution of each variable [to response strength] is based on observation of frequencies alone" (28). At the same time, it appears that frequency is a very misleading measure of strength, since, for example, the frequency of a response may be "primarily attributable to the frequency of occurrence of controlling variables" (27). It is not clear how the frequency of a response can be attributable to anything BUT the frequency of occurrence of its controlling variables if we accept Skinner's view that the behavior occurring in a given situation is "fully determined" by the relevant controlling variables (175, 228). Furthermore, although the evidence for the contribution of each variable to response strength is based on observation of frequencies alone, it turns out that "we base the notion of strength upon several kinds of evidence" (22), in particular (22-28): emission of the response (particularly in unusual circumstances), energy level (stress), pitch level, speed and delay of emission, size of letters etc. in writing, immediate repetition, and -- a final factor, relevant but misleading -- over-all frequency.

Of course, Skinner recognizes that these measures do not co-vary, because (among other reasons) pitch, stress, quantity, and reduplication may have internal linguistic functions.10 However, he does not hold these conflicts to be very important, since the proposed factors indicative of strength are "fully understood by everyone" in the culture (27). For example, "if we are shown a prized work of art and exclaim *Beautiful!*, the speed and energy of the response will not be lost on the owner." It does not appear totally obvious that in this case the way to impress the owner is to shriek *Beautiful* in a loud, high-pitched voice, repeatedly, and with no delay (high response strength). It may be equally effective to look at the picture silently (long delay) and then to murmur *Beautiful* in a soft, low-pitched voice (by definition, very low response strength).

It is not unfair, I believe, to conclude from Skinner's discussion of response strength, the *basic datum* in functional analysis, that his *extrapolation* of the notion of probability can best be interpreted as, in effect, nothing more than a decision to use the word *probability*, with its favorable connotations of objectivity, as a cover term to paraphrase such low-status words as *interest*, *intention*, *belief*, and the like. This interpretation is fully justified by the way in which Skinner uses the terms *probability* and *strength*. To cite just one example, Skinner defines the process of confirming an assertion in science as one of "generating additional variables to increase its probability" (425), and more generally, its strength (425-29). If we take this suggestion quite literally, the degree of confirmation of a scientific assertion can be measured as a simple function of the loudness, pitch, and frequency with which it is proclaimed, and a general procedure for increasing its degree of confirmation would be, for instance, to train machine guns on large crowds of people who have been instructed to shout it. A better indication of what Skinner probably has in mind here is given by his description of how the theory of evolution, as an example, is confirmed. This "single set of verbal responses ... is made more plausible -- is strengthened -- by several types of construction based upon verbal responses in geology, paleontology, genetics, and so on" (427). We are no doubt to interpret the terms *strength* and *probability* in this context as paraphrases of more familiar locutions such as "justified belief" or "warranted assertability," or something of the sort. Similar latitude of interpretation is presumably expected when we read that "frequency of effective action accounts in turn for what we may call the listener's 'belief'" (88) or that "our belief in what someone tells us is similarly a function of, or identical with, our tendency to act upon the verbal stimuli which he provides" (160).11

I think it is evident, then, that Skinner's use of the terms *stimulus*, *control*, *response*, and *strength* justify the general conclusion stated in the last paragraph of Section 2. The way in which these terms are brought to bear on the actual data indicates that we must interpret them as mere paraphrases for the popular vocabulary commonly used to describe behavior and as having no particular connection with the homonymous expressions used in the description of laboratory experiments. Naturally, this terminological revision adds no objectivity to the familiar mentalistic mode of description.

IV

The other fundamental notion borrowed from the description of bar-pressing experiments is *reinforcement*. It raises problems which are similar, and even more serious. In *Behavior of Organisms*, "the operation of reinforcement is defined as the presentation of a certain kind of stimulus in a temporal relation with either a stimulus or response. A reinforcing stimulus is defined as such by its power to produce the resulting change [in strength]. There is no circularity about this: some stimuli are found to produce the change, others not, and they are classified as reinforcing and nonreinforcing accordingly" (62). This is a perfectly appropriate definition12 for the study of schedules of reinforcement. It is perfectly useless, however, in the discussion of real-life behavior, unless we can somehow characterize the stimuli which are reinforcing (and the situations and conditions under which they are reinforcing). Consider first of all the status of the basic principle that Skinner calls the "law of conditioning" (law of effect). It reads: "if the occurrence of an operant is followed by presence of a reinforcing stimulus, the strength is increased" (*Behavior of Organisms*, 21). As *reinforcement* was defined, this law becomes a tautology.13 For Skinner, learning is just change in response strength.14 Although the statement that presence of reinforcement is a sufficient condition for learning and maintenance of behavior is vacuous, the claim that it is a necessary condition may have some content, depending on how the class of reinforcers (and appropriate situations) is characterized. Skinner does make it very clear that in his view reinforcement is a necessary condition for language learning and for the continued availability of linguistic responses in the adult.15 However, the looseness of the term *reinforcement* as Skinner uses it in the book under review makes it entirely pointless to inquire into the truth or falsity of this claim. Examining the instances of what Skinner calls *reinforcement*, we find that not even the requirement that a reinforcer be an identifiable stimulus is taken seriously. In fact, the term is used in such a way that the assertion that reinforcement is necessary for learning and continued availability of behavior is likewise empty.

To show this, we consider some examples of *reinforcement*. First of all, we find a heavy appeal to automatic self-reinforcement, Thus, "a man talks to himself... because of the reinforcement he receives" (163); "the child is reinforced automatically when he duplicates the sounds of airplanes, streetcars ..." (164); "the young child alone in the nursery may automatically reinforce his own exploratory verbal behavior when he produces sounds which he has heard in the speech of others" (58); "the speaker who is also an accomplished listener 'knows when he has correctly echoed a response' and is reinforced thereby" (68); thinking is "behaving which automatically affects the behaver and is reinforcing because it does so" (438; cutting one's finger should thus be reinforcing, and an example of thinking); "the verbal fantasy, whether overt or covert, is automatically reinforcing to the speaker as listener. Just as the musician plays or composes what he is reinforced by hearing, or as the artist paints what reinforces him visually, so the speaker engaged in verbal fantasy says what he is reinforced by hearing or writes what he is reinforced by reading" (439); similarly, care in problem solving, and rationalization, are automatically self-reinforcing (442-43). We can also reinforce someone by emitting verbal behavior as such (since this rules out a class of aversive stimulations, 167), by not emitting verbal behavior (keeping silent and paying attention, 199), or by acting appropriately on some future occasion (152: "the strength of [the speaker's] behavior is determined mainly by the behavior which the listener will exhibit with respect to a given state of affairs"; this Skinner considers the general case of "communication" or "letting the listener know"). In most such cases, of course, the speaker is not present at the time when the reinforcement takes place, as when "the artist...is reinforced by the effects his works have upon... others" (224), or when the writer is reinforced by the fact that his "verbal behavior may reach over centuries or to thousands of listeners or readers at the same time. The writer may not be reinforced often or immediately, but his net reinforcement may be great" (206; this accounts for the great "strength" of his behavior). An individual may also find it reinforcing to injure someone by criticism or by bringing bad news, or to publish an experimental result which upsets the theory of a rival (154), to describe circumstances which would be reinforcing if they were to occur (165), to avoid repetition (222), to "hear" his own name though in fact it was not mentioned or to hear nonexistent words in his child's babbling (259), to clarify or otherwise intensify the effect of a stimulus which serves an important discriminative function (416), and so on.

From this sample, it can be seen that the notion of reinforcement has totally lost whatever objective meaning it may ever have had. Running through these examples, we see that a person can be reinforced though he emits no response at all, and that the reinforcing *stimulus* need not impinge on the *reinforced person* or need not even exist (it is sufficient that it be imagined or hoped for). When we read that a person plays what music he likes (165), says what he likes (165), thinks what he likes (438-39), reads what books he likes (163), etc., BECAUSE he finds it reinforcing to do so, or that we write books or inform others of facts BECAUSE we are reinforced by what we hope will be the ultimate behavior of reader or listener, we can only conclude that the term *reinforcement* has a purely ritual function. The phrase "X is reinforced by Y (stimulus, state of affairs, event, etc.)" is being used as a cover term for "X wants Y," "X likes Y," "X wishes that Y were the case," etc. Invoking the term *reinforcement* has no explanatory force, and any idea that this paraphrase introduces any new clarity or objectivity into the description of wishing, liking, etc., is a serious delusion. The only effect is to obscure the important differences among the notions being paraphrased. Once we recognize the latitude with which the term *reinforcement* is being used, many rather startling comments lose their initial effect -- for instance, that the behavior of the creative artist is "controlled entirely by the contingencies of reinforcement" (150). What has been hoped for from the psychologist is some indication how the casual and informal description of everyday behavior in the popular vocabulary can be explained or clarified in terms of the notions developed in careful experiment and observation, or perhaps replaced in terms of a better scheme. A mere terminological revision, in which a term borrowed from the laboratory is used with the full vagueness of the ordinary vocabulary, is of no conceivable interest.

It seems that Skinner's claim that all verbal behavior is acquired and maintained in "strength" through reinforcement is quite empty, because his notion of reinforcement has no clear content, functioning only as a cover term for any factor, detectable or not, related to acquisition or maintenance of verbal behavior.16 Skinner's use of the term *conditioning* suffers from a similar difficulty. Pavlovian and operant conditioning are processes about which psychologists have developed real understanding. Instruction of human beings is not. The claim that instruction and imparting of information are simply matters of conditioning (357-66) is pointless. The claim is true, if we extend the term *conditioning* to cover these processes, but we know no more about them after having revised this term in such a way as to deprive it of its relatively clear and objective character. It is, as far as we know, quite false, if we use *conditioning* in its literal sense. Similarly, when we say that "it is the function of predication to facilitate the transfer of response from one term to another or from one object to another" (361), we have said nothing of any significance. In what sense is this true of the predication *Whales are mammals*? Or, to take Skinner's example, what point is there in saying that the effect of *The telephone is out of order* on the listener is to bring behavior formerly controlled by the stimulus *out of order* under control of the stimulus *telephone* (or the telephone itself) by a process of simple conditioning (362)? What laws of conditioning hold in this case? Furthermore, what behavior is controlled by the stimulus *out of order*, in the abstract? Depending on the object of which this is predicated, the present state of motivation of the listener, etc., the behavior may vary from rage to pleasure, from fixing the object to throwing it out, from simply not using it to trying to use it in the normal way (e.g., to see if it is really out of order), and so on. To speak of "conditioning" or "bringing previously available behavior under control of a new stimulus" in such a case is just a kind of play-acting at science (cf. also 43n).

V

The claim that careful arrangement of contingencies of reinforcement by the verbal community is a necessary condition for language-learning has appeared, in one form or another, in many places.17 Since it is based not on actual observation, but on analogies to laboratory study of lower organisms, it is important to determine the status of the underlying assertion within experimental psychology proper. The most common characterization of reinforcement (one which Skinner explicitly rejects, incidentally) is in terms of drive reduction. This characterization can be given substance by defining drives in some way independently of what in fact is learned. If a drive is postulated on the basis of the fact that learning takes place, the claim that reinforcement is necessary for learning will again become as empty as it is in the Skinnerian framework. There is an extensive literature on the question of whether there can be learning without drive reduction (latent learning). The "classical" experiment of Blodgett indicated that rats who had explored a maze without reward showed a marked drop in number of errors (as compared to a control group which had not explored the maze) upon introduction of a food reward, indicating that the rat had learned the structure of the maze without reduction of the hunger drive. Drive-reduction theorists countered with an exploratory drive which was reduced during the pre-reward learning, and claimed that a slight decrement in errors could be noted before food reward. A wide variety of experiments, with somewhat conflicting results, have been carried out with a similar design.[18] Few investigators still doubt the existence of the phenomenon, E. R. Hilgard, in his general review of learning theory,[19] concludes that "there is no longer any doubt but that, under appropriate circumstances, latent learning is demonstrable."

More recent work has shown that novelty and variety of stimulus are sufficient to arouse curiosity in the rat and to motivate it to explore (visually), and in fact, to learn (since on a presentation of two stimuli, one novel, one repeated, the rat will attend to the novel one),[20] that rats will learn to choose the arm of a single-choice maze that leads to a complex maze, running through this being their only "reward";[21] that monkeys can learn object discriminations and maintain their performance at a high level of efficiency with visual exploration (looking out of a window for 30 seconds) as the only reward[22] and, perhaps most strikingly of all, that monkeys and apes will solve rather complex manipulation problems that are simply placed in their cages, and will solve discrimination problems with only exploration and manipulation as incentives.[23] In these cases, solving the problem is apparently its own "reward." Results of this kind can be handled by reinforcement theorists only if they are willing to set up curiosity, exploration, and manipulation drives, or to speculate somehow about acquired drives[24] for which there is no evidence outside of the fact that learning takes place in these cases.

There is a variety of other kinds of evidence that has been offered to challenge the view that drive reduction is necessary for learning. Results on sensory-sensory conditioning have been interpreted as demonstrating learning without drive reduction.[25] Olds has reported reinforcement by direct stimulation of the brain, from which he concludes that reward need not satisfy a physiological need or withdraw a drive stimulus.[26] The phenomenon of imprinting, long observed by zoologists, is of particular interest in this connection. Some of the most complex patterns of behavior of birds, in particular, are directed towards objects and animals of the type to which they have been exposed at certain critical early periods of life.[27] Imprinting is the most striking evidence for the innate disposition of the animal to learn in a certain direction and to react appropriately to patterns and objects of certain restricted types, often only long after the original learning has taken place. It is, consequently, unrewarded learning, though the resulting patterns of behavior may be refined through reinforcement. Acquisition of the typical songs of song birds is, in some cases, a type of imprinting. Thorpe reports studies that show "that some characteristics of the normal song have been learned in the earliest youth, before the bird itself is able to produce any kind of full song."[28] The phenomenon of imprinting has recently been investigated under laboratory conditions and controls with positive results.[29]

Phenomena of this general type are certainly familiar from everyday experience. We recognize people and places to which we have given no particular attention. We can look up something in a book and learn it perfectly well with no other motive than to confute reinforcement theory, or out of boredom, or idle curiosity. Everyone engaged in research must have had the experience of working with feverish and prolonged intensity to write a paper which no one else will read or to solve a problem which no one else thinks important and which will bring no conceivable reward -- which may only confirm a general opinion that the researcher is wasting his time on irrelevancies. The fact that rats and monkeys do likewise is interesting and important to show in careful experiment. In fact, studies of behavior of the type mentioned above have an independent and positive significance that far outweighs their incidental importance in bringing into question the claim that learning is impossible without drive reduction. It is not at all unlikely that insights arising from animal behavior studies with this broadened scope may have the kind of relevance to such complex activities as verbal behavior that reinforcement theory has, so far, failed to exhibit. In any event, in the light of presently available evidence, it is difficult to see how anyone can be willing to claim that reinforcement is necessary for learning, if reinforcement is taken seriously as something identifiable independently of the resulting change in behavior.

Similarly, it seems quite beyond question that children acquire a good deal of their verbal and nonverbal behavior by casual observation and imitation of adults and other children.[30] It is simply not true that children can learn language only through "meticulous care" on the part of adults who shape their verbal repertoire through careful differential reinforcement, though it may be that such care is often the custom in academic families. It is a common observation that a young child of immigrant parents may learn a second language in the streets, from other children, with amazing rapidity, and that his speech may be completely fluent and correct to the last allophone, while the subtleties that become second nature to the child may elude his parents despite high motivation and continued practice. A child may pick up a large part of his vocabulary and "feel" for sentence structure from television, from reading, from listening to adults, etc. Even a very young child who has not yet acquired a minimal repertoire from which to form new utterances may imitate a word quite well on an early try, with no attempt on the part of his parents to teach it to him. It is also perfectly obvious that, at a later stage, a child will be able to construct and understand utterances which are quite new, and are, at the same time, acceptable sentences in his language. Every time an adult reads a newspaper, he undoubtedly comes upon countless new sentences which are not at all similar, in a simple, physical sense, to any that he has heard before, and which he will recognize as sentences and understand; he will also be able to detect slight distortions or misprints. Talk of "stimulus generalization" in such a case simply perpetuates the mystery under a new title. These abilities indicate that there must be fundamental processes at work quite independently of "feedback" from the environment. I have been able to find no support whatsoever for the doctrine of Skinner and others that slow and careful shaping of verbal behavior through differential reinforcement is an absolute necessity. If reinforcement theory really requires the assumption that there be such meticulous care, it seems best to regard this simply as a *reductio ad absurdum* argument against this approach. It is also not easy to find any basis (or, for that matter, to attach very much content) to the claim that reinforcing contingencies set up by the verbal community are the single factor responsible for maintaining the strength of verbal behavior. The sources of the "strength" of this behavior are almost a total mystery at present. Reinforcement undoubtedly plays a significant role, but so do a variety of motivational factors about which nothing serious is known in the case of human beings.

As far as acquisition of language is concerned, it seems clear that reinforcement, casual observation, and natural inquisitiveness (coupled with a strong tendency to imitate) are important factors, as is the remarkable capacity of the child to generalize, hypothesize, and "process information" in a variety of very special and apparently highly complex ways which we cannot yet describe or begin to understand, and which may be largely innate, or may develop through some sort of learning or through maturation of the nervous system. The manner in which such factors operate and interact in language acquisition is completely unknown. It is clear that what is necessary in such a case is research, not dogmatic and perfectly arbitrary claims, based on analogies to that small part of the experimental literature in which one happens to be interested.

The pointlessness of these claims becomes clear when we consider the well-known difficulties in determining to what extent inborn structure, maturation, and learning are responsible for the particular form of a skilled or complex performance.[31] To take just one example,[32] the gaping response of a nestling thrush is at first released by jarring of the nest, and, at a later stage, by a moving object of specific size, shape, and position relative to the nestling. At this later stage the response is directed toward the part of the stimulus object corresponding to the parent's head, and characterized by a complex configuration of stimuli that can be precisely described. Knowing just this, it would be possible to construct a speculative, learning-theoretic account of how this sequence of behavior patterns might have developed through a process of differential reinforcement, and it would no doubt be possible to train rats to do something similar. However, there appears to be good evidence that these responses to fairly complex "sign stimuli" are genetically determined and mature without learning. Clearly, the possibility cannot be discounted. Consider now the comparable case of a child imitating new words. At an early stage we may find rather gross correspondences. At a later stage, we find that repetition is of course far from exact (i.e., it is not mimicry, a fact which itself is interesting), but that it reproduces the highly complex configuration of sound features that constitute the phonological structure of the language in question. Again, we can propose a speculative account of how this result might have been obtained through elaborate arrangement of reinforcing contingencies. Here too, however, it is possible that ability to select out of the complex auditory input those features that are phonologically relevant may develop largely independently of reinforcement, through genetically determined maturation. To the extent that this is true, an account of the development and causation of behavior that fails to consider the structure of the organism will provide no understanding of the real processes involved.

It is often argued that experience, rather than innate capacity to handle information in certain specific ways, must be the factor of overwhelming dominance in determining the specific character of language acquisition, since a child speaks the language of the group in which he lives. But this is a superficial argument. As long as we are speculating, we may consider the possibility that the brain has evolved to the point where, given an input of observed Chinese sentences, it produces (by an *induction* of apparently fantastic complexity and suddenness) the *rules* of Chinese grammar, and given an input of observed English sentences, it produces (by, perhaps, exactly the same process of induction) the rules of English grammar; or that given an observed application of a term to certain instances, it automatically predicts the extension to a class of complexly related instances. If clearly recognized as such, this speculation is neither unreasonable nor fantastic; nor, for that matter, is it beyond the bounds of possible study. There is of course no known neural structure capable of performing this task in the specific ways that observation of the resulting behavior might lead us to postulate; but for that matter, the structures capable of accounting for even the simplest kinds of learning have similarly defied detection.33 Summarizing this brief discussion, it seems that there is neither empirical evidence nor any known argument to support any specific claim about the relative importance of "feedback" from the environment and the "independent contribution of the organism" in the process of language acquisition.

VI

We now turn to the system that Skinner develops specifically for the description of verbal behavior. Since this system is based on the notions *stimulus*, *response*, and *reinforcement*, we can conclude from the preceding sections that it will be vague and arbitrary. For reasons noted in Section 1, however, I think it is important to see in detail how far from the mark any analysis phrased solely in these terms must be and how completely this system fails to account for the facts of verbal behavior. Consider first the term *verbal behavior* itself. This is defined as "behavior reinforced through the mediation of other persons" (2). The definition is clearly much too broad. It would include as verbal behavior, for example, a rat pressing the bar in a Skinner-box, a child brushing his teeth, a boxer retreating before an opponent, and a mechanic repairing an automobile. Exactly how much of ordinary linguistic behavior is *verbal* in this sense, however, is something of a question: perhaps, as I have pointed out above, a fairly small fraction of it, if any substantive meaning is assigned to the term *reinforced*. This definition is subsequently refined by the additional provision that the mediating response of the reinforcing person (the *listener*) must itself "have been conditioned *precisely in order to reinforce* the behavior of the speaker" (225, italics his). This still covers the examples given above, if we can assume that the reinforcing behavior of the psychologist, the parent, the opposing boxer, and the paying customer are the result of appropriate training, which is perhaps not unreasonable. A significant part of the fragment of linguistic behavior covered by the earlier definition will no doubt be excluded by the refinement, however. Suppose, for example, that while crossing the street I hear someone shout *Watch out for the car* and jump out of the way. It can hardly be proposed that my jumping (the mediating, reinforcing response in Skinner's usage) was conditioned (that is, I was trained to jump) precisely in order to reinforce the behavior of the speaker; and similarly, for a wide class of cases. Skinner's assertion that with this refined definition "we narrow our subject to what is traditionally recognized as the verbal field" (225) appears to be grossly in error.

VII

Verbal operants are classified by Skinner in terms of their "functional" relation to discriminated stimulus, reinforcement, and other verbal responses. A *mand* is defined as "a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the functional control of relevant conditions of deprivation or aversive stimulation" (35). This is meant to include questions, commands, etc. Each of the terms in this definition raises a host of problems. A mand such as *Pass the salt* is a class of responses. We cannot tell by observing the form of a response whether it belongs to this class (Skinner is very clear about this), but only by identifying the controlling variables. This is generally impossible. Deprivation is defined in the bar-pressing experiment in terms of length of time that the animal has not been fed or permitted to drink. In the present context, however, it is quite a mysterious notion. No attempt is made here to describe a method for determining "relevant conditions of deprivation" independently of the "controlled" response. It is of no help at all to be told (32) that it can be characterized in terms of the operations of the experimenter. If we define deprivation in terms of elapsed time, then at any moment a person is in countless states of deprivation.34 It appears that we must decide that the relevant condition of deprivation was (say) salt-deprivation, on the basis of the fact that the speaker asked for salt (the reinforcing community which "sets up" the mand is in a similar predicament). In this case, the assertion that a mand is under the control of relevant deprivation is empty, and we are (contrary to Skinner's intention) identifying the response as a mand completely in terms of form. The word *relevant* in the definition above conceals some rather serious complications.

In the case of the mand *Pass the salt*, the word *deprivation* is not out of place, though it appears to be of little use for functional analysis. Suppose however that the speaker says *Give me the book*, *Take me for a ride*, or *Let me fix it*. What kinds of deprivation can be associated with these mands? How do we determine or measure the relevant deprivation? I think we must conclude in this case, as before, either that the notion *deprivation* is relevant at most to a minute fragment of verbal behavior, or else that the statement "X is under Y-deprivation" is just an odd paraphrase for "X wants Y," bearing a misleading and unjustifiable connotation of objectivity.

The notion *aversive control* is just as confused. This is intended to cover threats, beating, and the like (33). The manner in which aversive stimulation functions is simply described. If a speaker has had a history of appropriate reinforcement (e.g., if a certain response was followed by "cessation of the threat of such injury -- of events which have previously been followed by such injury and which are therefore conditioned aversive stimuli"), then he will tend to give the proper response when the threat which had previously been followed by the injury is presented. It would appear to follow from this description that a speaker will not respond properly to the mand *Your money or your life* (38) unless he has a past history of being killed. But even if the difficulties in describing the mechanism of aversive control are somehow removed by a more careful analysis, it will be of little use for identifying operants for reasons similar to those mentioned in the case of deprivation.

It seems, then, that in Skinner's terms there is in most cases no way to decide whether a given response is an instance of a particular mand. Hence it is meaningless, within the terms of his system, to speak of the *characteristic* consequences of a mand, as in the definition above. Furthermore, even if we extend the system so that mands can somehow be identified, we will have to face the obvious fact that most of us are not fortunate enough to have our requests, commands, advice, and so on characteristically reinforced (they may nevertheless exist in considerable *strength*). These responses could therefore not be considered mands by Skinner. In fact, Skinner sets up a category of "magical mands" (48-49) to cover the case of "mands which cannot be accounted for by showing that they have ever had the effect specified or any similar effect upon similar occasions" (the word *ever* in this statement should be replaced by *characteristically*). In these pseudo-mands, "the speaker simply describes the reinforcement appropriate to a given state of deprivation or aversive stimulation." In other words, given the meaning that we have been led to assign to *reinforcement* and *deprivation*, the speaker asks for what he wants. The remark that "a speaker appears to create new mands on the analogy of old ones" is also not very helpful.

Skinner's claim that his new descriptive system is superior to the traditional one "because its terms can be defined with respect to experimental operations" (45) is, we see once again, an illusion. The statement "X wants Y" is not clarified by pointing out a relation between rate of bar-pressing and hours of food-deprivation; replacing "X wants Y" by "X is deprived of Y" adds no new objectivity to the description of behavior. His further claim for the superiority of the new analysis of mands is that it provides an objective basis for the traditional classification into requests, commands, etc. (38-41). The traditional classification is in terms of the intention of the speaker. But intention, Skinner holds, can be reduced to contingencies of reinforcement, and, correspondingly, we can explain the traditional classification in terms of the reinforcing behavior of the listener. Thus, a question is a mand which "specifies verbal action, and the behavior of the listener permits us to classify it as a request, a command, or a prayer" (39). It is a request if "the listener is independently motivated to reinforce the speaker" a command if "the listener's behavior is... reinforced by reducing a threat, a prayer if the mand "promotes reinforcement by generating an emotional disposition." The mand is advice if the listener is positively reinforced by the consequences of mediating the reinforcement of the speaker; it is a warning if "by carrying out the behavior specified by the speaker, the listener escapes from aversive stimulation" and so on. All this is obviously wrong if Skinner is using the words *request*, *command*, etc., in anything like the sense of the corresponding English words. The word *question* does not cover commands. *Please pass the salt* is a request (but not a question), whether or not the listener happens to be motivated to fulfill it; not everyone to whom a request is addressed is favorably disposed. A response does not cease to be a command if it is not followed; nor does a question become a command if the speaker answers it because of an implied or imagined threat. Not all advice is good advice, and a response does not cease to be advice if it is not followed. Similarly, a warning may be misguided; heeding it may cause aversive stimulation, and ignoring it might be positively reinforcing. In short, the entire classification is beside the point. A moment's thought is sufficient to demonstrate the impossibility of distinguishing between requests, commands, advice, etc., on the basis of the behavior or disposition of the particular listener. Nor can we do this on the basis of the typical behavior of all listeners. Some advice is never taken, is always bad, etc., and similarly, with other kinds of mands. Skinner's evident satisfaction with this analysis of the traditional classification is extremely puzzling.

VIII

Mands are operants with no specified relation to a prior stimulus. A *tact*, on the other hand, is defined as "a verbal operant in which a response of given form is evoked (or at least strengthened) by a particular object or event or property of an object or event" (81). The examples quoted in the discussion of stimulus control (Section 3) are all tacts. The obscurity of the notion *stimulus control* makes the concept of the tact rather mystical. Since, however, the tact is "the most important of verbal operants," it is important to investigate the development of this concept in more detail.

We first ask why the verbal community "sets up" tacts in the child -- that is, how the parent is reinforced by setting up the tact. The basic explanation for this behavior of the parent (85-86) is the reinforcement he obtains by the fact that his contact with the environment is extended; to use Skinner's example, the child may later be able to call him to the telephone. (It is difficult to see, then, how first children acquire tacts, since the parent does not have the appropriate history of reinforcement.) Reasoning in the same way, we may conclude that the parent induces the child to walk so that he can make some money delivering newspapers. Similarly, the parent sets up an "echoic repertoire" (e.g., a phonemic system) in the child because this makes it easier to teach him new vocabulary, and extending the child's vocabulary is ultimately useful to the parent. "In all these cases we explain the behavior of the reinforcing listener by pointing to an improvement in the possibility of controlling the speaker whom he reinforces" (56). Perhaps this provides the explanation for the behavior of the parent in inducing the child to walk: the parent is reinforced by the improvement in his control of the child when the child's mobility increases. Underlying these modes of explanation is a curious view that it is somehow more scientific to attribute to a parent a desire to control the child or enhance his own possibilities for action than a desire to see the child develop and extend his capacities. Needless to say, no evidence is offered to support this contention.

Consider now the problem of explaining the response of the listener to a tact. Suppose, for example, that B hears A say *fox* and reacts appropriately -- looks around, runs away, aims his rifle, etc. How can we explain B's behavior? Skinner rightly rejects analyses of this offered by J. B. Watson and Bertrand Russell. His own equally inadequate analysis proceeds as follows (87-88). We assume (l) "that in the history of [B] the stimulus *fox* has been an occasion upon which looking around has been followed by seeing a fox" and (2) "that the listener has some current 'interest in seeing foxes' -- that behavior which depends upon a seen fox for its execution is strong, and that the stimulus supplied by a fox is therefore reinforcing." B carries out the appropriate behavior, then, because "the heard stimulus *fox* is the occasion upon which turning and looking about is frequently followed by the reinforcement of seeing a fox," i.e, his behavior is a discriminated operant. This explanation is unconvincing. B may never have seen a fox and may have no current interest in seeing one, and yet may react appropriately to the stimulus *fox*.[35] Since exactly the same behavior may take place when neither of the assumptions is fulfilled, some other mechanism must be operative here.

Skinner remarks several times that his analysis of the tact in terms of stimulus control is an improvement over the traditional formulations in terms of reference and meaning. This is simply not true. His analysis is fundamentally the same as the traditional one, though much less carefully phrased. In particular, it differs only by indiscriminate paraphrase of such notions as *denotation* (reference) and *connotation* (meaning), which have been kept clearly apart in traditional formulations, in terms of the vague concept *stimulus control*. In one traditional formulation a descriptive term is said to denote a set of entities and to connote or designate a certain property or condition that an entity must possess or fulfil if the term is to apply to it.36 Thus, the term *vertebrate* refers to (*denotes, is true of*) vertebrates and connotes the property *having a spine* or something of the sort. This connoted defining property is called the meaning of the term. Two terms may have the same reference but different meanings. Thus, it is apparently true that the creatures with hearts are all and only the vertebrates. If so, then the term *creature with a heart* refers to vertebrates and designates the property *having a heart*. This is presumably a different property (a different general condition) from having a spine; hence the terms *vertebrate* and *creature with a heart* are said to have different meanings. This analysis is not incorrect (for at least one sense of meaning), but its many limitations have frequently been pointed out.37 The major problem is that there is no good way to decide whether two descriptive terms designate the same property.38 As we have just seen, it is not sufficient that they refer to the same objects. *Vertebrate* and *creature with a spine* would be said to designate the same property (distinct from that designated by *creature with a heart*). If we ask why this is so, the only answer appears to be that the terms are synonymous. The notion *property* thus seems somehow language-bound, and appeal to "defining properties" sheds little light on questions of meaning and synonymy.

Skinner accepts the traditional account *in toto*, as can be seen from his definition of a tact as a response under control of a property (stimulus) of some physical object or event. We have found that the notion *control* has no real substance and is perhaps best understood as a paraphrase of *denote* or *connote* or, ambiguously, both. The only consequence of adopting the new term *stimulus control* is that the important differences between reference and meaning are obscured. It provides no new objectivity. The stimulus controlling the response is determined by the response itself; there is no independent and objective method of identification (see Section 3). Consequently, when Skinner defines *synonymy* as the case in which "the same stimulus leads to quite different responses" (118), we can have no objection. The responses *chair* and *red* made alternatively to the same object are not synonymous, because the stimuli are called different. The responses *vertebrate* and *creature with a spine* would be considered synonymous because they are controlled by the same property of the object under investigation; in more traditional and no less scientific terms, they evoke the same concept. Similarly, when metaphorical extension is explained as due to "the control exercised by properties of the stimulus which, though present at reinforcement, do not enter into the contingency respected by the verbal community" (92; traditionally, accidental properties), no objection can be raised which has not already been leveled against the traditional account. Just as we could "explain" the response *Mozart* to a piece of music in terms of subtle properties of the controlling stimuli, we can, with equal facility, explain the appearance of the response *sun* when no sun is present, as in *Juliet is [like] the sun*. "We do so by noting that Juliet and the sun have common properties, at least in their effect on the speaker" (93). Since any two objects have indefinitely many properties in common, we can be certain that we will never be at a loss to explain a response of the form *A is like B*, for arbitrary A and B. It is clear, however, that Skinner's recurrent claim that his formulation is simpler and more scientific than the traditional account has no basis in fact.

Tacts under the control of private stimuli (Bloomfield's "displaced speech") form a large and important class (130-46), including not only such responses as *familiar* and *beautiful*, but also verbal responses referring to past, potential, or future events or behavior. For example, the response *There was an elephant at the zoo* "must be understood as a response to current stimuli, including events within the speaker himself" (143).39 If we now ask ourselves what proportion of the tacts in actual life are responses to (descriptions of) actual current outside stimulation, we can see just how large a role must be attributed to private stimuli. A minute amount of verbal behavior, outside the nursery, consists of such remarks as *This is red* and *There is a man*. The fact that functional analysis must make such a heavy appeal to obscure internal stimuli is again a measure of its actual advance over traditional formulations.

IX

Responses under the control of prior verbal stimuli are considered under a different heading from the tact. An *echoic operant* is a response which "generates a sound pattern similar to that of the stimulus" (55). It covers only cases of immediate imitation.40 No attempt is made to define the sense in which a child's echoic response is "similar" to the stimulus spoken in the father's bass voice; it seems, though there are no clear statements about this, that Skinner would not accept the account of the phonologist in this respect, but nothing else is offered. The development of an echoic repertoire is attributed completely to differential reinforcement. Since the speaker will do no more, according to Skinner, than what is demanded of him by the verbal community, the degree of accuracy insisted on by this community will determine the elements of the repertoire, whatever these may be (not necessarily phonemes). "In a verbal community which does not insist on a precise correspondence, an echoic repertoire may remain slack and will be less successfully applied to novel patterns." There is no discussion of such familiar phenomena as the accuracy with which a child will pick up a second language or a local dialect in the course of playing with other children, which seem sharply in conflict with these assertions. No anthropological evidence is cited to support the claim that an effective phonemic system does not develop (this is the substance of the quoted remark) in communities that do not insist on precise correspondence.

A verbal response to a written stimulus (reading) is called *textual behavior*.

Other verbal responses to verbal stimuli are called *intraverbal operants*. Paradigm instances are the response *four* to the stimulus *two plus two* or the response *Paris* to the stimulus *capital of France*. Simple conditioning may be sufficient to account for the response *four* to *two plus two*,41 but the notion of intraverbal response loses all meaning when we find it extended to cover most of the facts of history and many of the facts of science (72, 129); all word association and "flight of ideas" (73-76); all translations and paraphrase (77); reports of things seen, heard, or remembered (315); and, in general, large segments of scientific, mathematical, and literary discourse. Obviously, the kind of explanation that might be proposed for a student's ability to respond with *Paris* to *capital of France*, after suitable practice, can hardly be seriously offered to account for his ability to make a judicious guess in answering the questions (to him new): *What is the seat of the French government?, ... the source of the literary dialect?,.. the chief target of the German blitzkrieg?*, etc., or his ability to prove a new theorem, translate a new passage, or paraphrase a remark for the first time or in a new way.

The process of "getting someone to see a point," to see something your way, or to understand a complex state of affairs (e.g., a difficult political situation or a mathematical proof) is, for Skinner, simply a matter of increasing the strength of the listener's already available behavior.42 Since "the process is often exemplified by relatively intellectual scientific or philosophical discourse," Skinner considers it "all the more surprising that it may be reduced to echoic, textual, or intraverbal supplementation" (269). Again, it is only the vagueness and latitude with which the notions *strength* and *intraverbal response* are used that save this from absurdity. If we use these terms in their literal sense, it is clear that understanding a statement cannot be equated to shouting it frequently in a high-pitched voice (high response strength), and a clever and convincing argument cannot be accounted for on the basis of a history of pairings of verbal responses.43

X

A final class of operants, called *autoclitics*, includes those that are involved in assertion, negation, quantification, qualification of responses, construction of sentences, and the "highly complex manipulations of verbal thinking." All these acts are to be explained "in terms of behavior which is evoked by or acts upon other behavior of the speaker" (313). Autoclitics are, then, responses to already given responses, or rather, as we find in reading through this section, they are responses to covert or incipient or potential verbal behavior. Among the autoclitics are listed such expressions as *I recall, I imagine, for example, assume, let X equal...*, the terms of negation, the *is* of predication and assertion, *all, some, if, then,* and, in general, all morphemes other than nouns, verbs, and adjectives, as well as grammatical processes of ordering and arrangement. Hardly a remark in this section can be accepted without serious qualification. To take just one example, consider Skinner's account of the autoclitic *all* in *All swans are white* (329). Obviously we cannot assume that this is a tact to all swans as stimulus. It is suggested, therefore, that we take *all* to be an autoclitic modifying the whole sentence *Swans are white*. *All* can then be taken as equivalent to *always*, or *always it is possible to say*. Notice, however, that the modified sentence *Swans are white* is just as general as *All swans are white*. Furthermore, the proposed translation of *all* is incorrect if taken literally. It is just as possible to say *Swans are green* as to say *Swans are white*. It is not always possible to say either (e.g., while you are saying something else or sleeping). Probably what Skinner means is that the sentence can be paraphrased "X is *white* is true, for each swan X." But this paraphrase cannot be given within his system, which has no place for *true*.

Skinner's account of grammar and syntax as autoclitic processes (Chap. 13) differs from a familiar traditional account mainly in the use of the pseudo-scientific terms *control* or *evoke* in place of the traditional *refer*. Thus, in *The boy runs*, the final *s* of *runs* is a tact under control of such "subtle properties of a situation" as "the nature of running as an *activity* rather than an object or property of an object."44 (Presumably, then, in *The attempt fails, The difficulty remains, His anxiety increases,* etc., we must also say that the *s* indicates that the object described as the attempt is carrying out the activity of failing, etc.) In *the boy's gun*, however, the *s* denotes possession (as, presumably, in *the boy's arrival, ... story, ... age,* etc.) and is under the control of this "relational aspect of the situation" (336). The "relational autoclitic of order" (whatever it may mean to call the order of a set of responses a response to them) in *The boy runs the store* is under the control of an "extremely complex stimulus situation," namely, that the boy is running the store (335). *And* in *the hat and the shoe* is under the control of the property "pair." *Through* in *the dog went through the hedge* is under the control of the "relation between the going dog and the hedge" (342). In general, nouns are evoked by objects, verbs by actions, and so on. Skinner considers a sentence to be a set of key responses (nouns, verbs, adjectives) on a skeletal frame (346). If we are concerned with the fact that Sam rented a leaky boat, the raw responses to the situation are *rent, boat, leak, and Sam*. Autoclitics (including order) which qualify these responses, express relations between them, and the like, are then added by a process called *composition* and the result is a grammatical sentence, one of many alternatives among which selection is rather arbitrary. The idea that sentences consist of lexical items placed in a grammatical frame is of course a traditional one, within both philosophy and linguistics. Skinner adds to it only the very implausible speculation that in the internal process of composition, the nouns, verbs, and adjectives are chosen first and then are arranged, qualified, etc., by autoclitic responses to these internal activities.45

This view of sentence structure, whether phrased in terms of autoclitics, syncategorematic expressions, or grammatical and lexical morphemes, is inadequate. *Sheep provide wool* has no (physical) frame at all, but no other arrangement of these words is an English sentence. The sequences *furiously sleep ideas green colorless* and *friendly young dogs seem harmless* have the same frames, but only one is a sentence of English (similarly, only one of the sequences formed by reading these from back to front). *Struggling artists can be a nuisance* has the same frame as *marking papers can be a nuisance*, but is quite different in sentence structure, as can be seen by replacing *can be* by *is* or *are* in both cases. There are many other similar and equally simple examples. It is evident that more is involved in sentence structure than insertion of lexical items in grammatical frames; no approach to language that fails to take these deeper processes into account can possibly achieve much success in accounting for actual linguistic behavior.

XI

The preceding discussion covers all the major notions that Skinner introduces in his descriptive system. My purpose in discussing the concepts one by one was to show that in each case, if we take his terms in their literal meaning, the description covers almost no aspect of verbal behavior, and if we take them metaphorically, the description offers no improvement over various traditional formulations. The terms borrowed from experimental psychology simply lose their objective meaning with this extension, and take over the full vagueness of ordinary language. Since Skinner limits himself to such a small set of terms for paraphrase, many important distinctions are obscured. I think that this analysis supports the view expressed in Section I, that elimination of the independent contribution of the speaker and learner (a result which Skinner considers of great importance, cf. 311-12) can be achieved only at the cost of eliminating all significance from the descriptive system, which then operates at a level so gross and crude that no answers are suggested to the most elementary questions.46 The questions to which Skinner has addressed his speculations are hopelessly premature. It is futile to inquire into the causation of verbal behavior until much more is known about the specific character of this behavior; and there is little point in speculating about the process of acquisition without much better understanding of what is acquired.

Anyone who seriously approaches the study of linguistic behavior, whether linguist, psychologist, or philosopher, must quickly become aware of the enormous difficulty of stating a problem which will define the area of his investigations, and which will not be either completely trivial or hopelessly beyond the range of present-day understanding and technique. In selecting functional analysis as his problem, Skinner has set himself a task of the latter type. In an extremely interesting and insightful paper,47 K. S. Lashley has implicitly delimited a class of problems which can be approached in a fruitful way by the linguist and psychologist, and which are clearly preliminary to those with which Skinner is concerned. Lashley recognizes, as anyone must who seriously considers the data, that the composition and production of an utterance is not simply a matter of stringing together a sequence of responses under the control of outside stimulation and intraverbal association, and that the syntactic organization of an utterance is not something directly represented in any simple way in the physical structure of the utterance itself. A variety of observations lead him to conclude that syntactic structure is "a generalized pattern imposed on the specific acts as they occur" (512), and that "a consideration of the structure of the sentence and other motor sequences will show...that there are, behind the overtly expressed sequences, a multiplicity of integrative processes which can only be inferred from the final results of their activity" (509). He also comments on the great difficulty of determining the "selective mechanisms" used in the actual construction of a particular utterance (522).

Although present-day linguistics cannot provide a precise account of these integrative processes, imposed patterns, and selective mechanisms, it can at least set itself the problem of characterizing these completely. It is reasonable to regard the grammar of a language L ideally as a mechanism that provides an enumeration of the sentences of L in something like the way in which a deductive theory gives an enumeration of a set of theorems. (*Grammar*, in this sense of the word, includes phonology.) Furthermore, the theory of language can be regarded as a study of the formal properties of such grammars, and, with a precise enough formulation, this general theory can provide a uniform method for determining, from the process of generation of a given sentence, a structural description which can give a good deal of insight into how this sentence is used and understood. In short, it should be possible to derive from a properly formulated grammar a statement of the integrative processes and generalized patterns imposed on the specific acts that constitute an utterance. The rules of a grammar of the appropriate form can be subdivided into the two types, optional and obligatory; only the latter must be applied in generating an utterance. The optional rules of the grammar can be viewed, then, as the selective mechanisms involved in the production of a particular utterance. The problem of specifying these integrative processes and selective mechanisms is nontrivial and not beyond the range of possible investigation. The results of such a study might, as Lashley suggests, be of independent interest for psychology and neurology (and conversely). Although such a study, even if successful, would by no means answer the major problems involved in the investigation of meaning and the causation of behavior, it surely will not be unrelated to these. It is at least possible, furthermore, that such a notion as *semantic generalization*, to which such heavy appeal is made in all approaches to language in use, conceals complexities and specific structure of inference not far different from those that can be studied and exhibited in the case of syntax, and that consequently the general character of the results of syntactic investigations may be a corrective to oversimplified approaches to the theory of meaning.

The behavior of the speaker, listener, and learner of language constitutes, of course, the actual data for any study of language. The construction of a grammar which enumerates sentences in such a way that a meaningful structural description can be determined for each sentence does not in itself provide an account of this actual behavior. It merely characterizes abstractly the ability of one who has mastered the language to distinguish sentences from nonsentences, to understand new sentences (in part), to note certain ambiguities, etc. These are very remarkable abilities. We constantly read and hear new sequences of words, recognize them as sentences, and understand them. It is easy to show that the new events that we accept and understand as sentences are not related to those with which we are familiar by any simple notion of formal (or semantic or statistical) similarity or identity of grammatical frame. Talk of generalization in this case is entirely pointless and empty. It appears that we recognize a new item as a sentence not because it matches some familiar item in any simple way, but because it is generated by the grammar that each individual has somehow and in some form internalized. And we understand a new sentence, in part, because we are somehow capable of determining the process by which this sentence is derived in this grammar.

Suppose that we manage to construct grammars having the properties outlined above. We can then attempt to describe and study the achievement of the speaker, listener, and learner. The speaker and the listener, we must assume, have already acquired the capacities characterized abstractly by the grammar. The speaker's task is to select a particular compatible set of optional rules. If we know, from grammatical study, what choices are available to him and what conditions of compatibility the choices must meet, we can proceed meaningfully to investigate the factors that lead him to make one or another choice. The listener (or reader) must determine, from an exhibited utterance, what optional rules were chosen in the construction of the utterance. It must be admitted that the ability of a human being to do this far surpasses our present understanding. The child who learns a language has in some sense constructed the grammar for himself on the basis of his observation of sentences and nonsentences (i.e., corrections by the verbal community). Study of the actual observed ability of a speaker to distinguish sentences from nonsentences, detect ambiguities, etc., apparently forces us to the conclusion that this grammar is of an extremely complex and abstract character, and that the young child has succeeded in carrying out what from the formal point of view, at least, seems to be a remarkable type of theory construction. Furthermore, this task is accomplished in an astonishingly short time, to a large extent independently of intelligence, and in a comparable way by all children. Any theory of learning must cope with these facts.

It is not easy to accept the view that a child is capable of constructing an extremely complex mechanism for generating a set of sentences, some of which he has heard, or that an adult can instantaneously determine whether (and if so, how) a particular item is generated by this mechanism, which has many of the properties of an abstract deductive theory. Yet this appears to be a fair description of the performance of the speaker, listener, and learner. If this is correct, we can predict that a direct attempt to account for the actual behavior of speaker, listener, and learner, not based on a prior understanding of the structure of grammars, will achieve very limited success. The grammar must be regarded as a component in the behavior of the speaker and listener which can only be inferred, as Lashley has put it, from the resulting physical acts. The fact that all normal children acquire essentially comparable grammars of great complexity with remarkable rapidity suggests that human beings are somehow specially designed to do this, with data-handling or "hypothesis-formulating" ability of unknown character and complexity.48 The study of linguistic structure may ultimately lead to some significant insights into this matter. At the moment the question cannot be seriously posed, but in principle it may be possible to study the problem of determining what the built-in structure of an information-processing (hypothesis-forming) system must be to enable it to arrive at the grammar of a language from the available data in the available time. At any rate, just as the attempt to eliminate the contribution of the speaker leads to a "mentalistic" descriptive system that succeeds only in blurring important traditional distinctions, a refusal to study the contribution of the child to language learning permits only a superficial account of language acquisition, with a vast and unanalyzed contribution attributed to a step called *generalization* which in fact includes just about everything of interest in this process. If the study of language is limited in these ways, it seems inevitable that major aspects of verbal behavior will remain a mystery.

### Notes

1 Skinner's confidence in recent achievements in the study of animal behavior and their applicability to complex human behavior does not appear to be widely shared. In many recent publications of confirmed behaviorists there is a prevailing note of skepticism with regard to the scope of these achievements. For representative comments, see the contributions to *Modern Learning Theory* (by W. K. Estes et al.; New York: Appleton-Century-Crofts, Inc., 1954); B. R. Bugelski, *Psychology of Learning* (New York: Holt, Rinehart & Winston, Inc., 1956); S. Koch, in *Nebraska Symposium on Motivation*, 58 (Lincoln, 1956); W. S. Verplanck, "Learned and Innate Behavior," *Psych. Rev.*, 52, (1955), 139. Perhaps the strongest view is that of H. Harlow, who has asserted ("Mice, Monkeys, Men, and Motives," *Psych. Rev.*, 60, [1953] 23-32) that "a strong case can be made for the proposition that the importance of the psychological problems studied during the last 15 years has decreased as a negatively accelerated function approaching an asymptote of complete indifference." N. Tinbergen, a leading representative of a different approach to animal behavior studies (comparative ethology), concludes a discussion of *functional analysis* with the comment that "we may now draw the conclusion that the causation of behavior is immensely more complex than was assumed in the generalizations of the past. A number of internal and external factors act upon complex central nervous structures. Second, it will be obvious that the facts at our disposal are very fragmentary indeed" -- *The Study of Instinct* (Toronto: Oxford Univ. Press, 1951), p. 74.

2 In *Behavior of Organisms* (New York: Appleton-Century-Crofts, Inc., 1938), Skinner remarks that "although a conditioned operant is the result of the correlation of the response with a particular reinforcement, a relation between it and a discriminative stimulus acting prior to the response is the almost universal rule" (178-79). Even emitted behavior is held to be produced by some sort of "originating force" (51) which, in the case of operant behavior is not under experimental control.

The distinction between eliciting stimuli, discriminated stimuli, and "originating forces" has never been adequately clarified and becomes even more confusing when private internal events are considered to be discriminated stimuli (see below).

3 In a famous experiment, chimpanzees were taught to perform complex tasks to receive tokens which had become secondary reinforcers because of association with food. The idea that money, approval, prestige, etc. actually acquire their motivating effects on human behavior according to this paradigm is unproved, and not particularly plausible. Many psychologists within the behaviorist movement are quite skeptical about this (cf. 23n). As in the case of most aspects of human behavior, the evidence about secondary reinforcement is so fragmentary, conflicting, and complex that almost any view can find some support.

4 Skinner's remark quoted above about the generality of his basic results must be understood in the light of the experimental limitations he has imposed. If it were true in any deep sense that the basic processes in language are well understood and free of species restriction, it would be extremely odd that language is limited to man. With the exception of a few scattered observations (cf. his article, "A Case History in Scientific Method," *The American Psychologist*, 11 [1956] 221-33), Skinner is apparently basing this claim on the fact that qualitatively similar results are obtained with bar pressing of rats and pecking of pigeons under special conditions of deprivation and various schedules of reinforcement. One immediately questions how much can be based on these facts, which are in part at least an artifact traceable to experimental design and the definition of *stimulus* and *response* in terms of *smooth dynamic curves* (see below). The dangers inherent in any attempt to *extrapolate* to complex behavior from the study of such simple responses as bar pressing should be obvious and have often been commented on (cf., e.g., Harlow, op. cit.). The generality of even the simplest results is open to serious question. Cf. in this connection M. E. Bitterman, J. Wodinsky, and D. K. Candland, "Some Comparative Psychology," *Am. Jour. of Psych.*, 71 (1958), 94-110, where it is shown that there are important qualitative differences in solution of comparable elementary problems by rats and fish.

5 An analogous argument, in connection with a different aspect of Skinner's thinking, is given by M. Scriven in "A Study of Radical Behaviorism," *Univ. of Minn. Studies in Philosophy of Science*, I. Cf. Verplanck's contribution to *Modern Learning Theory*, *op. cit.* pp. 283-88, for more general discussion of the difficulties in formulating an adequate definition of *stimulus* and *response*. He concludes, quite correctly, that in Skinner's sense of the word, stimuli are not objectively identifiable independently of the resulting behavior, nor are they manipulable. Verplanck presents a clear discussion of many other aspects of Skinner's system, commenting on the untestability of many of the so-called "laws of behavior" and the limited scope of many of the others, and the arbitrary and obscure character of Skinner's notion of *lawful relation*; and, at the same time, noting the importance of the experimental data that Skinner has accumulated.

6 In *Behavior of Organisms*, Skinner apparently was willing to accept this consequence. He insists (41-42) that the terms of casual description in the popular vocabulary are not validly descriptive until the defining properties of stimulus and response are specified, the correlation is demonstrated experimentally, and the dynamic changes in it are shown to be lawful. Thus, in describing a child as hiding from a dog, "it will not be enough to dignify the popular vocabulary by appealing to essential properties of *dogness* or *hidingness* and to suppose them intuitively known." But this is exactly what Skinner does in the book under review, as we will see directly.

7 253f. and elsewhere, repeatedly. As an example of how well we can control behavior using the notions developed in this book, Skinner shows here how he would go about evoking the response *pencil*. The most effective way, he suggests, is to say to the subject, "Please say *pencil*" (our chances would, presumably, be even further improved by use of "aversive stimulation," e.g., holding a gun to his head). We can also "make sure that no pencil or writing instrument is available, then hand our subject a pad of paper appropriate to pencil sketching, and offer him a handsome reward for a recognizable picture of a cat." It would also be useful to have voices saying *pencil* or *pen and* ... in the background; signs reading *pencil* or *pen and* ...; or to place a "large and unusual pencil in an unusual place clearly in sight." "Under such circumstances, it is highly probable that our subject will say *pencil*." "The available techniques are all illustrated in this sample." These contributions of behavior theory to the practical control of human behavior are amply illustrated elsewhere in the book, as when Skinner shows (113-14) how we can evoke the response *red* (the device suggested is to hold a red object before the subject and say, "Tell me what color this is").

In fairness, it must be mentioned that there are certain nontrivial applications of *operant conditioning* to the control of human behavior. A wide variety of experiments have shown that the number of plural nouns (for example) produced by a subject will increase if the experimenter says "right" or "good" when one is produced (similarly, positive attitudes on a certain issue, stories with particular content, etc.; cf. L. Krasner, "Studies of the Conditioning of Verbal Behavior," *Psych. Bull.*, 55 [1958], for a survey of several dozen experiments of this kind, mostly with positive results). It is of some interest that the subject is usually unaware of the process. Just what insight this gives into normal verbal behavior is not obvious. Nevertheless, it is an example of positive and not totally expected results using the Skinnerian paradigm.

8 "Are Theories of Learning Necessary?", *Psych. Rev.*, 57 (1950), 193-216.

9 And elsewhere. In his paper "Are Theories of Learning Necessary?" Skinner considers the problem how to extend his analysis of behavior to experimental situations in which it is impossible to observe frequencies, rate of response being the only valid datum. His answer is that "the notion of probability is usually extrapolated to cases in which a frequency analysis cannot be carried out. In the field of behavior we arrange a situation in which frequencies are available as data, but we use the notion

of probability in analyzing or formulating instances of even types of behavior which are not susceptible to this analysis" (199). There are, of course, conceptions of probability not based directly on frequency, but I do not see how any of these apply to the cases that Skinner has in mind. I see no way of interpreting the quoted passage other than as signifying an intention to use the word *probability* in describing behavior quite independently of whether the notion of probability is at all relevant.

10 Fortunately, "In English this presents no great difficulty" since, for example, "relative pitch levels ... are not ... important" (25). No reference is made to the numerous studies of the function of relative pitch levels and other intonational features in English.

11 The vagueness of the word *tendency*, as opposed to *frequency*, saves the latter quotation from the obvious incorrectness of the former. Nevertheless, a good deal of stretching is necessary. If *tendency* has anything like its ordinary meaning, the remark is clearly false. One may believe strongly the assertion that Jupiter has four moons, that many of Sophocles' plays have been irretrievably lost, that the earth will burn to a crisp in ten million years, and so on, without experiencing the slightest tendency to act upon these verbal stimuli. We may, of course, turn Skinner's assertion into a very unilluminating truth by defining "tendency to act" to include tendencies to answer questions in certain ways, under motivation to say what one believes is true.

12 One should add, however, that it is in general not the stimulus as such that is reinforcing, but the stimulus in a particular situational context. Depending on experimental arrangement, a particular physical event or object may be reinforcing, punishing, or unnoticed. Because Skinner limits himself to a particular, very simple experimental arrangement, it is not necessary for him to add this qualification, which would not be at all easy to formulate precisely. But it is of course necessary if he expects to extend his descriptive system to behavior in general.

13 This has been frequently noted.

14 See, for example, "Are Theories of Learning Necessary?", *op. cit.*, p. 199. Elsewhere, he suggests that the term *learning* be restricted to complex situations, but these are not characterized.

15 "A child acquires verbal behavior when relatively unpatterned vocalizations, selectively reinforced, gradually assume forms which produce appropriate consequences in a given verbal community" (31). "Differential reinforcement shapes up all verbal forms, and when a prior stimulus enters into the contingency, reinforcement is responsible for its resulting control.... The availability of behavior, its probability or strength, depends on whether reinforcements *continue* in effect and according to what schedules" (203-4); elsewhere, frequently.

16 Talk of schedules of reinforcement here is entirely pointless. How are we to decide, for example, according to what schedules covert reinforcement is arranged, as in thinking or verbal fantasy, or what the scheduling is of such factors as silence, speech, and appropriate future reactions to communicated information?

17 See, for example, N. E. Miller and J. Dollard, *Social Learning and Imitation* (New York, 1941), pp. 82-83, for a discussion of the "meticulous training" that they seem to consider necessary for a child to learn the meanings of words and syntactic patterns. The same notion is implicit in O. H. Mowrer's speculative account of how language might be acquired, in *Learning Theory and Personality Dynamics*, (New York: The Ronald Press, Inc., 1950), Chap. 23. Actually, the view appears to be quite general.

18 For a general review and analysis of this literature, see D. L. Thistlethwaite, "A Critical Review of Latent Learning and Related Experiments," *Psych. Bull.*, 48 (1951), 97-129. K. MacCorquodale and P. E. Meehl, in their contribution to *Modern Learning Theory op. cit.*, carry out a serious and considered attempt to handle the latent learning material from the standpoint of drive-reduction theory, with (as they point out) not entirely satisfactory results. W. H. Thorpe reviews the literature from the standpoint of the ethologist, adding also material on homing and topographical orientation (*Learning and Instinct in Animals* [Cambridge, 1956]).

19 *Theories of Learning*, 214 (1956).

20 O. E. Berlyne, "Novelty and Curiosity as Determinants of Exploratory Behavior," *Brit. Jour. of Psych.*, 41 (1950), 68-80; *id.*, "Perceptual Curiosity in the Rat," *Jour. of Comp. Physiol. Psych.*, 48 (1955), 238-46; W. R. Thompson and L. M. Solomon, "Spontaneous Pattern Discrimination in the Rat," *ibid.*, 47 (1954), 104-7.

21 K. C. Montgomery, "The Role of the Exploratory Drive in Learning," *ibid.* pp. 60-63. Many other papers in the same journal are designed to show that exploratory behavior is a relatively independent primary "drive" aroused by novel external stimulation.

22 R. A. Butler, "Discrimination Learning by Rhesus Monkeys to Visual-Exploration Motivation," *ibid.*, 46 (1953), 95-98. Later experiments showed that this "drive" is highly persistent, as opposed to derived drives which rapidly extinguish.

23 H. F. Harlow, M. K. Harlow, and D. R. Meyer, "Learning Motivated by a Manipulation Drive," *Jour. Exp. Psych.*, 40 (1950), 228-34, and later investigations initiated by Harlow. Harlow has been particularly insistent on maintaining the

inadequacy of physiologically based drives and homeostatic need states for explaining the persistence of motivation and rapidity of learning in primates. He points out, in many papers, that curiosity, play, exploration, and manipulation are, for primates, often more potent drives than hunger and the like, and that they show none of the characteristics of acquired drives. Hebb also presents behavioral and supporting neurological evidence in support of the view that in higher animals there is a positive attraction in work, risk, puzzle, intellectual activity, mild fear and frustration, and so on. "Drives and the CNS," *Psych. Rev.*, 62 [1955], 243-54.) He concludes that "we need not work out tortuous and improbable ways to explain why men work for money, why children learn without pain, why people dislike doing nothing." In a brief note "Early Recognition of the Manipulative Drive in Monkeys," *British Journal of Animal Behaviour*, 3 [1955], 71-72), W. Dennis calls attention to the fact that early investigators (G. J. Romanes, 1882; E. L. Thorndike, 1901), whose "perception was relatively unaffected by learning theory, did note the intrinsically motivated behavior of monkeys," although, he asserts, no similar observations on monkeys have been made until Harlow's experiments. He quotes Romanes (*Animal Intelligence* [1882]) as saying that "much the most striking feature in the psychology of this animal, and the one which is least like anything met with in other animals, was the tireless spirit of investigation." Analogous developments, in which genuine discoveries have blinded systematic investigators to the important insights of earlier work, are easily found within recent structural linguistics as well.

24 Thus, J. S. Brown, in commenting on a paper of Harlow's in *Current Theory and Research in Motivation* (Lincoln: Univ. of Nebraska Press, 1953), argues that "in probably every instance [of the experiments cited by Harlow] an ingenious drive-reduction theorist could find some fragment of fear, insecurity, frustration, or whatever, that he could insist was reduced and hence was reinforcing" (53). The same sort of thing could be said for the ingenious phlogiston or ether theorist.

25 Cf. H. G. Birch and M. E. Bitterman, "Reinforcement and Learning: The process of Sensory Integration," *Psych. Rev.*, 56 (1949), 292-308.

26 See, for example, his paper "A Physiological Study of Reward" in D. C. McClelland, ed., *Studies in Motivation* (New York: Appleton-Century-Crafts, Inc., 1955), pp. 134-43.

27 See Thorpe, op. cit., particularly pp. 115-18 and 337-76, for an excellent discussion of this phenomenon, which has been brought to prominence particularly by the work of K. Lorenz (cf. "Der Kumpan in der Umwelt des Vogels," parts of which are reprinted in English translation in C. M. Schiller, ed., *Instinctive Behavior* [New York: International Universities Press, 1957], pp. 83-128).

28 *Op. cit.*, p. 372.

29 See, e.g., J. Jaynes, "Imprinting: Interaction of Learned and Innate Behavior," *Jour. of Comp. Physiol. Psych.*, 49 (1956), 201-6, where the conclusion is reached that "the experiments prove that without any observable reward, young birds of this species follow a moving stimulus object and very rapidly come to prefer that object to others."

30 Of course, it is perfectly possible to incorporate this fact within the Skinnerian framework. If, for example, a child watches an adult using a comb and then, with no instruction, tries to comb his own hair, we can explain this act by saying that he performs it because he finds it reinforcing to do so, or because of the reinforcement provided by behaving like a person who is "reinforcing" (cf. 164). Similarly, an automatic explanation is available for any other behavior. It seems strange at first that Skinner pays so little attention to the literature on latent learning and related topics, considering the tremendous reliance that he places on the notion of reinforcement; I have seen no reference to it in his writings. Similarly, F. S. Keller and W. N. Schoenfeld, in what appears to be the only text written under predominantly Skinnerian influence, *Principles of Psychology* (New York: Appleton-Century-Crofts, Inc., 1950), dismiss the latent learning literature in one sentence as "beside the point," serving only "to obscure, rather than clarify, a fundamental principle" (*the law of effect*, 41). However, this neglect is perfectly appropriate in Skinner's case. To the drive-reductionist, or anyone else for whom the notion *reinforcement* has some substantive meaning, these experiments and observations are important (and often embarrassing). But in the Skinnerian sense of the word, neither these results nor any conceivable others can cast any doubt on the claim that reinforcement is essential for the acquisition and maintenance of behavior. Behavior certainly has some concomitant circumstances, and whatever they are, we can call them *reinforcement*.

31 Tinbergen, *op.cit.*, Chap. VI, reviews some aspects of this problem, discussing the primary role of maturation in the development of many complex motor patterns (e.g., flying, swimming) in lower organisms, and the effect of an "innate disposition to learn" in certain specific ways and at certain specific times. Cf. also P. Schiller, "Innate Motor Action as a Basis for Learning," in C. H. Schiller, ed., *Instinctive Behavior* (New York: International Universities Press, 1957), pp. 265-88, for a discussion of the role of maturing motor patterns in apparently insightful behavior in the chimpanzee.

Lenneberg ("The Capacity for Language Acquisition", in J. A. Fodor, ed., *The Structure of Language* [Prentice-Hall, Inc., 1964]) presents a very interesting discussion of the part that biological structure may play in the acquisition of language, and the dangers in neglecting this possibility.

32 From among many cited by Tinbergen, *op. cit.*, p. 85.

33 Cf. K. S. Lashley, "In Search of the Engram," *Symposium of the Society for Experimental Biology*, 4 (1950), 454-82. R. Sperry, "On the Neural Basis of the Conditioned Response," *British Journal of Animal Behavior*, 3 (1955), 41-44, argues that

to account for the experimental results of Lashley and others, and for other facts that he cites, it is necessary to assume that high-level cerebral activity of the type of insight, expectancy, and so on is involved even in simple conditioning. He states that "we still lack today a satisfactory picture of the underlying neural mechanism" of the conditioned response.

34 Furthermore, the motivation of the speaker does not, except in the simplest cases, correspond in intensity to the duration of deprivation. An obvious counter-example is what Hebb has called the "salted-nut phenomenon" (*Organization of Behavior* [New York, 1949], p. 199). The difficulty is of course even more serious when we consider *deprivations* not related to physiological drives.

35 Just as he may have the appropriate reaction, both emotional and behavioral, to such utterances as *the volcano is erupting* or *there's a homicidal maniac in the next room* without any previous pairing of the verbal and the physical stimulus. Skinner's discussion of Pavlovian conditioning in language (154) is similarly unconvincing.

36 J. S. Mill, *A System of Logic* (1843). R. Carnap gives a recent reformulation in "Meaning and Synonymy in Natural Languages," *Phil. Studies*, 6 (1955), 33-47, defining the meaning (intension) of a predicate Q for a speaker X as "the general condition which an object *y* must fulfil in order for X to be willing to ascribe the predicate Q to *y*." The connotation of an expression is often said to constitute its "cognitive meaning" as opposed to its "emotive meaning," which is, essentially, the emotional reaction to the expression.

Whether or not this is the best way to approach meaning, it is clear that denotation, cognitive meaning, and emotive meaning are quite different things. The differences are often obscured in empirical studies of meaning, with much consequent confusion. Thus, Osgood has set himself the task of accounting for the fact that a stimulus comes to be a sign for another stimulus (a buzzer becomes a sign for food, a word for a thing, etc.). This is clearly (for linguistic signs) a problem of denotation. The method that he actually develops for quantifying and measuring meaning (cf. C. E. Osgood, G. Suci, P. Tannenbaum, *The Measurement of Meaning* [Urbana: Univ. of Illinois Press, 1957]) applies, however, only to emotive meaning. Suppose, for example, that A hates both Hitler and science intensely, and considers both highly potent and "active," while B, agreeing with A about Hitler, likes science very much, although he considers it rather ineffective and not too important. Then, A may assign to "Hitler" and "science" the same position on the semantic differential, while B will assign "Hitler" the same position as A did, but "science" a totally different position. Yet, A does not think that "Hitler" and "science" are synonymous or that they have the same reference, and A and B may agree precisely on the cognitive meaning of "science." Clearly, it is the attitude toward the things (the emotive meaning of the words) that is being measured here. There is a gradual shift in Osgood's account from denotation to cognitive meaning to emotive meaning. The confusion is caused, no doubt, by the fact that the term *meaning* is used in all three senses (and others). [See J. Carroll's review of the book by Osgood, Suci, and Tannenbaum in *Language*, 35, No. 1 (1959).]

37 Most clearly by Quine. See *From a Logical Point of View* (Cambridge, 1953), especially Chaps. 2, 3, and 7.

38 A method for characterizing synonymy in terms of reference is suggested by Goodman, "On Likeness of Meaning," *Analysis*, 10 (1949), 1-7. Difficulties are discussed by Goodman, "On Some Differences about Meaning," *ibid*., 13 (1953) 90-96. Carnap, *op. cit.*, presents a very similar idea (Section 6), but somewhat misleadingly phrased, since he does not bring out the fact that only extensional (referential) notions are being used.

39 In general, the examples discussed here are badly handled, and the success of the proposed analyses is overstated. In each case, it is easy to see that the proposed analysis, which usually has an air of objectivity, is not equivalent to the analyzed expression. To take just one example, the response *I am looking for my glasses* is certainly not equivalent to the proposed paraphrases: "When I have behaved in this way in the past, I have found my glasses and have then stopped behaving in this way," or "Circumstances have arisen in which I am inclined to emit any behavior which in the past has led to the discovery of my glasses; such behavior includes the behavior of looking in which I am now engaged." One may look for one's glasses for the first time; or one may emit the same behavior in looking for one's glasses as in looking for one's watch, in which case *I am looking for my glasses* and *I am looking for my watch* are equivalent, under the Skinnerian paraphrase. The difficult questions of purposiveness cannot be handled in this superficial manner.

40 Skinner takes great pains, however, to deny the existence in human beings (or parrots) of any innate faculty or tendency to imitate. His only argument is that no one would suggest an innate tendency to read, yet reading and echoic behavior have similar "dynamic properties." This similarity, however, simply indicates the grossness of his descriptive categories. In the case of parrots, Skinner claims that they have no instinctive capacity to imitate, but only to be reinforced by successful imitation (59). Given Skinner's use of the word *reinforcement*, it is difficult to perceive any distinction here, since exactly the same thing could be said of any other instinctive behavior. For example, where another scientist would say that a certain bird instinctively builds a nest in a certain way, we could say in Skinner's terminology (equivalently) that the bird is instinctively reinforced by building the nest in this way. One is therefore inclined to dismiss this claim as another ritual introduction of the word *reinforce*. Though there may, under some suitable clarification, be some truth in it, it is difficult to see how many of the cases reported by competent observers can be handled if *reinforcement* is given some substantive meaning. Cf. Thorpe, *op. cit.* p. 353f.; K. Lorenz, *King Solomon's Ring* (New York, 1952), pp. 85-88; even Mowrer, who tries to show how imitation might develop through secondary reinforcement, cites a case, *op. cit.*, p. 694, which he apparently believes, but where this could hardly be true. In young children, it seems most implausible to explain imitation in terms of secondary reinforcement.

41 Although even this possibility is limited. If we were to take these paradigm instances seriously, it should follow that a child who knows how to count from one to 100 could learn an arbitrary 10 x 10 matrix with these numbers as entries as readily as the multiplication table.

42 Similarly, "the universality of a literary work refers to the number of potential readers inclined to say the same thing" (275; i.e., the most "universal" work is a dictionary of clichés and greetings) a speaker is "stimulating" if he says what we are about to say ourselves (272) etc.

43 Similarly, consider Skinner's contention (362-65) that communication of knowledge or facts is just the process of making a new response available to the speaker. Here the analogy to animal experiments is particularly weak. When we train a rat to carry out some peculiar act, it makes sense to consider this a matter of adding a response to his repertoire. In the case of human communication, however, it is very difficult to attach any meaning to this terminology. If A imparts to B the information (new to B) that the railroads face collapse, in what sense can the response *The railroads face collapse* be said to be now, but not previously, available to B? Surely B could have said it before (not knowing whether it was true), and known that it was a sentence (as opposed to *Collapse face railroads the*). Nor is there any reason to assume that the response has increased in strength, whatever this means exactly (e.g., B may have no interest in the fact, or he may want it suppressed). It is not clear how we can characterize this notion of "making a response available" without reducing Skinner's account of "imparting knowledge" to a triviality.

44 (332). On the next page, however, the *s* in the same example indicates that "the object described as *the boy* possesses the property of running." The difficulty of even maintaining consistency with a conceptual scheme like this is easy to appreciate.

45 One might just as well argue that exactly the opposite is true. The study of hesitation pauses has shown that these tend to occur before the large categories -- noun, verb, adjective; this finding is usually described by the statement that the pauses occur where there is maximum uncertainty or information. Insofar as hesitation indicates on-going composition (if it does at all), it would appear that the "key responses" are chosen only after the "grammatical frame." Cf. C. E. Osgood, unpublished paper; F. Goldman-Eisler, "Speech Analysis and Mental Processes," *Language and Speech*, 1 (1958), 67.

46 E.g., what are in fact the actual units of verbal behavior? Under what conditions will a physical event capture the attention (be a stimulus) or be a reinforcer? How do we decide what stimuli are in "control" in a specific case? When are stimuli "similar"? And so on. (It is not interesting to be told, e.g., that we say *Stop* to an automobile or billiard ball because they are sufficiently similar to reinforcing people [46].) The use of unanalyzed notions like *similar* and *generalization* is particularly disturbing, since it indicates an apparent lack of interest in every significant aspect of the learning or the use of language in new situations. No one has ever doubted that in some sense, language is learned by generalization, or that novel utterances and situations are in some way similar to familiar ones. The only matter of serious interest is the specific "similarity." Skinner has, apparently, no interest in this. Keller and Schoenfeld, *op. cit.*, proceed to incorporate these notions (which they identify) into their Skinnerian "modern objective psychology" by defining two stimuli to be similar when "we make the same sort of response to them" (124; but when are responses of the "same sort"?). They do not seem to notice that this definition converts their "principle of generalization" (116), under any reasonable interpretation of this, into a tautology. It is obvious that such a definition will not be of much help in the study of language learning or construction of new responses in appropriate situations.

47 "The Problem of Serial Order in Behavior," in L. A. Jeffress, ed., *Hixon Symposium on Cerebral Mechanisms in Behavior* (New York: John Wiley & Sons Inc., 1951). Reprinted in F. A. Beach, D. O. Hebb, C. T. Morgan, H. W. Nissen, eds., *The Neuropsychology of Lashley* (New York: McGraw-Hill Book Company, 1960). Page references are to the latter.

48 There is nothing essentially mysterious about this. Complex innate behavior patterns and innate "tendencies to learn in specific ways" have been carefully studied in lower organisms. Many psychologists have been inclined to believe that such biological structure will not have an important effect on acquisition of complex behavior in higher organisms, but I have not been able to find any serious justification for this attitude. Some recent studies have stressed the necessity for carefully analyzing the strategies available to the organism, regarded as a complex "information-processing system" (cf. J. S. Bruner, J. J. Goodnow, and G. A. Austin, *A Study of Thinking* [New York, 1956]; A. Newell, J. C. Shaw, and H. A. Simon, "Elements of a Theory of Human Problem Solving," *Psych. Rev.*, 65, [1958], 151-66), if anything significant is to be said about the character of human learning. These may be largely innate, or developed by early learning processes about which very little is yet known. (But see Harlow, "The Formation of Learning Sets," *Psych. Rev.*, 56 (1949), 51-65, and many later papers, where striking shifts in the character of learning are shown as a result of early training; also D. O. Hebb, *Organization of Behavior*, 109 ff.). They are undoubtedly quite complex. Cf. Lenneberg, *op. cit.*, and R. B. Lees, review of N. Chomsky's *Syntactic Structures* in *Language*, 33 (1957), 406f, for discussion of the topics mentioned in this section.

# Learning theory (education)
from Wikipedia Encyclopedia.

In education and psychology, learning theories help us understand the process of learning.

There are basically two main perspectives in learning theories:

**Constructivism** views learning as a process in which the learner actively constructs or builds new ideas or concepts based upon current and past knowledge. In other words, "learning involves constructing one's own knowledge from one's own experiences" (Ormrod, J. E., Educational Psychology: Developing Learners, Fourth Edition. 2003, p. 227). Constructivist learning, therefore, is a very personal endeavor, whereby internalized concepts, rules, and general principles may consequently be applied in a practical real-world context. According to Jerome Bruner and other constructivists, the teacher acts as a facilitator who encourages students to discover principles for themselves and to construct knowledge by working to solve realistic problems, usually in collaboration with others.

This collaboration is also known as knowledge construction as a social process. Some benefits of this social process are, 1.) Students can work to clarify and organize their ideas so they can voice them to others. 2.) It gives them opportunities to elaborate on what they learned. 3.) They are exposed to the views of others. And 4.) It enables them to discover flaws and inconsistencies (Ormrod, J. E., Educational Psychology: Developing Learners, Fourth Edition. 2003, p. 232). Cognitive theorists such as Jean Piaget and David Ausubel, and others, were concerned with the changes in a student's understanding that result from learning and with the fundamental importance of the environment. Constructivism itself has many variations, such as Generative Learning, Cognitive Apprenticeship, Problem-Based (Inquiry) Learning, Discovery Learning, situated learning. Regardless of the variety, constructivism promotes a student's free exploration within a given framework or structure.

**Behaviorism** in an educational theory grounded on the seminal works of B._F. Skinner and Ivan Pavlov, both scientists well known for their studies in animal behavior. Behaviorists believe that organisms need reinforcements to keep them interested and that the use of stimuli can be very effective in controlling behavior. For the behaviorist, environment directly shapes behavior, and complex learning requires a series of small, progressive steps. The behaviorist theory of education is probably by far the most commonly practiced, because the behaviors of the learners can be easily viewed and therefore measured, which is itself a basic premise of the scientific method.

## About accelerating the learning process:

- mnemonic techniques: mind mapping, peg lists, loci
- formulating knowledge for learning
- spaced repetition
- incremental reading

## About the mechanisms of memory and learning:

- neural networks in the brain (see also: neural networks)
- synapse
- hippocampus vs. neocortex
- sleep and learning
- memory consolidation
- short-term memory vs. working memory
- long-term memory
- declarative memory vs. procedural memory
- molecular mechanisms of memory
- the cerebellum and motor learning

# Space-time theories of consciousness

**Space-time theories of consciousness** relate the geometrical features of conscious experience, such as viewing things in space-time at a point, to the geometrical properties of the universe itself. These theories sometimes make specific predictions and so their proponents assert that they should be considered as protoscience rather than pseudoscience. This article is included to provide an insight into highly speculative physical thinking on the problem of consciousness; it is an extension of the philosophy of consciousness and should be read as *ideas* or speculation, not facts.

## *Background*

Space-time theories of consciousness have been advanced by Arthur Eddington, John Smythies and other scientists. The concept was also mentioned by Hermann Weyl who wrote that reality is a "...four-dimensional continuum which is neither 'time' nor 'space'. Only the consciousness that passes on in one portion of this world experiences the detached piece which comes to meet it and passes behind it, as history, that is, as a process that is going forward in time and takes place in space".

CD Broad (1953), in common with most authors in this field, proposed that there are two types of time, imaginary time measured in imaginary units (i) and real time measured on the real plane.

Different types of time are introduced in these hypotheses because they can interact mathematically in the equation of spacetime to produce no separation between two points. The equation of spacetime gives the spacetime separation (*ds*) between two points as:

$$ds^2 = dx^2 + dy^2 + dz^2 - c^2dt^2$$

In recent years this has been interpreted as a dynamical equation but when it was first formulated it was interpreted as a geometrical equation, specifying real separations. The geometrical interpretation arose because it was proposed that the minus sign was the result of multiplying *cidt* by *cidt* where *i* is the square root of minus one (See Einstein (1920)). It can be seen that for any separation in 3D space there is a time at which the separation in 4D spacetime is zero. Similarly, if another coordinate axis is introduced called 'real time' that changes with imaginary time then historical events can also be no distance from a point. The combination of these result in the possibility of brain activity being at a point as well as being distributed in 3D space and time. This might allow the conscious individual to observe things, including whole movements, as if viewing them from a point.

It should be stressed that, although not impossible, the simple geometrical interpretation of spacetime using imaginary numbers is no longer widely accepted in physics. It is however often used to simplify calculations and is implicit in the Wick rotation.

John Smythies proposes that there are extra dimensions for arranging things that form a separate "phenomenal space of consciousness". The phenomenal space would be a physical instantiation of Descartes' Res Cogitans, the point from which he proposed things in the brain were seen.

Alex Green has developed an empirical theory of phenomenal consciousness that proposes that conscious experience can be described as a five-dimensional manifold. As in Broad's hypothesis, space-time can contain vectors of zero length between two points in space and time because of an imaginary time coordinate. A 3D volume of brain activity over a short period of time would have the time extended geometric form of a conscious observation in 5D. Green points out that imaginary time is incompatible with the modern physical description of the world and proposes that the imaginary time coordinate is a property of the observer and unobserved things (things governed by quantum mechanics) whereas the real time of general relativity is a property of observed things.

Elizabeth Rauscher (2001) has developed a detailed theory of an eight dimensional complex Minkowski space in which such phenomena as remote viewing would be possible as well as apparently being able to view things at a point.

These space-time theories of consciousness are highly speculative but have features that their proponentes consider attractive: every individual would be unique because they are a space-time path rather than an instantaneous object (ie: the theories are non-fungible), and also because consciousness is a material thing so direct supervenience would apply. The possibility that conscious experience occupies a short period of time (the 'specious present') would mean that it can include movements and short words; these would not seem to be possible in a presentist interpretation of experience.

Theories of this type are also suggested by cosmology. The Wheeler-De Witt equation describes the quantum wave function of the universe (or more correctly, the multiverse). This equation does not involve time. Time was explained by Bryce De Witt by dividing the multiverse into an observer with measuring devices and the rest of the universe. The rest of the universe then changes relative to the observer. This introduction of time results in the occurrence of space-time, gravity and the rest of the observed material world. As the famous cosmologist Andrei Linde (2003) puts it:

> "The general theory of relativity brought with it a decisive change in this point of view [the 3D world]. Space-time and matter were found to be interdependent, and there was no longer any question which one of the two is more fundamental. Space-time was also found to have its own inherent degrees of freedom, associated with perturbations of the metric - gravitational waves. ..........."
> "Is it possible that consciousness, like space-time, has its own intrinsic degrees of freedom, and that neglecting these will lead to a description of the universe that is fundamentally incomplete?"

## Predictions

Proponents of the "Space-time theories of consciousness" assert that they make predictions, and are thus to be distinguished from pseudoscience. The predictions presented are:

The empirical theory of Alex Green predicts that a small part of the brain such as the centromedian nucleus will be sensitive to mechanical deformation and topical application of general anaesthetics, that cognitive experiments will demonstrate the creation of models of the world by the cerebral cortex that form the input to conscious experience and that consciousness is involved in the maintainence of the global stability of brain activity.

There is no evidence that these predictions have been tested specifically.

The theory of Elizabeth Rauscher predicts that certain psychic phenomena, in particular remote viewing will occur. This prediction has been examined but the existence of

## References


- Einstein, Albert, (1920). *Relativity. The Special and General Theory* (*http://www.bartleby.com/173/17.html*) online. ISBN 0517029618
- Linde, Andrei, *Science and Ultimate Reality: From Quantum to Cosmos, honoring John Wheeler's 90th birthday*. J. D. Barrow, P.C.W. Davies, & C.L. Harper eds. Cambridge University Press (2003) (*http://arxiv.org/PS_cache/hep-th/pdf/0211/0211048.pdf*)
- Broad, C.D. (1953), *Religion, Philosophy and Psychical Research* (London: Routledge & Kegan Paul). ISBN 0391004417
- Smythies, John. "Space, Time and Consciousness". (*http://www.imprint.co.uk/pdf/smythies.pdf*) *Journal of Consciousness Studies*, 10, No. 3, 2003, pp. 47-56
- Green, Alex (2002). The Description and Definition of Consciousness. (*http://www.sci-con.org/news/articles/20020901.html*) *Science and Consciousness Review*
- Rauscher, E.A. & Targ, R. (2001) "Speed of Thought: Investigation of a Complex Space-Time Metric to Describe Psychic Phenomena." (*http://www.scientificexploration.org/jse/articles/pdf/15.3_rauscher_targ.pdf*) *Journal of Scientific Exploration*, Vol. 15, No. 3, pp. 331;354, 2001

# American Mind Control in Baghdad

*Spooks use technology "proved" on one-million dead Africans* by Joe Vialls, 29 May 2003

During the late afternoon of 6 April 1994, a hail of cannon shells tore through the fuselage of a commercial airliner flying overhead central Rwanda. Several seconds later the blazing plane exploded on impact with the ground. killing President Habyarimana of Rwanda, President Ntaryamira of Burundi, and most of their senior government officials. In that fatal millisecond of time, the entire political command structure of central Africa was decapitated, leaving the way open for "Operation Crimson Mist", the most obscene terminal mind control experiment ever mounted by the United States of America against a sovereign nation. That "Crimson Mist" has been used again recently on a smaller scale in Iraq, is now beyond doubt.

As Habyarimana and his colleagues made their death dive, a small group of American men and women lounged around in a large hut at the edge of a discreet gravel airstrip a few miles from the Rwandan capital Kigali, temporary home for their three unmarked C-130 Hercules transport planes. All crewmembers carried forged credentials showing them as "atmospheric researchers" employed by an authentic civilian American agency, but these were only for emergency identification if one of the aircraft was forced to make an unscheduled landing on unfriendly territory. For all practical security purposes, neither they nor their three large aircraft were even in Africa.

When news of the presidential crash came in over the VHF radio, one of the Hercules planes was swiftly prepared for take off. The flight engineer checked the attachment of the RATO [Rocket Assisted Takeoff] packs, while the scientists made final adjustments to a large microwave dish mounted on the rear loading ramp of the aircraft. It was this strange and esoteric piece of equipment alone that would directly contribute to the deaths of more than one million African civilians during the hundred days that followed. Though completely silent in operation, the single microwave dish had more killing potential than a whole squadron of AC-130 Spectre gunships armed with fifty Gatling cannons.

Though officially tagged an "experiment", none of those present had any doubt that this was merely a cosmetic cover for the gruesome operational work ahead. Each member had been carefully vetted and then vetted again by US Intelligence to ensure they had the "right stuff", and were philosophically committed to two objectives. First was the evolving need to control or eliminate political dissent by remote means in the run up to the 21st Century, and second was the need to stem or reverse massive population increases across the world, which threatened to overwhelm existing natural resources, especially water and food. Intrinsically this required a willingness to commit mass murder, and everyone present had passed this critical test with flying colors.

As the Hercules' engines started with a roar, American agents in Kigali were working alongside local civil servants and members of the Rwandan security service, ramping up public suspicion about foul play in the presidential air crash. Urged on by corrupt officialdom, Hutu tribesmen started marching on Tutsi tribesmen and threw a few rocks at them. Innocent enough at the outset, although with a few nasty machete cuts here and there. But then the C-130 Hercules made a carefully-calculated pass directly over the advancing Hutu, and they suddenly went berserk. Eyes glazed, the mood of the Hutu crowd went from simple anger to uncontrollable rage, and within minutes, hundreds of assorted Tutsi body parts were flying through the air

What the Hercules crew had just achieved has been an open secret since the late fifties, when researchers accidentally discovered that there is a precise "control" brain wave for literally everything we do, and for everything we feel. The problem back then was that each of these control brain waves [rage, fear, panic, lethargy, vomiting and so on] had to be transmitted with an accuracy taken out to three decimal places, or they simply did not work at all. But as the years rolled by, and with the advent of transistors and microprocessors, the operational application of precise control brain waves became practical reality.

It is important to note here that the lethal trick repeated hundreds of times by the C-130 Hercules in Rwanda during April – July 1994, was not "classic mind control" in the ultimate conspiratorial meaning of the term, i.e. where people claim to hear complicated messages inside their heads, or where it is feared that the NSA [or similar] intend to turn everyone into helpless Zombies by implanting electronic chips in their arms or necks. What the C-130 crew were actually engaged in was "electromagnetically augmenting" a preexisting state.

Remember that the agents and security service personnel first had to point the Hutu tribesmen in the direction of the Tutsi, induce reasonable anger, and make sure they were appropriately armed. Only then could the C-130 go to work with the precise control brain wave of “rage”, augmenting and thus upgrading crowd behavior from that of angry demonstrators to uncontrollable genocidal maniacs. Although not “classic”, this was and is unquestionably mind control, for the simple reason that external means were being used to force an irresistible change in behavior.

For those who really want to know how governments or agencies change public behavior on a whim, the explanation is not too complicated, though obtaining details of the classified control brain frequencies is all but impossible. Various academics have actually demonstrated some of these effects quasi-publicly over the year, which provides hard reality for skeptics.

One of the leading lights in this field is Dr. Elizabeth Rauscher-Bise, who was a nuclear scientist and researcher at Lawrence Berkeley National Laboratory, and at Stanford Research Institute, Professor of Physics at John F. Kennedy University of California, research consultant to NASA and the U.S. Navy, and a member of IEEE, APS, AAAS, MAA, ANA, AAMI. Elizabeth Rauscher-Bise identified specific frequency effects to induce nausea, happiness and many other behavioral states decades ago. Clearly, Dr. Rauscher-Bise is an enthusiast: "Give me the money and three months", she boasts, "and I'll be able to affect the behavior of 80 per cent of the people in this town without their knowing it. Make them happy - or at least they'll think they're happy. Or aggressive."

Unlike many researchers in this field, Elizabeth Rauscher-Bise tends to be open about her work, has demonstrated the effects many times in quasi-public forums, and claims to experiment only on fully informed people. Many years ago during one memorable demonstration in California, she turned a specific brain wave on all students in the left-side of her auditorium, whereupon their teeth started chattering collectively and uncontrollably. When the unaffected students on the right-side of the auditorium suggested this might be some sort of trick, Elizabeth Rauscher-Bise calmly turned the specific brain wave on them instead. The right-side now suffered exactly the same fate, watched by the stunned but no longer affected students on the left-side.

The main problem lies in the delivery of the these brain waves to the target, because they all lie in the extremely low spectrum, between 0.1 and 25 Hertz [Cycles], with all control brain waves in an even narrower central band between 0.6 and 10.2 Hertz. These are effectively the same as “earth” frequencies, meaning that they are very hard to direct via conventional radio transmission. Remember that in order to be effective in selective crowd behavior augmentation, you must be able to restrict delivery to clearly defined crowds in clearly defined areas. This is achieved by using an extremely high frequency microwave beam, which is then amplitude modulated at exactly the same rate as the desired control brain wave. This is much easier to explain with pictures, so take a good look at the diagram below.

Microwaves in the 1.0 to 3.0 Gigahertz range travel in perfectly straight lines, like light, making them easy to control in terms of direction, and regardless of power output. In most cases microwaves are transmitted by a dish aerial of the sort you frequently see located low down on a tall television transmitter mast. These are designed to transfer high volume electronic data between the television studio and transmitter, and vice versa. Where the American “Mind Controllers” score with their airborne and truck mounted equipment is by using microwave aerials that can be adjusted, in exactly the same way as you would adjust the focus on a variable beam flashlight. How this is done is shown in the second diagram below.

In the Rwandan Hutu tribesmen example shown at the start of this report, the crew of the C-130 Hercules only needed to know the width of the target crowd on the ground, and the width of their own microwave beam at any given true altitude in feet [as read directly from the radar altimeter]. With those two values available, it is then a simple matter to adjust beam width to accurately bracket the target crowd from any altitude chosen.

But this equipment is not just deployed in large lumbering Hercules transport planes. During recent weeks, European security experts have concluded that smaller versions of Crimson Mist were recently deployed on the street of Baghdad, designed in part to augment the media propaganda line that Iraqi citizens are dangerous savages, all badly in need of direct supervision by “democratic” American authorities. One classic example of this was the “looting” of the Baghdad Museum, apparently by a crowd of undisciplined rabble, but video footage tells a very different story.

To pull off this stunt the American authorities needed to assemble a crowd, managed quite easily with a promise of free food. Then they needed to place the crowd outside the museum, which again was easy because they located the free food outside the museum itself. Next up, the attention of the crowd had to be drawn to the museum itself, which was achieved in spectacular fashion by firing two 120-mm shells from an Abrams tank gun straight through the main doors.

Fine so far, but how to get them inside? The video shows two soldiers gesticulating to the crowd, urging them to go in and help themselves, thereby clearly identifying the target "Rwanda-style". Then it starts to get really interesting! The two soldiers rapidly withdraw, leaving the Iraqis standing leaderless outside the open doors, and then CLICK, just like flicking a light switch, the entire crowd goes nuts absolutely simultaneously, which never happens in real life. In the real world there is always a leader visibly stirring up the crowd and preparing them for action, but not outside the Baghdad Museum. One second these folk are dull hungry Iraqis, next second they are instant uncontrollable maniacs streaming in though the museum doors.

It is also suspected that the same equipment was used to augment the "looting attacks" on various hospitals around central Baghdad, though this claim seems to be based as much on logic as it is on video footage. These so-called "looters" are Iraqi citizens who received essentially free health care in the hospitals under Saddam Hussein. Not only that, but their wives and children are being bombed and shot by Americans, meaning that their free hospitals are absolutely essential to them, and thus the very places they would normally defend in the first instance. Bearing this logic in mind, it seems likely that the European security experts are also correct in this claim. While there is unlikely to be very much concern in America, Britain and Australia for the plight of Iraqis on the streets of Baghdad, it may be time to examine what is likely to happen in our own "democratic" countries if things get more out of control than they are at present. Remember that the 2.2-million-strong demonstration in London just before the illegal invasion of Iraq, had little if anything to do with English folk liking Saddam Hussein. Iraq was merely an excuse for this unprecedented mass of human beings to migrate to London waving banners that mostly read "Not in Our Name" at corrupt politicians.

The bottom line is that the next time 2.2 million British citizens descend on the capital to have a go at the politicians [their real targets], they might be carrying something far more dangerous than banners. Every policeman and military man knows very well that a 2.2 million strong mass with hostile intent, simply cannot be stopped by standard riot control techniques, and they cannot be stopped by bullets fired by soldiers on the streets. Even if British soldiers could be persuaded to open fire on their own neighbors [most unlikely], the entire Army would be powerless to act. So what then?

Across the Atlantic in America, and in Australia, things are really no better. As I write, the American dollar is heading straight for basement levels, which in turn will lead to a depression and increased anger on the part of all Americans, aimed largely at corrupt politicians on Capitol Hill. Naturally the politicians will try to put the people down as usual, but what if this time it is a step too far. What if a few hundred or few thousand of the 260 million private weapons in American hands are brought into play, what then?

The chances are that in all affected western countries, politicians and their real masters will try to invoke the use of highly unconventional weapons in order to try and save their own worthless hides. How successful they might be when that day comes, as it surely will, is largely up to you.

# Cahra

"Psychotronic War and the Security of Russia"
by V.N Lopatin and V.D. Tsygankov
Moscow, 1999

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## *Summary*

Please note that the opinions in this article are the opinions of Cheryl Welsh, alone.

Throughout this booklet, the words electromagnetic radiation or electromagnetic frequency are abbreviated with "emr". The terms, athermal and nonthermal electromagnetic radiation effects are used interchangeably and mean the same thing. Thermal effects of emr refers to the effects caused by heating. The cooking of food in a microwave oven is a thermal effect of microwaves, for example. The nonthermal emr effects are any effect not caused by heating.

Psychotronic is the russian term for mind control, although it has been given many meanings. Generally, psychotronic is term for the use of emr to affect the brain.

Section I

The best argument for the existence of U.S. EMR Mind Control Weapons: The Russian evidence

Thanks to your generous donations, sixty-two pages of the V.N. Lopatin and V.D. Tsygankov book "Psychotronic Weapons and the Security of Russia, 1999, Moscow were translated by the UC Davis team of student translators. The whole translation is included in this compilation and a few main conclusions are listed below.

Cahra purchased a second book by Igor Vinokurov and Georgij Gurtovoj, "Society for the Research of Secrets and Mysteries of the Earth Mysteries", 1993, Moscow. Mojmir Babacek translated sections of this book on psychotronic war and one highlight is the section on Emilia Cherkova, who is mentioned in a Stolitza article below. Ms. Cherkova was a Zelenograd deputy and has filed complaints to the government of Russia on behalf of Russian psychotronic victims and became a target herself. In addition, the Fetzer Foundation of Kalamazoo, Michigan sponsored a Russian/US conference on bio-energetics and the Gurtovi book featured the 1989 Fetzer Foundation resolution signed by several scientists stating that they would not use their scientific knowledge to create weapons. Cahra purchased a third book, by V.D. Tsygankov entitled, "Neurocomputers and It's Applications, 1993. This book is in the process of being translated.

The two books, so far corroborate the previous 20+ articles gathered mainly from the Russian press since the break up of the Soviet Union. The 20+ newspaper articles can be found on Lexis Nexis library database available at most university libraries. Like the 1993 Defense News article included below, the Lopatin book is significant because it adds to the list of public figures talking openly about Russian mind control weapons. More research and analysis is needed but the information found so far is solid and will be helpful to victims of government mind control experiments.

Below are some of the highlights of the Russian book translation. This evidence is the best Russian mind control information that Cahra has found. It does not meet the scientific level of proof or the legal level of proof but it does meet the level of proof required to ask congress, human rights groups and others for an investigation into government mind control experiments. This evidence also meets the requirements of a journalism level of proof, that is several independent credible sources corroborating the evidence in a news story. In addition, information on the nonthermal effects of emr and how this ties into Russian mind control is included below. This nonthermal emr effects evidence spans fifty years and reveals an outdated U.S. cover story for mind control weapons. New evidence described below support the fact that the science behind the mind control weapons has been suppressed. As shown in previous Cahra papers, the open literature on neuroscience supports an athermal basis for at least some brain mechanisms. Hopefully, translation and research and analysis of the Tsygankov book will help in this area.

For over ten years, V.N. Lopatin has been prominent and influential in the Russian government. He has advocated the banning of Russian mind control weapons since the breakup of the Soviet Union and has taken this cause to the UN. Mr. Lopatin has a law degree, was a member of the state Duma of Russia and is currently a Russian government representative to Japan. The book includes his outline of the problem and threat of psychotronic weapons and war and the importance of public relations concerning this global threat. He writes of the proposed Russian federal law "Informational-psychological safety" concerning the protection and defense of rights and lawful interests of citizens and society. Internationally, Mr. Lopatin stands out as the most powerful public figure to advocate a ban on mind control weapons.

Evidence from the 20+ Russian articles on mind control confirm the evidence in the partial translations of the two books. There are hundreds of articles and books on psychotronic weapons in Russia. It is a popular topic, as can be seen in the 186 citations at the end of the Lopatin book, not to mention numerous footnotes. With the break up of the Soviet Union, the existence of a classified Russian mind control program was revealed by several independent and reliable sources. There were concerns that the mind control technology would fall into the hands of the Mafia, see for example, Defense News, 1993, below. Therefore, US and Russia were discussing the need for bilateral controls of the technology. Several articles allege Russian government experiments, experiments on military personnel and use of mind control weapons in Afghanistan. See below. Here are some of the sources that Cahra is trying to obtain; the Duma legislation proposed three times by Deputy Lopatin, the government documents of hundreds of complaints by citizens, military personnel and Russian government employees, the references to the Russian government documents on mind control weapons and the books and articles written on psychotronic weapons.

Credible, independent sources are stating that Russian mind control weapons exist, are being illegally used and laws are needed to protect Russian citizens. Here are a few examples with citations and full articles below.

Numerous public officials, including scientists, journalists and lawyers stated that mind control technology exists and needs to be controlled. Emilia Cherkova was discussed in the Gurtovoj book and three Russian newspapers.

Dr. Kaaznacheev, who was mentioned in the Gurtovoj book in the Fetzer Foundation letter and Emilia Cherkova are saying that mind control weapons exist and are in the hands of the military and government.

The scientist from Kiev, Sedletsky and Cherkova say there are experiments on Russian citizens. Stolitza, 1992.

Lopatin acknowledges the existence of mind control technology and even states that it was "secret for so many years". Moscow Times 1995. He dismisses the paranoid and conspiracy label on the allegations and instead takes mind control weapons very seriously, calling for legislation to ban their illegal use.

In the Moscow Times, 1995, Dr. Rudakov built the equipment and states that similar equipment was used in Afghaniztan, as does the Defense Electronics article above. The Russian journalist Vorobyovsky has studied this story for three years. A complaint was filed with the CSCE, Stolitza, 1992.

Dr. Possony is an academic and public policy analyst who stands behind his statements. He stated that emr athermal effects are the scientific basis for mind control weapons. Defense and Foreign Affairs, 1983.

1998 German TV Document, "The Zombies of the Red Czars"

Thanks to Blanche Chavoustie, Cahra has obtained a translation of the 1998 German TV channel ZDF documentary, "The Zombies of the Red Czars". This important documentary filmed the protesters demonstrating against psychotronic experiments in Moscow Square and interviewed some of the organizations against the misuse of psychotronic weapons. They allege secret psychiatric experiments all over Russia going back to the 1950s and continuing up to the present. Like their U.S. counterparts, Russian victims are labeled mentally ill, (zombies) and are not getting help.

Soviet and U.S. victims symptoms match and span over fifty years. The ZDF video described victims with psychotronic attacks on the organs of the body, including the heart. "Strange things. But when you go see a doctor he doesn't find anything." A political prisoner in the Stalinistic concentration camps was brought to an isolation cell in the KGB prison in the Lubyanka, where he experienced a psychotronic treatment of "strong sounds in the head, very strong acoustic and visual hallucinations." "The leader of the "Moscow Zombies" believes the malfunctions of the telephone are due to the effect of a psychotronic generator."

The book "Psychotronic War" by Gurtovi included a description. "The weapon seems to be capable, secretly, imperceptibly, work on his psyche, mind, behavior, desires, wishes, ...A wave of monstrous heat struck all of his body and firmly squeezed him." The section by Emilia Cherkova stated, "The victims are `tortured' secretly right in their house, from behind the walls of neighboring rooms ..." An article in the book stated, "persecution of citizens by methods of distant manipulation of the brain by means of ultrasound, microwaves, laser beams and as well computers..."

In the newspaper Delovoi Mir, "Mind Control" by Ivan Tsarev, 1992, a victim wrote, "They controlled my laughter, my thoughts, and cause pain in various parts of my body...It all started in October 1985, after I had openly criticized the first secretary of the City Committee of the Communist Party." "Sometimes voices can be heard in the head form the effect of microwave pulse radiation which causes acoustic oscillations in the brain," explained Gennady Schchelkunov, a radio electronics researcher from the Istok Association."

Here is a comparison to U.S. victims. Cahra has heard from victims all over the world. Here is a description of the cluster of symptoms common to most victims. 24 hours 7 days a week, for years on end, victims are subjected to all kinds of harassment and torture. Most agree that the technology can remotely target and control every nerve of the body. Heart rate can speed up and slow down, bowel movements can be regulated, illnesses can turn on and off in an instant. Victims report microwave hearing or voices in the head and sleep deprivation. Thoughts can be read, and played back to the victim, instanteously. People around the victim can repeat verbatim, the victim's immediate thoughts. Dreams are manipulated, behaviors controlled, emotions literally played with and all types of pain can be started and stopped in all parts of the body. Remote sexual manipulation and abuse with pedophilia, homosexual and degrading themes are reported regularly. Microwave burns are frequently reported, along with all types of bizarre and harassive manipulation of electrical equipment, phone, car, TV and computers. Black bag intelligence tactics of tire slashings, break ins and mail tampering are reported. Hologram are projected. According to victims, it is vicious, amoral, sadistic and cruel. Most victims describe the experience as very debilitating and liken it to mental rape, prison or total destruction of the quality of one's life. Most are labeled mentally ill and live with financial ruin. loss of health, social life and career. All say the technology is very sophisticated and effective as a weapon. Some victims say they would use it on their torturers and feel vindication. It is like a slow death.

1984 BBC Video, "Opening Pandora's Box"

Results from Harlan Girard's request under the freedom of information act on nonlethal weapons development in China and Russia are included here as background information V.D. Tsygankov wrote extensively of the U.S. nonlethal program and the threat that Russia must protect itself from. Tysgankov's biography is impressive, see below. Tsygankov graduated from the Odessa Electrical Engineering Institute of Communication, specializing in radio engineering. Tsygankov collaborated for many years with neuro-physiologist and academician P.K Anokhin. Dr. Anokhin's books can be found in medical libraries such as U.C. Davis. In addition Dr. Anokhin's extensive list of published works include collaboration with Dr. Mary Brazier, UCLA, 1961, for example. Of course the book does not reveal national security secrets or mind control equipment schematics, but both Tsygankov and Lopatin convey a sense of deep concern for a serious global issue. Lopatin and Tsygnkov are important to victims of government illegal experiments because they state that Russian psychotronic or mind control weapons exist and that their use should be placed under international control.

How important is the Russian information?

Nothing in the U.S. is comparable to this body of evidence of Russian mind control weapons, nothing even close. The US has been silent on this issue for over fifty years. The U.S. has repeatedly stated that Russia has mind control research, technology and weapons based on athermal effects of emr. But contrary to logic, the U.S. position was that there are no provable athermal effects from emr, according the U.S. scientists. (See DIA report and Project Pandora below). Overall, the U.S. position is that there was no U.S. research, technology or weapons based on athermal emr effects. Up to the 1990s, the U.S. government has stated that RF weapons are "too sensitive to discuss'(CNN1985) and that "Soviet mind control information" is classified, (1997 CIA/NSA foia letter). With the break up of the Soviet Union, the Pentagon unveiled the nonlethal weapons program, including weapons based on athermal emr effects, (U.S. News, 1997). Publicly, the fifty year U.S. policy of `no proven athermal emr effects' took a 180 degree about face.

The value of the Russian information to U.S. victims is that it is powerful support for the argument that the U.S. would have to be developing mind control weapons also. The Russian evidence presented here is believable and convincing, therefore it is nearly impossible for the US to deny with any credibility the existence of their own mind control arsenal.

The evidence of Russian mind control weapons is substantial in quality and quantity. Each independent source verifies almost every other source. Although there is a definite limit to the Russian mind control technology discussed and the articles all state basically the same thing, it is revealing. For example, only with the breakup of the Soviet Union, did Russia make the decision to share Smirnov's acoustic psychocorrection mind control computer programs with the FBI during consultations concerning Koresh, in order "to improve U.S/Russian relations",(Defense News, 1993).

The break up of the Soviet Union has been a unique opportunity to gather declassified evidence of a very large, very black Russian mind control program. The facts show that the U.S. was aware of the Russian program for decades. It is improbable that there will be another comparable opportunity to pierce the veil of secrecy.

U.S. victims can use this very powerful information as a group and approach Congress, human rights groups The Russian evidence validates the claims made by victims of U.S. government mind control experiments. U.S. and Russian victims can now combine their claims which date back to the 1950s and make a strong case.

Section II

The second and equally convincing argument in support of the existence of U.S. EMR mind control weapons: The East/West Controversy over Thermal/Athermal Effects of EMR Ends With the 1990s Exposure of a U.S. Cold War Cover Story for EMR Weapons

With the break up of the Soviet Union, the U.S. military unveiled a nonlethal weapons arsenal. U.S. News and World Report 1997 stated that ...And for a good 40 years the U.S. military has quietly been pursuing [emr] weapons of this sort. ...scientists, aided by government research on the "bioeffects" of beamed energy, are searching the electromagnetic and sonic spectrums for wavelengths that can affect human behavior." Looking back and reevaluating the history of emr weapons development, it becomes clear that the big users of emr technology, the military and emr related industry conducted secret research into athermal weapons effects and suppressed althermal em effects research the open literature. Government officials lied about athermal effects of emr to the U.S. public in the 60s, 70s and 80s. A quote from U.S. News provides an explanation. The public denial of athermal effects of emr was a cover story for a very long term, very classified emr weapons program. Dr. Louis Slesin, editor of Microwave News, U.S. News, 1997, "...the human body is essentially an electrochemical system, and devices that disrupt the electrical impulses of the nervous system can affect behavior and body functions. But these programs- particularly these involving antipersonnel research- are so well guarded that details are scarce. "People [in the military] go silent on this issue ...more than any other issue. People just do not want to talk about this."

The thermal/athermal or nonthermal controversy has ended with the cold war. Dr. Robert Becker, Dr. Cyril Smith and Paul Brodeur wrote books in the 1970s and 1980s about the history of emr technology development and all three presented evidence of athermal biological effects from emr. In addition they cited the Russian literature going back to the 1930s in support of nonthermal effects of emr. In contrast, the military, industry and government supported the position of Dr. Herman Schwan, the Nazi paperclip scientist who established the safety limits of emr exposure for the United States in the 1950s. Dr. Schwan's position that there are no proven athermal effects of emr is still in place today.

Dr. Stefan Possony was called the "intellectual father of Star Wars" and "one of the most influential civilian strategic planners in the Pentagon" (Guardian, 1995). Called "the greatest strategic philosophers of the 20th Century", founder of International Strategic Studies Association and former psychological warfare expert with the Office of Naval Research, Dr. Possony wrote in Defense and Foreign Affair, Psy-war: Soviet Device Experiment,6-7-83, mind control by emr is feasible and militarily important. Dr. Possony also refuted the U.S. State department's athermal theory of emr in 1983. See below for athermal controversy.

1984 BBC video, "Opening Pandora's Box", national security and the athermal controversy

Thank to Harlan Girard for a copy of the 1984 British TV documentary, "Opening Pandora's Box'. This video contains interviews with top public officials and emr experts and now, almost 20 years later, the emr weapons cover up can be clearly delineated in this video. One segment of the video features Dr. Robert Becker discussing his work for the CIA on U.S pilots shot down and captured by the Russians in the 1960s. Dr. Becker was asked by the CIA to determine if the pilots were exposed to emr similar to the Moscow Embassy microwave bombardment from 1953 to 1976. The CIA was looking for an answer to the personality changes in the psychological tests given before and after their capture.

Russian UN documents from the 1970s through the 1990s also support the video evidence, which stated that scientific evidence supports the fact that nonthermal effects could be developed for weapons. With the Pentagon's unveiling of the U.S. nonlethal weapons program , Dr. Becker's theory that the U.S. is running a very black and very large emr weapons program in the 1970s is well supported. Dr. Becker discussed the Moscow Embassy microwave bombardment by the Russians from 1953 to at least 1988, (AP, 1988, Reppert), and the Russian Woodpecker signal, used by the Russians to irradiate the U.S. beginning in 1977 and later verified at least to 1988. Dr. Becker and others suspected that the Russians were attempting to create health and psychological effects in the U.S. population from the emr.

Significant facts of 1984 BBC video

Project Pandora: The U.S. government explores whether the Soviets are using emr as a weapon The Soviets started bombarding the American Embassy in Moscow in 1953 and the U.S. government funded Project Pandora to find out why.

Nonthermal effects of emr used as psychological and biological weapons by U.S./Soviets 1976 DIA Report based on soviet research state that Soviets claimed that microwaves could be found in human beings, to disorientate a person and a specific frequency could cause a heart attack.

Nonthermal emr effects controversy is born. U.S denies effects, Soviets disagree Dr. Sam Koslov, director of Project Pandora continued, "[We] thought about it, don't get me wrong,... but nothing was found, it doesn't

look like[there is]...militarily at this time, there is no emr weapons potential. There is nothing to the biological effects claim. There is an amount of power problem."

Since the Korean war, the art of brainwashing has improved significantly, says David Jones. Dr. Becker was asked by the CIA in early 60s to determine whether pilots shot down and captured by Soviets in the 1960s could possibly have been exposed to emr without them realizing it and would that have caused personality change. Dr. Becker stated, "Yes, there is a distinct possibility, we don't know at this time for sure."

The Moscow microwave bombardment is a prototype weapon of the 1977 Soviet Woodpecker Emr signal: Soviet emr weapons go public Dr. Beck stated, "[the 1976] Russian woodpecker signal is the most powerful man made emr source ever. 10 pulses per second, 40 million watts per pulse, it is psycho active." It is generated in the Soviet Union and permeates everything in the U.S. It was picked up by power grids and irradiated into homes."

Persistent rumors that U.S. signal beamed over Russia. "They are the most expensive and powerful in the world." "Dr. Becker said there are persistent rumors that the U.S. is doing the same to the Soviet Union, powerful U.S. transmitters beaming 16 cycles per second to produce the same effect as the Soviets, into the Soviet Union.' "We are in the middle of electronic warfare aimed at citizens of both countries."

Twenty years later: Conclusions of 1984 BBC video

Athermal effects of emr are used as a basis for weapons and is a national security issue. The controversy over athermal effects of emr is described as a national security issue by top emr scientists such as Dr. Becker, Dr. Beck and Dr. Zaret, all of whom were consulted by the CIA about the irradiation of the Moscow Embassy. The U.S. government trusted their judgment in the most demanding situation, national security matters.

HAARP, the U.S. transmitter of the 1990s, part of a vast weapons system capable of influencing human behavior. The article, "Apocalypse Now? HAARP or How the US Military is Playing the Sorcerer's Apprentices", by Alain Gossens, Bussels Telemoustique, 22-5-97 was translated by FBIS from french,(see foia section). The article describes the controversy surrounding the HAARP project. "Unofficially, HAARP will use the ionosphere, turning it into an energy weapon." Similar to the Moscow Embassy microwave bombardment and the Russian Woodpecker, the public is never told what is really going on. It is difficult to not believe that these are powerful weapons because both countries continue for decades to develop them. Mind control purposes are equally plausible as other theories such as over- the horizon radar which is better accomplished by other means, Dr. Becker stated.

U.S. cover story of no provable athermal effects can no longer be credibly maintained by U.S. According to Dr. Becker, consultant to the CIA in the early 1960s, the Soviets irradiated the Moscow Embassy and U.S citizens with the Woodpecker signal at great cost and for decades. Dr. Becker described these aggressive acts by the Soviets and the U.S. as an electronic war on the citizens of both countries.

A cover up begins: U.S. government knew of athermal emr effects at least in the 1960s. By basing the U.S. safety standard for emr exposure on politics rather than scientific evidence, the U.S. government knowingly risked the health of U.S. citizens.

Evidence supports a `Manhattan Project' mind control program based on emr athermal effects. The argument can now move to the extent that athermal biological emr weapon effects are capable of controlling the human body and behavior. Fifty years later, the U.S. government is on the record for lying about this issue. There is a mind control program more secret than the Manhattan Project, as Dr. Becker theorized and brain function is based on an athermal emr biological effects. Very sophisticated technology has been developed to control the mind, comparable to the atomic bomb.

Here is one stunning example of many available examples to show how far unclasified neurology research has advanced. A logical conclusion, given all of the evidence presented in this compilation, is that the classified research would make a very powerful mind control weapon. The article illustrates the convenient cover story that the Soviets have mind control research, that brain research for weapons purposes is classified and that emr athermal effects are the basis of mind control weapons. The stunning information is that the U.S. military is funding research to make a device for "inject[ing] information into the brain via electromagnetic waves."

U.S. News, 1-3-2000, John Norseen, Reading and changing your mind. [Lockheed Martin neuroengineer in Intelligent Systems Division] Norseen's interest in the brain stems from a Soviet book he read in the mid-1980s, claiming that research on the mind would revolutionize the military and society at large. [He] coined the term "Biofusion" to cover his plans to map and manipulate [the brain] leading to advances in ...national security... and ...would be able to convert thoughts into computer commands by deciphering the brain's electrical activity. BioFusion would reveal the fingerprints of the brain by using mathematical models, [Smirnov's computer program uses mathematical models also]. It sound crazy,...The National Aeronautics and Space Administration, the Defense Advanced Research Projects Agency, ...have all awarded...research contracts to Norseen. Norseen is waiting to hear if the second stage of these contracts-portions of them classified- comes through. Norseen's theories are grounded in current science. ...By MRI, scientists can tell what the person was doing at the time of the recording...Emotions from love to hate can be recognized from the brain's electrical activity. ...Norseen predicts profiling by brain print will be in place by 2005. ...Norseen would like to draw upon Russian brain-mimicking software and American brain -mapping breakthroughs to allow that communication to take place in a less invasive way. A modified helmut could record a pilot's brainwaves. "When you say right 090 degrees...the computer would see that electrical pattern in the brain and turn the plane 090 degrees. If the pilot misheard instructions to turn 090 degrees and was thinking "080 degrees," the helmut would detect the error, then inject the right number via electromagnetic waves."

An Electronic War starting with the Moscow Embassy: Serious Implications for the World Besides the need to stop illegal government emr weapons experiments, it is important to educate the public because of the far-reaching global effects surrounding this issue.

2000 Video, "Public Exposure", Cell Phone industry and athermal controversy

Thanks to Betsy Manning for the 2000 video, "Public Exposure" by the Council on Wireless Technology Impacts. This video exposes emr industry abuses similar to the tobacco industry. Billions of dollars in cell phone sales are behind the athermal controversy and a complete lack of concern for the health of consumers. Because Dr. Schwan's 1950s safety limit for exposure to emr is the U.S. standard today, the U.S public health is at risk. While the cell phone industry testified in a 2000 California Senate hearing that there were no health risks from cell phone use, a scientist testified that the cell phone industry was suppressing research. Another expert, Cindy Sage, Environmental Policy analyst explained the controversy. Athermal effects occur below the U.S. safety standard. The U.S. safety standard is the guideline for the cell phone industry. The scientific studies are reporting damaging health effects below the safety standard but the cell phone industry ignores the research because it is below the U.S. safety standard. Science author B. Blake Levitt wrote the book "Electromagnetic Fields", and explained that the industry knows it will take twenty years for scientific evidence to prove possible damaging health effects from cell phone emr exposure. In the meantime, billions of dollars are pocketed and there is little research into the rising incidence of cancer because the major funder of research is the cell phone industry. In another segment of the video, there were protest marches around the country against section 704 of the Telecommunications Act of 1996. Section 704 states that local governments are banned from taking into consideration the health effects of microwave, TV, radio and other emr towers which are to be located in their area.

Standard of proof: lessons learned from the cell phone video.

Cindy Sage in the 2000 video entitled "Public Exposure" described three levels of proof, the scientific level of proof, which is the highest level, almost 100%, the legal standard of proof, or 51%, the more probable than not standard and the environmental law standard, in the 10 to 30% range. Ms. Sage stated that the environmental law standard is the level at which public decision making on environmental issues takes place, i.e., at the potential level for a significant health impact. Ms. Sage believes that the emr controversy should be judged by the environmental law standard of proof and she mentioned the California Environmental Quality Act. [Note, I took an environmental law class in summer 2001 and the 2001 environmental law text book listed emr under toxic substances and described it as a controversial topic.]

An association but not a direct cause and effect scientific relationship between the exposure to emr from cell phones and the risk of detrimental health effects has been established. The cigarette industry used the scientific standard of proof, saying that there is no scientific cause and effect between smoking and lung cancer. The cell phone industry is using the same tactic. Environmental issues are decided at the 10-30% level of potential harm in order to protect public health. The cigarette industry's scientific standard of proof did not protect the public. In the late 1990s, all of the top executives of the major tobacco companies testified before Congress, under oather that cigarette smoking does not cause harm to a smoker's health. This is a blatant indicative of the lengths that companies will go to sell their products. Today, it is well known that many smokers died from lung cancer as a result of smoking and the addictive qualities of nicotine. Therefore the environmental standard of proof should be used in the emr research evaluations in order to protect the public.

In addition human rights violations standard of proof is lower and showld apply to mind control victims because this is a human rights issue.

Section III

Conclusion: What this information means to victims of nonconsensual government experiments

Victims have two strong arguments for demanding an investigation into their allegations. If the Russians have mind control weapons, the U.S. undoubtedly has a mind control arsenal.

The evidence in this compilation spans 50 years, includes several independent, mainstream sources, and credible professionals, all stating that mind control in Russia exists. The historical and scientific evidence also supports a very long-term, large and classified emr weapons program in Russia and the U.S. The U.S government is on record for lying to the U.S. public about lack of proof of nonthermal effects while the Russians claim that nonthermal effects of emr are being used for weapons. Now in the 1990s, the U.S. reveals the nonlethal weapons program and claims in U.S. News and World Report, 7-7-97, that "scientists, aided by the military research on the `bioeffects' of beamed energy are searching the electromagnetic and sonic spectrums for wavelengths that can affect human behavior." The translation of the 1999 Lopatin book is the best evidence yet, a top Russian politician and scientist claim Russian mind control weapons exist and should be under international control.

Second, the athermal controversy is equally convincing historical evidence of a classified U.S. mind control program.

The number of victims in the U.S. and Russia, not to mention other countries is growing. For the first time, victims as a group can now organize and go to their congressional representatives, human rights groups, lawyers and investigative reporters and present an adequate level of proof of their claims, never before possible. The evidence now meets the standard of proof required for mainstream journalism, public knowledge and investigations such as a GAO investigation or a congressional hearing or a human rights investigation. Please see below for evidence and citations.

Electronic warfare since 1953, without public knowledge

In "Project Pandora", Dr. Becker, an emminent scientist consulted by the U.S. government on emr national security issues has warned of the electronic war on the citizens of the U.S and U.S.S.R. Many experts including Oppenheimer have warned that the Orwellian dangers of mind control are worse than the atomic bomb,(American Psychological Association). Information warfare using the mind as a target was described in the tv program, War 2020. War would be fought without even knowledge of a war taking place, (See Cahra International Campaign section).

In his 1990s book, "Crosscurrents", Dr. Becker wrote that it may be too late to stop the ongoing weapons programs. Unlike peace, electronic warfare resembles another cold war with its resultant high costs. Experts and public officials from the east and west warn of the dangers of psychotronic weapons or nonlethal emr weapons, the need for international control and of the need for open public debate.

What can be done?

Cahra does not have the resources to organize victims but I hope that others will. If this issue is presented as the international human rights issue that it is, public officials will be able to use their authority to ask for an investigation. Cahra will send this compilation with original articles and translation at cost for xeroxing and postage to anyone interested in stopping nonconsensual government experiments.

Finally, thank you to all of the victims who generously donated to this project and also to those who shared their information included in this article. I could not have done it without you. The Russian translation project is a major step forward. I hope that much more research can be done and that as a result, a better strategy to stop illegal government experiments will be found in our lifetime.

Russian Experts State Mind Control Weapons Exist and
Warn of Dangers of Psychotronic Weapons and War.

"...decades of research and investment of untold millions of rubles in the process of psycho-corrections has produced the ability to alter behavior on willing and unwilling subjects, experts add. The Russian experts, including George Kotov, A former KGB general also report a list of software and hardware associated with their psycho-correction program that could be procured for as little as $80,000. As far as it has become possible to probe and correct psychic contents of human beings despite their will and consciousness by instrumental means; results having been achieved can get out of [our] control and be used with inhumane purposes of manipulating psyche," Defense News 1993.

U.S. sources said government officials and leaders from the business and medical communities will consider Russian offers to place the mind-control capability under bilateral controls. The sources say the Russian government, in the spirit of improved U.S.-Russian relations, is beginning to lift the veil of secrecy surrounding the technology [acoustic psycho-corrections, the transmission of specific commands via static or white noise bands into the human subconscious without upsetting other intellectual functions]. Defense News, 1993.

Dr. Igor Smirnov, consultant to the FBI about the use of acoustic psycho-correction on Koresh and one of the most important Russian psychiatrists, showing a computer illustration of the human subconscious, "To rule the [human] soul, one only has to put them into the area of effective vicinity of the apparatus. Or, there is already a method to transmit hidden information over long distances. According to Smirnov [such a method] does exist. ZDF, 1998.

V.N. Lopatin, author of "Psychotronic War and the Security of Russia", 1999, Moscow, Russian duma deputy advocates against mind control weapons in Russia and internationally for ten years. Lopatin proposes three times, legislation to ban illegal development and sale of mind-control devices. Lopatin quote in Moscow Times, 7-11-95, "Of course this project [psychotronics] is surrounded with alot of hysteria and conjecture. ....Something that was secret for so many years is the perfect breeding ground for conspiracy theories."

V.D. Tsygankov, co-author of "Psychotronic War and the Security of Russia",1999, Moscow, scientist spent many years studying bionics and the development of neuro-computers. Tsygankov describes the problems of psychotronic weapons and war.

Lieutenant Colonel Timothy L. Thomas, US Army, Retired, writing about information warfare and a hard to believe report by a Russian scientist form the renowned Russian Baumann Technical Institute on use of computer screens to control or kill people. "...Yet in hindsight, man once could not comprehend electricity either, and we should at least consider the possibility of this phenomenon. As the Russians have noted on several occasions, he who makes the first inroads into this area will control the destiny of mankind in the near future. Military Review, 1997

Victor Sedletsky, scientist interviewed by Stolitsa, 1992, "As an expert and a juridical person, I assert that mass productions of psychotronic biogenerators and their testing is underway in Kiev."

Academician V. Kaznacheyev from Novosibirsk writes in Stolitsa, "The military may use ESP to paralyze the will of other people turning them into obedient slaves." Kaznacheyev therefore insists on placing this kind of research under international control.

Fetzer Foundation of Michigan, Resolution, from Gurtovi book, "Psychotronic War", on emr research, "...we voluntarily undertake an agreement to never use, under any conditions, such weaponry and to sign any international agreements concerning this end.", signed by 20 science and administrative Fetzer conference participants, 1989.

From Gurtovi book, 1988, psychologist and psychotherapist from Netherlands, Vim Kramer, in a speech to First European Conference of Parapsychological Association, "What is needed now is openness of the research and freedom of information with respect to those perhaps secretly performed works, the results of which may be guilefully used in psychotronic war. ...It is necessary to hurry.. Since, in the opposite case, in the next century, perhaps it will be difficult to survive not only for parapsychology, but to the whole mankind."

"Ludmila Pikhova, an experienced presidential aide and speech writer turned on Rogozin,[Kremlin Security, former KGB and chief scientist on security problems], during a recent Kremlin meeting, screaming, "Don't you try to control my subconscious ever again.", reported in 1995 Washington Times.

Sergei Parkhmenko Russian journalist, Sevodnya newspaper put together a dossier of strange goings-on, including Ludmila Pikhova and other top officials in the Kremlin and confirms many persistent rumors of unusual surveillance, including mind control, Washington Post 1995

Journalist Yury Vorobyovsky has been investigating the top secret program of "psychotronic" brainwashing techniques developed by the KGB and the Ministry for three years. Moscow Times, 7-11-95.

Dr. Rudakov worked in a Defense Ministry psychotronic research laboratory and claimed that psychotronics were used on Spetsnaz troops in Afghanistan according to Moscow Times, 7-11-95. Defense Electronics, 1992 confirmed Dr. Rudakov's information and reported an intelligence agency source, "...we know there is evidence the Soviet Army's Special Forces used the technology during the conflict in Afghanistan."

Anatholiy Ptushenko, member of the Russian Federation of Space Exploration Scientific and Technical Council, 1994, Moscow Rabochaya Truibuna. "So a microwave system can easily be tuned into a psychotropic weapon--formidable in that it has a direct effect on the human brain...just by retuning the generator. ...which started to be developed in the sixties. ...The terrible danger of psychotropic weapons is the possibility of their simultaneously and unequivocally affecting large masses of people over huge areas. ...Nevertheless, faced with such a terrible danger as psychotropic weapons..., it is our duty to ensure that the development and operation of space based solar energy system receive popular and above all mass media scrutiny."

Moscow Armeyskiy Sbornik, 1996, by Major General Valeriy Menshikov, doctor of technical sciences and Colonel Boris Rodionov, "A psychophysical effect on people also is possible for the purpose of altering their behavior and even controlling the social aims...Thus, the new space systems are potentially dangerous from the aspect of unfolding a wide-scale "information war" and even creating a global systems for controlling people's behavior in any region...A country possessing them will gain an enormous advantage."

1983 Defense and Foreign Affairs. Dr. Stefan Possony was a Stanford Hoover Institute fellow and was called "the intellectual father of `Star Wars" and "one of the most influential civilian strategic planners in the Pentagon" (Guardian, 1995, obituary). Dr. Possony describes the feasibility of communicating directly with the brain using emr and developing emr weapons. Dr. Possony discussed the microwave bombardment of the Moscow Embassy and inferred that the State Department lied about athermal health effects from the microwave irradiation.

# Scientifically Proven Victim Symptoms

| Symptoms | Scientifically Proven | Scientifically Feasible and Military Interest |
|---|---|---|
| 1. Microwave Hearing. (DIA Report 1976), NASA DOC AD AO90426, Dr. Allan Frey, Dr. James Lin | Yes | Yes |
| 2. Smirnov acoustic psycho-correction, transmission of specific commands into subconscious, Demonstration, Defense News, 1993 Defense Electronics, 1992 | Yes, per Janet Morris, 1990s | Yes, bilateral controls. US Corp. Russian equipment |
| 3. Emr signals to brain causing visual disturbances. Demonstration by Dr. Rauscher, Bise on CNN 1985. | Yes | Yes, Dr. Becker |
| 4. Inject words, numbers into brain via emr waves. U.S. News, 2000, J. Norseem | No | Yes, review by military for funding |
| 5. Manipulation of emotions via magnetic signals to the br ain. ABC News 1998, demonstration Magnetic Therapy for depression | Yes | Russian newspaper allegations Yes, War 2020, Discovery Chan., demonstration |
| 6. Reading thoughts by deciphering brain electromagnetic signals U.S. News, 2000, J. Norseen, LA Times, 1976, etc. | Yes | Yes |
| 7. Disruption of internal organs, severe pain, nausea, diarrhea, Bul. Atomic Sci. 1994, etc. | Yes, heating weapon demonstration, rest heavily discussed | Yes, nonlethal |
| 8. Remote manipulation of human behavior from space | | |
| 1. Russian Federation of Space Exploration Scientific and Technical Council, member Anatoliy Pushenko | No, credible account of 1960s Russian weapons programs | Yes |
| 2. Also, Russian Major General and only Colonel FBIS article | No, accounts only | Yes |
| 3. Scientists, weapons experts, EU members on U.S. HAARP Project, from Brussels Telemoustique,1997, FBIS article. | No | Yes |

Thanks to an anonymous tip, Cahra is sponsoring the translation of the 1999 Russian book, "Psychotronic War and Security of Russia", by V.N. Lopatin and V.D. Tsygankov. "Psychotronic" includes electromagnetic radiation, (emr) and mind control weapons.

This is the Russian translation of the author and title, above. ISBN 5-89638-006-2. 99-5371.

A few people in Cahra's network have engineering backgrounds and may use the technical information in the book. The U.S. government position is that emr technology is classified. Therefore technical information on Russian victims and Russian mind control technology will support the claims of extensive use of mind control weapons and the obvious need for the US to have corresponding mind control technology, a fact which is denied by the US government.

There are a few attorneys working on freedom of information requests and this information could narrow the search. The Russian legal and political writings and government documents by Duma expert Lopatin will be invaluable for credibility and substantiation of mind control experiments on an international level. Finally, the information on victims in Russia could be evaluated and added to the literature review in the Dr. Bertell Preliminary Study.

Background information

Yuriy Lopatin, author of the Russian book, is mentioned in two unclassified government documents received under a freedom of information act request. The subject was a Moscow Russian Public Television program on Oct 6, 1995 entitled "Man and Law", Scientists Discuss Mind Control Technology. The program included an interview of ;

"State Duma expert Yuriy Lopatin calling for legislation banning illegal development and sale of mind-control devices." The documents stated further, "A State Duma expert, Yuriy Lopatin says: "Psychotronic Technology is spreading illegally. A law banning the illegal development, production, retailing, and spreading of psychotronic devices which influence the minds and behavior of citizens is badly needed." He goes on to say: "The use of the mass media for psychological experiments should be banned and all the state-ordered research in human genetic experiments should be strictly registered. This was approved by Georgiy Georgiyevich Rogozin, first Deputy Head of the Presidential Security Service."

A highly recommended , credible book on a topic rarely written about.

An AP reporter familiar with the emr issue, recommended translating this book after reviewing an excerpt. The UC Davis Russian Studies professor was impressed with Lopatin. At forty, according to the biography in the book, he had accomplished alot and held a high position in the Russian government. The second author, a radio engineer or scientist, V.D. Tsigankov is also well recommended.

A Russian view of mind control weapons not reported in the western press and a strong recommendation of this book.

The person who gave the anonymous tip wrote the following insightful information, which correlates which the 25 Russian articles which Cahra has collected from the library database Lexis Nexis. (See Cahra website, entry 11, chapter 5 for a partial list of the Russian articles.)

"There is also published in 1999 in Moskow very serious and fundamental book by Lopatin. He is author of the third legislation project, the chairman of Dumas Ecological Committee before the autumn of 1999. I have read about Emilia Cherkova and her group in Russian book "Psychotronic War" by A.Vinokurov and M.Gurtovoi, edited in Moskow in 1993. This organization had approximately 500 members in 1990-1993, mostly democratic activists from Russia and Moskov - victims, targeted by KGB using infrasonic and psychotronic weapon in combination with direct "hunting" on the cities streets.

Even after the dead of USSR in 1991, in the summer of 1992 KGB in Russia hired graduated students from medical universities (psychiatrists, psychoanalytics) to work in secret laboratories on human behavior control experimentation. After the second victory of democracy in October 1993 the hunting on people was officially prohibited. But a large amount of psychotronic devices had been sold to criminals and different kinds of private Security Services. After that this devices often used for apartment extortion, criminal attacks, and racket.

In Russian Parliament from 1993 till 1999 were prepared 3 different legislation projects against human behavior control experimentation and non-lethal weapon harassment, but no one had been accepted. In Ukrainan and Russian press from 1990 published a lot of articles concerning development and usage of psychotronic weapon (psychotronic generators) on the territory of former USSR and in Ukraine, and now I have found a lot of resources In Russian and Ukrainan segments of Internet."

The table of contents of the Lopatin book has been translated and includes the following highlights.

Chapter 1. The Problem of Psychotronic Weapons and Psychotronic War.

Chapter 2. The Informational Foundations of PSO

Chapter 3. The Physical-Biological Basis of PSO

Chapter 3.1. Elementary Particles, The Interaction of Radiation and Matter

Chapter 3.2. Chromosomal Target, Mitogenetic Rays and A.G. Gorvich's Biological Fields

Chapter 4. Types of PSO, Its Harmful Factors and Field Applications

Chapter 4.3 Hypnosis

Chapter 4.6 Telepathy

Chapter 4.14 Technical Means of PSO, Interactions

Chapter 4.15 Neurocomputers As Possible PSO Means

Chapter 5.4 V.I. Vernadki's Noosphere and the Russian Nationalist Idea

Chapter 6. State Defense Initiative and Conceptions of Arms

Chapter 6.1 ONSD- Weapons of Nonfatal Effect

Chapter 6.2. Financial Fights in the U.S. Military

Chapter 6.3. Conception of PSO Weapons

Chapter 7. Legal Problems of Defense From Informational Weapons

Chapter 7.1. Topicality of Problems, Forms, And Harmful Information

Chapter 7.3 State System of Guaranteeing Informational-Psychological Safety

Chapter 7.4 Informational Weapons in Informational War

Chapter 7.5 Particularities in Legal Protection and the Proper Defense for Informational Systems

More Russian book translations to follow.

This may be just the beginning of an expanding Russian translation project. There is an extensive bibliography in the Lopatin book and a translation may lead to more critical Russian government documents and papers. The Russian group of human rights experts including Lopatin, who are against the illegal use of psychotronic (emr) weapons and also the victims of Russian psychotronic experiments, have made highly commendable progress in Russia. I hope that we can work with our Russian counterparts in the future. And finally, Cahra is trying to find a second book given in the anonymous tip above, entitled

"Psychotronic War" by A. Vinokurov and M. Gurtovoi, edited in Moskow in 1993. If anyone has information on this book, please contact Cahra.

Short Comments

Thanks to your generous donations, 62 pages out of a total of 140 of the V.N. Lopatin and V.D. Tsygankov book "Psychotronic Weapons and the Security of Russia, 1999, Moscow were translated by the UC Davis team of student translators. A summary of the main conclusions and highlights of the Russian book translation are below. The whole translation, so far is included in this compilation just after the summary.

This evidence is the most substantiating Russian mind control information that Cahra has found. Internationally, Mr. Lopatin stands out as the most powerful public figure to advocate a ban on mind control weapons.

The evidence in this compilation does not meet the scientific level of proof or the legal level of proof but it does meet the level of proof required to ask congress, human rights groups and others for an investigation into government mind control experiments. This evidence also meets the requirements of a journalism level of proof; several independent credible sources corroborating the evidence in a news story.

V.N. Lopatin: prominent and influential public official in Russian Government for ten years.

For over ten years, V.N. Lopatin has been prominent and influential in the Russian government. He has advocated the banning of Russian mind control weapons since the breakup of the Soviet Union and has taken this cause to the UN. Mr. Lopatin has a law degree, was a member of the state Duma of Russia and is currently a Russian government representative to Japan. The book includes his outline of the problem and threat of psychotronic weapons and war and the importance of public relations concerning this global threat. He writes of the proposed Russian federal law "Informational-psychological safety" concerning the protection and defense of rights and lawful interests of citizens and society. Internationally, Mr. Lopatin stands out as the most powerful public figure to advocate a ban on mind control weapons.

Yuriy Lopatin, author of the Russian book, is mentioned in two unclassified government documents received under a freedom of information act request. The subject was a Moscow Russian Public Television program on Oct 6, 1995 entitled "Man and Law", Scientists Discuss Mind Control Technology. The program included an interview of Lopatin.

"State Duma expert Yuriy Lopatin calling for legislation banning illegal development and sale of mind-control devices." The documents stated further, "A State Duma expert, Yuriy Lopatin says: "Psychotronic Technology is spreading illegally. A law banning the illegal development, production, retailing, and spreading of psychotronic devices which influence the minds and behavior of citizens is badly needed." He goes on to say: "The use of the mass media for psychological experiments should be banned and all the state-ordered research in human genetic experiments should be strictly registered. This was approved by Georgiy Georgiyevich Rogozin, first Deputy Head of the Presidential Security Service."

The following article excerpt discusses Lopatin's ten year work to ban mind control weapons.

February 14, 2000, Monday THE RIDERS OF THE "PSYCHOTROPIC" APOCALYPSE Segodnya, February 11, 2000, by Andrei Soldatov

"THE RUSSIAN DEPUTIES INTEND TO DISCUSS THE DRAFT LAW ON INFORMATION SECURITY IN THE COUNTRY. THIS DECISION AROSE FROM THE FACT THAT THE US ALLEGEDLY CREATED A LOT OF DEVICES, WHICH CAN DESTROY INFORMATION SYSTEMS IN RUSSIA AND INFLUENCE THE POPULATION. According to "Segodnya," currently the Duma is actively discussing the draft law on the information-psychological security submitted by Vladimir Lopatin. It is possible that the fruit of ten years of work (the works on the draft law began in 1990) will be discussed in the first reading in April.

Such laws have never been discussed in any country. But this fact does not embarrass the deputies because they discovered that the enemy, which threatens Russia in this sphere, is dreadful and powerful. Secret methods of information-psychological influence can not only harm a person's health, but also lead to "the loss of people's freedom on the unconscious level, the loss of capability of political, cultural and other self-identification, manipulations with social consciousness" and even "the destruction of a common informational and spiritual integrity of the Russian Federation".

The next Lexis-Nexis article excerpt is an example of Lopatin's high position in Russian government.

Interfax Russian News, August 16, 1999, DUMA TO DEBATE PM'S CONFIRMATION, DAGESTAN ON MONDAY MOSCOW. Aug 16 (Interfax) The Russian State Duma will debate at its meeting on Monday the confirmation of Vladimir Putin, nominated by President Boris Yeltsin for premiership, and the situation in Dagestan.

Four hundred and four out of the total membership of 450 are attending the session which started at 2 p.m.

The Communist Party of Russia (KPRF) group's coordinator Sergei Reshulsky suggested that the Dagestan issue be included in the agenda. Defense Committee Chairman Roman Popkovich, Our Home Is Russia, and Vladimir Lopatin, Russia's Regions, support him. Lopatin went so far as to suggest skipping speeches by party group leaders in debating Putin's confirmation so as to allow time for debating a resolution on Dagestan. ...

This final article on Lopatin's background describes Lopatin's visit with U.S. Defense Secretary Cheney and Lopatin's press conference at the National Press Club. See also Bulletin of Atomic Scientist, Jan/Feb. 1991 "Renegade Russians Grab For Military Control" by Jennifer Scheck Lee which stated, "...Yeltsin's September 1990 choice of Lopatin, a former navy officer equivalent to major, to head the republic's new State Committe on Public Security..."

The Xinhua General Overseas News Service

Xinhua News Agency.OCTOBER 11, 1990, THURSDAY u.s. defense secretary to visit Moscow Cheney will stop over in London on his way to Moscow and in Paris on the way back. William's also disclosed today that yesterday, Cheney met with a young soviet military "reformer," Major Vladimir Lopatin, and had a "private conversation" with him. he declined to reveal the contents of the conversation. Lopatin, who addressed a press conference at the national press club here today, is in the united states on a visit hosted by "Global Outlook," a research institute.

V.D. Tsygankov writes six chapters of summary of psychotronic war, V.N. Lopatin writes one chapter about legislation to control psychotronic weapons use.

From the Publisher. Here are excerpts from pages 6,7 and 8 by "publisher and scientific editor of the serious informationization of Russian the 21st century. Cand/ Tech/ Scie/ V.L. Gyrevich, Moscow, Nov. 1998". Gyrevich describes the organization and subject-matter of the book.

...A psychotronic weapon is an effect on the brain, not as much an effect of the words as it is the energy information fields, for example (tertionic fields). A psychotronic war will not need big financing, and it will not cause the destruction of material objects. It means the consistent distortion of the people's psyche. ...The first six chapters of this book were prepared by the candidate of science, Vladimir Dimitrievich Sigankoff, The seventh chapter of the book was prepared by the candidate of jurisprudence, the head of the union of lawyers of Vologotskaya area, Vadimir Nickolaevich Lopatin- As opposed to the first six chapters, there are materials about the peculiarity of legislative defense and the defense of the rights of information systems during the availability of psychological security. ...These materials are new and available to the reader for the first time.

V.D. Tsygankov summarizes psychotronic weapons. Further research is needed.

Here are highlights of chapter 6. State Defense Initiative and Concept of Arms By V.D. Tygankov. The science described by Tsygankov is not clear to a layman and further research is needed. Tysgankov refers to Dr. Shipov and Dr. Akimov in chapter 3 and cites their scientific work in the literature section. The Russian Academy of Science debunked their work on torsion fields and questioned their credentials and this information is included below. In addition, see Fate Magazine article in 20+ Russian article section below for reference to Dr. Akimov and mind control research. Dr. Akimov received a tremendous amount of state funding according to the Stolita article below and yet was later debunded by science officials. There are Russian government documents mentioned in the Stolita and Fate Magazine articles that can be obtained so that this controversy can be explored further. The possibilty of government cover up of a Russian mind control program is possible.

Tsygankov writes that after the breakup of the USSR and the Warsaw Pact, the US considers itself "the single superpower" and `a monopolistic technological leader in the world'. Tsygankov states that in addition to the nuclear doctrine, is the threat of US development of nonlethal weapons. He surveys the US Department of Defense finances and key technologies and his analysis reveals that the main emphasis in choice of key technologies is the development of GAUGE, or means of global monitoring of space and utilization of informational technologies.

Next, Tsygankov writes that each and every country should be able to provide adequate means and force to oppose the US. Tsygankov's opinion is that Russia should use "the State Defense Initiative'. It is as follows and includes Tsygankov's capitalization and bold writing.

PUBLICLY, OPENLY, with complete INFORMATION and OPEN DIALOGUE with each interested individual or country;

In the creation of a POWERFUL PUBLIC OPINION and the IMPERMISSABILITY of SECRET PROJECTS in the sphere of PSW, in the prohibition of such projects and in the DESTRUCTION of samples and supplies of PSW;

Openly conducting projection CREATING means of defense from PSW influence under complete and strict INTERNATIONAL CONTROL;

In an urgent conclusion of international agreements of organizing a joint INSPECTION of projects and state territories conducting Psi-developments;

In creating a COLLECTIVE intergovernment, international SCIENTIFIC CENTERS (similar to UNI-United Nuclear Institute) coordinating plans and programs for solving complex global Psi-problem.

Tsygankov then lists 19 Basic Propositions of Psi-Weapons. He explains that PSW psychotronic weapons are related to the Pi-problem. "The fundamental principle of Psi-armament concept is its humane direction in the name of survival of humanity."

The chapter ends with 5 conclusions. First, "...Prohibition and destruction of PSW under strict international control." Second, "...preservation of a healthy ecology of consciousness of all the citizens, of the most valuable intellectual gene repository of Russia." Third, "...removal of veil of secrecy,..." Fourth, "...Creation of the Global system of rapid-monitoring of consciousness' ecology and Psi-conditions." Fifth, "...create an organizational structure under the President."

V.N. Lopatin discusses his detailed and legalistic views on psychotronic weapons. Mind control weapons are categorized as an information weapons.

A Note on the Tsygankov science controversy

Here is an article that indicates how the Lopatin/ Tsygankov book may be analyzed on the international level. See especially the third paragraph. Also note that Lopatin refers to the Virus 666 in chapter 7.

The article is "The Age of the New Persuaders", by Lieutenant Colonel Timothy L. Thomas, US Army, Retired May/June 1997 Military Review, p 72. 1st paragraph:

"There is another, more serious danger in the technical computer-manipulation arena, one which many Americans might expect to find in the pages of the National Enquirer. It does not involve semantic, informational or psychological devices, but focuses instead on a combination of technical and psychological devices that allegedly affect body processes. For the most part, this danger has been attributed to the Russian press and Russian scientists. Today, these scientists are studying how the display of information on computer monitors can affect the computer operator's bodily processes. They are looking for ways to manipulate the operator to make him press certain buttons or pass along or destroy certain information as if he were hypnotized. The Russians are seriously investigating the potential of this phenomenon."

2nd paragraph:

"There are reports that the Russians have developed "Virus 666," which displays certain color and number combinations on a computer screen to affect bodily processes. According to a Russian report delivered by a scientist from the renowned Russian Baumann Technical institute at an information Warfare conference in Washington, DC, Virus 666 has been responsible for shutting down the bodily functions of more than 50 people, resulting in their deaths. 18"

3rd paragraph:

"Can such things happen? Americans are doubtful, because there is no proof computer screens can be used to control or kill people. Most believe such reports are not credible, even though Russian scientists, supported by highly influential people close to Russian leadership, are responsible for the information. Is Virus 666 a Russian manipulation effort to make the United States spend money on counter measures research and development? Perhaps. Yet in hindsight, man once could not comprehend electricity either, and we should at least consider the possibility of this phenomenon. As the Russians have noted on several occasions, he who makes the first inroads into this area will control the destiny of mankind in the near future."

In the Lopatin book, Tysgankov is a scientist and co-author with Lopatin, a duma expert. Tsygankov's views on mind control are supported by the highly influential Lopatin but the information is not believed. There is proof of mind control, but not at the scientific or legal level of proof. Unfortunately there is not yet a short and concise explanation because the information has been suppressed and each fact must be proven and also supported by experts.

Tsygankov is a `highly influential' person close to Russian leadership, Lopatin and Tsygankov published information on mind control weapons that most US experts deny publicly or think is doubtful. Top Russian scientists like Tsygankov put out incomplete or publicly discredited information. Americans would doubt the validity of Tsygankov's scientific information. Lopatin and Tsygankov do seem to be highly concerned Russians worried about new weapons. The Lopatin book may also be used for diplomatic communication, testing the diplomatic and scientific waters or as Dr. Thomas explained, the information warfare game.

Questions remain about Tsygankov's scientific work and more research is needed. It could be that Tsygankov did not want to reveal national security secrets. It is interesting to note that Tsygankov did not have money to publish his books on neurocomputers, although Lopatin supports his views and Tsygankov has extensive credentials. Tsygankov could be a targeted dissident.

Highlights from chapter 7 Legal Problems of Defense From Informational Weapons by V.N. Lopatin

The last chapter begins with an overview of Informational weapons to include "unlawful utilization of commercial information, industrial espionage and hacking". Lopatin writes, "That necessitates solving problems related to the possibility of an informational war, negative informational influence upon the individual and public consciousness and psyche of people, upon the computer networks and other informational systems from the organizational, technical as well as from the rights points of view."

Next, Lopatin writes, "it is still necessary to elaborate on destructive influences on human from cults, people who have parapsychological abilities, and others who covertly program via information sources, generators of physical fields and radiation, computer programs and other psycho-technologies." The reference to this quote includes I. Smirnov, et al, "psycho-technology: Computer Psycho-semantic Analysis and Psycho-correction On the Unconscious Level, M, 1996. (See Smirnov and Waco, FBI article on Cahra website.)

Lopatin writes

"...To the repeated appeals of Moscow's committee of habitat ecology to the organs of public prosecutor concerning the experiments upon the inhabitants of weapons of psychotronic type, in Moscow's public prosecutor reply #32-7-15-97 from 4/7/1997, it is stated that they are worried about the problem and they do send the "pertinent information" to the Attorney General of the Russian Federation. They are forced to note that:

"The given documents are proof that the principal requirement comes down to establishing control to research rights in this area of study. However, there is no legislation on this subject. therefore, the office of the prosecutor of the city has no ability to in any way protect the rights of citizens who are subjected to the influence of psychotronic technology."

That is already demonstrated by active research done in this area abroad. For example, intensive developments of methods and means of specific influence upon the human psyche, which originated in the 1950s in the US, are conducted. Since the 1970s, research programs have been conducted in the best universities around the world: USA, Germany, Austria, France, Italy, Japan, Israel, China and others. In the US in 1993, a prestige committee of American Society of Physics published their research results. In it, they concluded that such weapons systems (Psychological Weapon System) could be used effectively for solving a wide variety of military issues. The systems can be used for creation of new means and methods of conducting a war and for creation of a new type of strategic weapons (informational weapons in an informational war).3 ...adoptions of the special federal law "Informational-psychological safety."

Lopatin then defines Informational-psychological safety "as the state of defense of the human psyche from destructive informational influences (intrusion of destructive information into the conscience and/or subconscious of a human, causing incomplete comprehension of reality by the human).4" The 4 citation is "Lopatin V.N. Legislative problems of providing informational-psychological safety for individuals/ Stenography of the Round Table in the Council of the Federation of Russia about the informational-psychological safety of individual. 1/27/95.

Lopatin lists `Potential sources of threats in this area", including "generators of physical fields and radiation;" He lists basic threats of informational-psychological safety including "restricting the freedom of human will on the imperceptible level, artificial engrafting a syndrome of dependence upon a human; development, creation and utilization of special technical and programmed means for destructive influence upon the psyche of a human; manipulation of the public conscience through the utilization of special means of influence;"

Lopatin writes, "Providing informational-psychological safety is the most important goal of the state and therefore guarantees of human protection from the destructive informational influences should be established. The state has to guarantee:

-imperceptible informational influence upon the human psyche (including hypnotism) cannot be carried out without the person being informed, except in instances prescribed by the law;

...-The government of the Russian Federation will inform the citizens, agencies of power, organizations, and local self-governments about the possibility of using destructive imperceptible informational influence, ... It should also notify the above mentioned parties about the means taken to neutralize the threats related to informational-psychological safety;

Lopatin then describes the state system necessary to provide informational-psycholgoical safety. "The system needs to include in its structure agencies, strengths, and means to enforce them."

Agency power to provide informational-psychological safety should include:

-leading research, design, and other state organizations which carry out research and development of creation of means and methods of defense from imperceptible informational influence upon the human psyche;

-educational facilities of preparation and continuous training of human resources to provide informational-psychological safety.;

-individuals and organizations authorized by the system of state agencies to carry out separate functions of providing informational-psychological safety.

Lopatin states that registering and monitoring in order to account for potential threat sources, licensing individual and organization actions related to the development, production, and utilization of means and methods of imperceptible informational influence.

Lopatin concludes this section with the following. "If psycho-ecological expertise results in a destructive influence upon the human psyche and that leads to inadequate comprehension of reality, then that individual should receive medical help in accordance with the active laws. Reparation for harm and expenditures of those who suffered from destructive informational influence should be carried out according to law. Special attention to defending the rights and lawful interests of the individual, society, and the state is needed due to the threat of usage of informational weapons (including destructive informational influence) during international informational exchange."

In the next section, Lopatin defines Informational Weapons (iw) as the "means of destruction, manipulation, and theft of mass information, obtaining from it necessary information after overcoming defense systems, limiting or prohibiting access of lawful users to that information, scrambling technical means, making dysfunctional telecommunication networks, computer systems, society's high-tech infrastructure and government capabilities". Lopatin writes that "Additionally, considering its results, iw is comparable to weapons of mass destruction. Means of defeat of informational computer systems and defeat of people (their psyche) in times of peace and war can be classified as iw. ...Ways to defeat (influence) humans and their psyche are distinguished by their goals in a psychological war. Such goals are:

-Distortion of information received by an adversary's political administration, the authorities and the armed forces personal staff and imposing upon them false information which strips them of their ability to correctly understand events or the current situation and make sound decisions;

-Psychological influence upon the population and troops;

-Ideological sabotage and false information;

-Upholding popular public opinion;

-Organization of mass demonstrations under false slogans;

-Propaganda and spreading false information;

-Manipulating and directing individual and collective behavior.

Along with the traditional means (printed and electronic mass media), they are actively developing and testing ways of influencing humans through mass media and through computer networks: means of informational-psychological (psycho-physical) influence (including the parameters of the MC-Ultra (Ultra Mind Control) MC-Delta (Delta Mind Control), remote human behavior alteration, Bluebird, Artichoke)...

In the next section, Lopatin writes Last year, the author came forward with the initiative supported by parliamentary committees of the State Duma. In December 1997 it became the political initiative of the nine states of the Union of Independent States (UIS). The Interparliamentary Assembly of the UIS addressed in the UN and OSCE (Organization on Security and Cooperation in Europe) the countries of

Interparliamentary Union with an offer to add to the agenda of the General Assembly the question of preparation and conclusion of the international convention "preventing informational wars and limiting the exchange of informational weapons, then on protection from it, then from its destruction as it has been earlier with atomic, chemical and bacteriological (biological) weapons in the 20th century."

Lopatin's Main Conclusions

Here are Lopatin's verbatim conclusions to chapter 7.

1. Development of public relations in the sphere of informational safety outstrips the creation of law and their application concerning the protection of individual, societal and state's life interests from external and internal threats from informational sphere.

2. The federal law "Informational-psychological safety" is necessary and additional changes to the current laws, which permit the use of established prohibitions concerning the protection and defense of rights and lawful interests of citizens and society.

3. For effective protection from threats during international informational exchange in an interdependent world, unified efforts of the international society are necessary concerning the unification of international laws and the participation in the international convention "Preventing informational wars and limiting the exchange of informational weapons."

The Book's Conclusion

Here is the conclusion to the book, in its entirety.

Conclusion

"In this analysis, I tried to state objectively and without bias my view of the problems of psychotronic weapons (PSO) and psychotronic wars from the standpoint of Psi-phenomena and Psi-effects, primarily on the brain and human consciousness.

The mental degradation of society in the immediate foreseeable future is a distinct possibility if the state leaders and their administration do not analyze the situation which is taking shape in the world, regarding the ecology of consciousness, and don't make an accordingly constructive conclusions. rather than watching passively for the growth of destructive forces and power of diverse facilities that they use, the government should undertake the essential steps towards the protection of humanity from any possible violence by means of PSW defending the individual intellect of each citizen as the most valuable genetic repository of the nation and state. If it takes these steps openly and is will be available to general international participation in the work and the monitoring , then preventions against the possibility of psychotronic wars will be completely practical.

God willing that Humanity, Earth, and the Cosmos will not come to know and do not experience the psychotronic terror, the horror and the force which destroys Life functions with psychotronic weaponry in a " nonfatal" psychotronic war."

List of 186 citations are worth researching further. Help if you can.

Here is a partial listing of the 186 citations including familiar U.S. literature and many promising leads to research further. Anyone who may find copies of any of the following books and articles, please pass on the information to Cahra.

## Literature

1. Demkin S. Suschestvuet li psyckhotronnoye oruzhiye?[Do psychotronic weapons exist?] // Rossiiskiye Vsti. 1994. 1 july

2. Vkladov V. Zombi [Zombie] //Zhisn'. 1991. 6 December

5. "Leptonnoye Oruzhye" -konets atomnogo veka ["leptonic weapons"- The end of the atomic centruy] //Rabochaya tribuna. 1990. 19 December

7. Maydurov A. Mozgovoy kontrol' [Brain control]//Golos Vselennoy. 1991, #7

8. Dichev T. Psykhofashism [Psychofascism] Golos Vselennoy. 1991 # pg 14-15

14. Pvlychev V. Psykhotronnoye oruzhiye: myph ili real'nost'? [Psychotronic weapons: myth or reality?] // Zarubenznoye voennoye obozreniye. 1993, #2. Pgs 17-19.

28. Prilutsky V.V. Analyz problem sozdaniya psykhotronnogo oruzhiya i sposobov ego primeneniya. [Analysis of problems of creation of psychotronic weapons and ways to utilize it] m. (In print)

29. Targ R., Kharari K. Psykhicheskaya gonka [Psychological Race]. New York. 1984

33. Pukhtov G. E., Targ R. Pertseptivniy canal peredachi informatsiyi na dal'nii rasstoyaniya. [Perception channel of long distance information transmission]. TIIER. 64(3). 1976.

42. Bekhtereva N.P Yest' li Zazerkal `Ye? [Does wonderland exist?//terminator. 1994 #2-3 #1-3 Editor comment: academician Natali (Natalija Petrovna) Bekhtereva (Behtereva) She is Chief of "Center of Brain (Research)" of Rus Acad Sci and Ministry of Healthcare. She is granddaughter of famous phisiologist Bekhterev...

46. L.R. Hubbard. Dianetika. Sovremennaya nauka dushevnogo vyzhivaniy [ianoetics. Contemporary Science of Spiritual survival.] M. New Era. 1995

51. R. Penrose. The Emperor's [Emperor's] New Mind: Concerning Computers, Mind and Laws of Physics: Oxford University Press/Oxford/1989

57. Astakhov. K. Psykhotronnoye oruzhiye [Psychotronic Weapons}//Moskovskiye Vedomosti. 1990, noyabr'-dekabr' [november-december]

60. Kazhinsky B.B. Biologicheskaya radiosvyaz'. [Biological radio contact]. Kiev. 1962

70. Bekhtereva N.P. Mozgovye kody psykhicheskykh prosessov. [Br8ain codes of mental processes]. Saint Petersburg. 1977.

71. Kholodov y. Dialog s magnitnym polem [Dialog with the magnetic field]. //Sotsial'naya Industriya. 1986.

100. E. Shredinger. Chto takoe zhisn'? [What is life] M. Atomizdat. 1972.

86. R. Feinman KED. Strannaya teoriya sveta i veschestva [Strange theory of light and matter]. M. Nauka. 1983

109. Gurvich A.A. Problema mitogeneticheskogo izlucheniya kak aspect moleculyarnoy biologii [Problem of mitogenetic radiation as an aspect of molecular biology]. M. Meditsina. 1968

113. Pavlova L.P. Systemniy podkhod v elekronentsephalopgraphycheskom issledovaniy biotelesvyasi v physiologicheskoy shkole. [Systematic approach for electroencephalographical research of biotelecommunication in the school of physiology].

126. Pavlov I.P. Dvadtsatiletny opyt ob'ektivnogo izucheniya vysshey nervnoy deyatel'nosty. [20 year experience of objective study of higher nervous activity]. M. Medgyz. 1951.

Short Comments

Translation excerpts from second book "Pscyhotronic War, From Myths to Facts" by Igor Vinokurov and Georgij Gurtovoj", Moscow 1993, Translated by Mojmir Babacek

One highlight is the section on Emilia Cherkova, who is mentioned in a Stolitza article below. Ms. Cherkova was a Zelenograd deputy and has filed complaints to the government of Russia on behalf of Russian psychotronic victims and became a target herself. In addition, the Fetzer Foundation of Kalamazoo, Michigan sponsored a Russian/ U.S. conference on bio-energetics and the Gurtovi book featured the1989 Fetzer Foundation resolution signed by several scientists stating that they would not use their scientific knowledge to create weapons. See copy of letter from

Vinokurov book. Cahra purchased a third book, by V.D. Tsygankov entitled, "Neurocomputers and It's Applications, 1993. This book is in the process of being translated.

There is so much research that could be done. This book references other books, newspaper articles and government documents. A letter with the Fetzer Foundation letterhead which was reproduced in the book, is reliable information. Fetzer Foundation has a website and an electromagnetic group which includes a Stanford professor. The Fetzer librarian was generous with information and sent a VCR tape of the 1989 conference featuring the Russian scientists Vlail Kaznacheev, mentioned in the letter above.

Emilia Cherkova describes her experience with psychotronic attack, (not translated yet). She is a reliable public figure and source of Russian mind control experiment victims and her human rights work is worth pursuing. Cherkova describes the torture of victims "right in their house" She stated, "the arsenal of secretly perfected KGB weapon is unbelievable...It is using the latest discoveries of physics, electronics, biology, etc...."

The Russian victims sound strikingly similar to the American victims in their descriptions. This example from the book was published in the newspaper Zlenogradskaya Gazeta. She was published in the newspaper Stolitza below and therefore it would be worth contacting her in order to exchange information and form an international movement.

Here is the partial translation by Mojmir Babacek.

Psychotronic War
From Myths to Facts

Igor Vinokurov
Georgij Gurtovoj

Society for the research of secrets and mysteries of the Earth
„Mysteries"
Moscow 1993

This book on psychotronic war, presenting a lot of factual and historical materials, the first one published in Russia, considers possible military use of parapsychological or psi-phenomens.

The book is destinated to the widest public of readers.

3

Is telepathical terrorism feasible? Did Hitler own the „magic" weapon? Does Saddam Hussein own it? What are psychotronic generators? Are not they used to irradiate us in our appartments? What was fearing general Kobets when the „White House" was in danger of being attacked by special troops?

Those and many other unusual questions are considered on the pages of the presented book. Its authors are for years professionally engaged in the work in the area of parapsychology, psychotronics, bioenergoinformatics. They show conclusively how eternal, but untold effort for inhuman and especially military use of extrasensory, psychokinetic and other unusual human abilities gradually turns into everyday reality subjected to scientific research.

In the opinion of the authors, the psychotronic war, if it ever takes place, may prove to be the most cruel experience of mankind in all of its history. But this is - only their professionally founded view of the future. So far we do not face such a danger - the psychotronic weapon is still under development.

The book „Psychotronic War" - is, in some way, the call on all those who are engaged in psychotronic research to never and under no circumstances use the knowledge they have achieved to the detriment of Man and mankind.

4

Taking into account a destructive experience in using atomic energy for military and political purposes and in order to prevent harmful consequences of uncontrolled use of these abalities, instruments or equipment created from its base, we address our appeal to the scientists, general public of the world, governments, and private organizations dealing with bio-energetics and exceptional human mental abilities. We declare it to be inadvisable to use these energies of man in any possible cases directed against humankind and we voluntary undertake an agreement to never use, under any conditions, such weaponry and to sign an international agreement concerning this end.

From the Resolution of participants of international colloqium ‚New Frontiers in Experimental medicine and Energy Fields"

The John E. Tetzer Foundation
Kalamazoo, Michigan, USA
April 13, 1989

5

EXPERIMENT IN SARATOVO
(Instead of introduction)

A wave of monstrous heat struck all of his body and firmly squeezed him. He had the feeling that his hair is in flames. ‚War, bomb!" the first idea that came across his mind was as a matter of fact very close to the rignt one (as became clear much later). In March 1983, in Saratovo, the first experiment was carried out with the noted psychotronic weapon. But he was not aware of it. He looked around at the unbroken walls, ceiling, wall papers - through the waves of plasma licking his body. - ‚But where are the flames? Is it a laser? Radiation? Microwaves? What is it?" - He did not panic for few moments, he had not yet realized that the pain in the burning skin, all of his body and under his hair on the head makes him faint.

We will contravene the rules and will not place this strange story in paranthesis. And it should be done. But we wished to hit the reader in the flesh, in the same way we were hit some time ago: and more than that this story has been already expressed. Its heroe, it is B. E. Uzunov, the author of the book ‚Magicians, Women Magicians" published in 1991 in Obninsk (publishing house ‚Irina-Tch") - impressively and in an unusual, artfull, form - it presents the experiences of a man unwittingly falling victim to the effects of psychotronic weapon, so far unknown to majority of the people, but however already highly advanced. The weapon seems to be capable, secretly, imperceptibly, work on his psyche, mind, behavior, desires, wishes, interferes with his most intimate ‚self", in the most intimate spheres of his psychic life.

So who is it this B. E. Uzunov - the author of the book ‚Magicians, Women Magicians"? First of all we would never found out if it had not been for M. M. Bogatchikhin, thanks to whom the book got published. Let us see what Mai Mikhailovitch tells about its author:

Boris Ienverovitch Uzunov graduated from Saratovo University. His, too a degree unstandardized, psyche made jit impossible for him to stay on serious job and preserve his family life. Some time ago he sent me a manuscript for editing and publication and. disappeared. I found the material interesting, even serious and that is why the effort was taken to publish it.. It seems Boris will receive his author's fee.

Those words were written on June 27, 1990. Since this time Boris Ienverovitch has not appeared.

This is followed by excerpts from the book by Uzunov. His experience is certainly well known to the U.S. mind control victims.

The comments of the authors of the present book are those:

(page 9)

.what B.E. Uzunov describes we can refer realistically rather to some future than present days (if we leave out purely clinical motives - they were, are and will be every time). But the fact that the work toward the construction of psychotronic weapon is under way, with allways growing intensity, can not be denied any more in any way.

This is absolutely no myth, no fruit of somebody's ill imagination and certainly not an invention of journalists. This is a reality around which, this is true, is heaped quite a lot of myths, prefabrications and mistakes. We too. made effort to understand and make sense of this reality.

Now until page 16 follows analysis of parapsychological phenomenons

Page 16

Until now we have spoken about the first stage of the realization of the idea of PSI-weapon. In the second stage the methods were developed to strenghten the existing PSI-abilities using different pharmacological, psycho-technical and even technical means. And now we proceed to the third stage of the works toward the construction of principally new generation of psychotronic weapon, based in technical - with the use of apparatus or devices - modelling of those "incomprehensible" biophysical phenomenons, which lay in the fundament of the unusual abilities demonstrated by certain people. The third stage was connected with the construction of the so called psychotronic generators. The name of those generators was inspired by the name of the new area of the scientific research - psychotronics - in the cadres of which were developed the ideas making it possible to define the task of the construction of psychotronic generators and theoretical principles of its solution.

The note at the same page : .abroad, with allways growing intensity, the research is being carried out into the development of methods and means of defense against the allleged PSI- effects.

Follows the history which led to creation of the term "psychotronics" - basically there were several conferences on parapsychology - one of them in Prague in 1973 - where the International Association for the Research of Psychotronic Problems" was established and Zdenek Rejdak from Czechoslovakia was elected as a chairman. According to Rejdak three quarters of the materials presented at this conference were scientific and technical in character, 180 out of 250 participants took part in the section (one out of six) "psychotronics and physics", two thirds of members of the Association were physics and engineers, three quarters of Czechoslovaks interested in psychotronics were engineers, physics, cybernetics and biocybernetics. In parapsychology the majority was formed by psychologists, biologists, physiologists and medics.

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We would like to stress especially the fact that the book "Psychotronic War: from Myths to Reality " is based in personal, years long , experience of the research in the area of bioenergoinformatics and strictly documented (more than 400 sources were used)*. We based our work on materials, in most of the cases completely unknown to the reader or presumably forgotten by him, though most of the resources were published either in our country or abroad.

We especially concentrated on the afterwar period, burdened with the events of the Cold War. It is evident that in those conditions the interest of the waring sides in military aspects of psychotronics was very strong. Describing this interest and the consequencies which it bears we made effort to make understand to what ends could lead the psychotronic competition in case of unexpected success of one of the powers in the construction of "magic" weapon.

However the succesfull construction of psychotronic weapon by the totalitarian regime may turn into psychotronic genocide of one's own nation.

Page 21

In 1988 a psychologist and psychoterapist from Netherlands, Vim Kramer, in his speech at the first Eeuropean conference of Parapsychological Association, said that if the parapsychology wants to survive in the next century it must undergo "perestroika and glasnost". In our opinion this is evidently insufficient. Perestroika and glastnost have already finished their job. What is needed now is openness of the research and freedom of information with respect to those pehaps secretly performed works, the results of which may be guilefully used in psychotronic war. A clear NO must be expressed to all attempts to keep in secret not only the results of such research but as well to the fact that such research is being carried out.

It is necessary to hurry. Since, in the opposite case, in the next century, perhaps it will be difficult to survive not only for parapsychology, but to the whole mankind.

***

The note of the translator: The text, as it is presented, shows a lot of jugglery around the possible reality of psychotronic weapons. At least to one of the authors, Georgij Gurtovoj, should have, as a pupil of S. IA. Turlygin, very clear idea of how far the research of psychotronic weapons reached the production stage. S. IA. Turlygin carried out experiments with the effects of electromagnetic fields on human psyche already in the thirties.

( Mojm¡r Babacek)

Cherkina - Zelenogradskaya Gazeta

(Gurtovoi - page 45 - 51)

Lunacy of Senseless Democrats?

"The newspaper Zelenogradskaza Gazeta" appearing in the city of Zelenograd near Moscow , on June 10, 1991, in the section dedicated to discussions, published an interesting material. It is entitled " The Science in the Service of KGB or the Lunacy of Senseless Democrats".

The material is introduced by the following note written by the newspaper staff: "The problem we want to dicuss may provoke among raders conflicting reactions. What we are going to dicuss is the use of the latest scientific discoveries for political terrorism, the use, by the secret services, of technical means for dealing with alternatively thinking individuals or simply experiments on unwitting citizens. This is the opinion of the authors of publications scarcely appearing in our as well as foreign press, this is the opinion of the authors of letters reaching "Zelenogradskaya Gazeta", who are trying to understand what is happening to them and around them. To closer define the topica we publish two letters which have in common the above introduced subject."

The author of one of the letters, entitled "Underground Genocide", is E. C. Chirkova, the national deputy of the city council of the city of Zelenograd, the member of the Comission on Human Rights. The authors of the second letter, entitled "Appartment Ecology", are Moscowers O. Lavrova and N. Kroschkina.

"As a member of the Comission on Human Rights of the City Council of Zelenograd, engaged in the research of contactless terrorism - one of the dangerous latent crimes - writes E.S. Chirkova- I want to draw the attention of general public to the continuation of the use, by the KGB, of methods of the Gestapo. But this is no more the 1937. This is much more horrible. The victims are "tortured" secretly right in their house, from behind the walls of neighboring rooms and appartments or neighboring houses by special services of KGB.. The arsenal of secretly perfected KGB weapon is unbelievable. It is using the latest discoveries of physics, electronics, biology etc. I am in touch with the victims from different districts of Moscow, different cities of the Soviet Union.

I have got many declarations - 20 from the citizens of Zelenograd. I will give real examples. I, myself, E. S. Chirkova. after taking part in the study of declarations, fell under the directed "fire" of the sadists, practically deprived of normal life, conditions for the activities of a deputy.

The first one to address us was E.V. Kirilov, the retired candidate of technical sciences. The similar effects and anomalies pertaining to the health of citizens appear practically in all microregions of Zelenograd. "

The authors of the second letter describe the same specific problems of the "apartment ecology", they write "Amongst the methods how to do away with social activists . one is in prevalence - the irradiation in appartments. This is secret method and rather impossible to prove. The sources of irradiation may be situated in the neighboring rooms of appartment houses or in the houses across the street."

There are two more materials refering to this subject.

"One sixth of the World - the Hall Number 6"

(Molodost Sibiri - The Youth of Siberia - , 1991, Number 6) and the Appeal of victims of psychoterrorism to the Parliament of Russia (Golos Vselenoi - The Voice of the Space -, 1991, number 6 and 7).

In the first material it is communicated that few years ago, under the auspices of International Organization for Human Rights, a Committee for Social Defense was established, with the objective to disclose the "persecution of citizens by methods of distant manipulation of the brain by means of ultrasound, microwaves, laser beams and as well computers..extrasensors and telepaths". The representatives of the committee "declare that it is necessary to form the centers for the defense of personality outfitted with the equipment capable to register the effects on human beings from outside, operated by independent personel and that it is necessary to enact legislation to this effect."

The members of the Committee are victims of experiments with those weapons.

In the Appeal by Victims of Psychoterrorism to the Parliament of Russia the necessity is proclaimed "to ban and destroy in Russia all bioenergetic weapons capable to affect at distance the activity of human psyche and reason . immediately stop the psychoterror performed by government organizations and scientific mafia" and "the ban of psychotronic and leptonic weapon at the territory of Russia" and also they demand the legislation "defining the punishment for the use of psychotronic and leptonic weapons at the territory of Russia".

L. Petrov comments in Zelenogradskaya Gazeta the first two letters, saying that if such unlawfull events indeed took effect in Russia, then the only effort the government and its executive branches would make, would consist of the effort to hide their crimes against their defenseless citizens from the nation.

Short Comments

20+ Russian articles corroborate Lopatin and Gurtovoj books

The first article, Jan 11-17, 1993 Defense news article "U.S. Explores Russian Mind Control Technology" is a milestone document for the following reasons.

Mind control is a legitimate term according to Russian and U.S. government experts. Both sides state that the government technology exists and is not sci-fi.

Both Russia and the U.S. state that the technology should be placed under international control.

"Decades of research and investment of untold millions of rubles in the process of psycho-correction has produced the ability to alter behavior on willing and unwilling subjects, the experts say."

The Russian and U.S. sources in this article speak for their governments and are very trustworthy and believable. The government representatives state that mind control technology exists and is an arms control issue. International controls on mind control technology are and will be classified, making the information in this compilation a unique look into classified mind control weapons.

The next series of articles discuss Dr. Igor Smirnov. Newsweek and Moscow News reported on Dr. Smirnov and his consultations with the FBI about using his psychocorrection equipment on David Koresh. Also see ZDF section in this compilation, in which Smirnov is described as `one of the most important Russian psychiatrists".

Moscow News, 3-25-94 reported that Igor Smirnov has 80 scientific publications and 17 discoveries. "a long time ago it was hammered home that psychotronic weapons were being created "in the basements of the CIA." And it was clear that the USSR would not sit idle waiting for a surprise." "...the [Smirnov] lab has been assailed by tough guys wanting its personnel on their pay-roll. Smirnov says no.

The 7-16-94 Moscow News stated, "The search for funding has taken the scientists who have developed an "Americanized" version of the program, to the United States. Smirnov said his firm is in "commercial discussions" with Psychotechnologies Corp., a Richmond Virginia-based firm."

The 1992 Defense Electronics article corroborated the series of Smirnov articles and further stated, "There was a strong interest among the intelligence agencies because they had been tracking Smirnov for years ...and because we know there is evidence the Soviet Army's Special Forces used the technology during the conflict in Afghanistan." " ...Officials from the Central Intelligence Agency, Defense Intelligence Agency and the Advanced Research Projects Agency were also present,... The memo went on to note that meeting attendees were also interested in whether `psycho-correction detection, decoding and counter-measures programs should be undertaken by the U.S."

This information originates from the intelligence community and it can be concluded that mind control technology has been explored at least as long as Smirnov's work was being monitored.

The next article on Igor Smirnov that reveals how his work on mind control was classified. The FBI consulted with Dr. Smirnov and private U.S. companies are investing in his technology. The FBI brought him to the U.S. and only turned down the offer to use his technology on Koresh because Smirnov could only guarantee a 70% certainty that it would work on Koresh. Therefore, Dr. Smirnov's information is very believable.

Moscow News 3-25-94. Medics, who dabbled in psychodiagnostics and psychocorrection for purely scientific interest, became objects of attention by the defense industry and the security service. They were not apprehended, but their steps were closely followed. The laboratory, [Smirnov's laboratory of Psychocorrection at the Moscow Medical Academy] its personnel (out of the same scientific interest the physicians came to need physicists and programmers) and all of its projects were classified and publications banned."

The U.S. scientific community would have to have a similar classified system.

The July 16, 1994 Moscow Times article stated, "Smirnov declined to talk about the early days, although he said that the state program was a large one and that the scientists had all the resources they needed. ...but the days of generous state funding for such projects are over. ...The search for funding has taken the scientists who have developed an "Americanized" version of the program to the United States."

Moscow Times, 7-16-94 described the capabilities of Dr. Smirnov's technology.

"Psychiatrists at the Moscow Medical Academy's Department of Psycho-Correction believe they have the answer. By using a system of computerized psychoanalysis that relies on subliminal stimuli, the psychiatrists say they can understand a person's subconscious and even change a person's personality. ...the method works roughly like this: Electrodes that register the electrical activity of the brain are put on a patient's head. The patient is then given aural and visual stimuli-words flashed quickly on a screen or voices manipulated into a code that sounds like white noise- that can only be understood on a subconscious level. A computer program then coordinates the reactions of the brain with the specific stimuli and assembles the data into a graph that can be analyzed to determine a patient's subconscious attitudes to different concepts. Smirnov calls it a kind of "truth detector." ..."Our machine reveals hidden information that sometimes is not realized by the person himself." In the next stage, the patient listens repeatedly to a tape of specific messages that have also been coded and will be understood subconsciously."

The 1985 CNN video featuring Dr. Rauscher and Dr. Bise demonstrated "technology from Russian literature"

in which visual disturbances were caused by small electromagnetic signals to the brain of the reporter, Chuck DeCaro, (See International Campaign paper on Cahra website) The unclassified technology describes microwave hearing, visual hallucinations, sending subliminal messages to the subconscious, causing health effects from Radio Frequency Sickness, causing nausea, heating of the skin, etc. Not surprisingly U.S. and Russian victims are experiencing symptoms which reflect much more sophisticated and classified mind control technology. Several independent facts from several different sources over several years indicate that mind control technology is more classified than the Manhattan Project.

Top Kremlin officials and Russian journalists confirm the use of Russian mind control weapons.

The next two articles on General Georgy Gorgyevich Rogozin are worth exploring and further research is needed.

The 1995 Washington Times and the 1995 European newspaper reported that Gen. Rogozin works in the Kremlin and that there are numerous reports of his surveillance techniques on them. Gen. Rogozin's background describes his KGB work form 1989-1991 as chief scientist dealing with security problems. He pursued a program which included mind-reading from a distance and control of the subconscious by telepathy. "Ludmila Pikhova, an experienced presidential aide and speech writer who is known for her iron strength of character and calm temperament, turned on Rogozin during a recent story Kremlin meeting, dragging him outside a conference room and screaming: "Don't you try to control my subconscious ever again." Sergei Parkhomenko, the Russian journalist for Sevodnya newspaper has put together a dossier of the strange goings-on, "... everybody I talk to at the Kremlin confirms the nightmare. ... Members of the Russian Parliament question what kind of influence is being wielded by this former KGB officer with his projects and what proportion of state funds are being squandered on black magic. ...A highly placed officer of the electronic surveillance service FAPSI warned: "It cannot be permitted that parquet (desk-bound)generals from the Kremlin guard are allowed to usurp power in this country...."

Emilia Cherkova and Psychotronic Victims Groups

Next are three articles on Emilia Cherkova and her human rights work to help victims of psychtronic experiments. As in the above articles, the references to scientists and top public officials discussing mind control and the resolution in the CSCE, i.e. more government documents, is substantial evidence. Here are the highlights from the articles.

Delovoi Mir, 2-15-92 Press reports that Ruslan Khasbulatov, Speaker of the Russian parliament, had to move from his flat, one possibility listed was the high level electromagnetic radiation felt in his flat. During the August coup General Kobets warned publicly that pscyhotropic generators might be used against the White House defenders. June 1991, a group of Zelenograd deputies sent an appeal signed by 150 people to President Yeltsin, demanding an investigation into the use of bio-electronic weapons.

Stolitsa, 11-2-92. Victor Sedletsky, a scientist from Kiev stated that "As an expert and a juridical person, I assert that mass production of psychotronic biogenerators and their testing is underway in Kiev."

Academician V. Kaznacheyev from Novosibirsk does not rule out military uses or the development of plans for a "psychic war" which, in his view, is more dangerous than any other kind of warfare. The military may use ESP to paralyze the will of other people, "turning them into obedient slaves," the scientist writes. Kaznacheyev therefore insists on placing this kind of research under international control.

The international seminar on human rights held last year in the framework of the CSCE Conference on the Human Dimension passed a resolution, according to which the health Ministry and the KGB were requested to provide official information on the use of various means of influencing human behavior."

Moscow Times, 7-11-95. Journalist Yury Vorobyovsky has been investigating the top secret program of "psychotronic" brainwashing techniques developed by the KGB and the Ministry for three years.

Emilia Cherkova claims that there are over a million victims. Her group, Ecology and Living Environment has filed damages against the Federal Security Service or FSB. The newspaper reports, "there is strong evidence that some kind of psychotronic warfare program did exist in the Soviet period, and that the technology may be falling into the wrong hands.

Lopatin calls for legislation, which would "bring Russia into line with Bulgaria, the only other country to outlaw such equipment specifically." Lopatin concludes the article, "of course this project is surrounded with a lot of hysteria and conjecture. ...Something that was secret for so many years is the perfect breeding ground for conspiracy theories."

Dr. Yakov Kudakov used to work in a Defense Ministry psychotronic research laboratory and built a machine using powerful electromagnets. Dr. Rudakov claimed that psychotronics were used on Spetsnaz troops in Afghanistan."

Intelligence Agency reports of Russian mind control capabilities, 1976

The next two 1976 U.S. articles discuss the DIA, Defense Intelligence Agency report on Russia's deep involvement in researching ways to use microwaves to induce disease and control minds.

Los Angeles Herald Examiner, 11-22-76. "A newly declassified U.S. Defense Intelligence Agency report says-extensive Soviet research into microwaves might lead to methods of causing disoriented human behavior, nerve disorders or even heart attacks. "Soviet scientists are fully aware of the biological effects of low-level microwave radiation which might have offensive weapons application," says the report, based on an analysis of experiments conducted in the Soviet Union and Eastern Europe."

The article discussed the Soviet microwave bombardment of the U.S. Embassy in Moscow. "The [State] department spokesmen insist that medical tests have found no adverse health effects attributable to the microwaves."

The article also discussed microwave hearing. "Sounds and presumably even words which appear to be originating intracranially (within the head) can be induced by signal modulation at very low average power densities," the study said. "The report concluded that Soviet research in this are "has great potential for development into a system for disorienting or disrupting the behavior patterns of military or diplomatic personnel: it could be used equally as well as an interrogation tool."

The Paul Bannister Enquirer article quoted Dr. Zaret [a scientist consulted by the U.S. intelligence agencies for Project Pandora work to find the reasons for the microwave bombardment of the Moscow Embassy] on microwave hearing, "You could drive somebody mad with this." "Research in Russia, according to the report, has established that microwave radiation can induce such effects as "headaches, fatigue, perspiring, dizziness, menstrual disorders, irritability, tension, drowsiness, sleeplessness, depression, forgetfulness and lack of concentration."

The importance of this declassified 1976 DIA document is that it is a US government document discussing Soviet athermal emr research for weapons development. The DIA report was based on Soviet research. It becomes clear that both the Soviets and the U.S. were developing weapons based on the athermal effects of emr. For further details on this DIA report, refer to the Paul Brodeur book, "Zapping of America". Broduer pointed out that the DIA report failed to mention scientist Allan Frey's work on microwave hearing beginning in the 1960s in the U.S.

Looking at the report over 25 years later, given the 1990s unveiling of the nonlethal emr weapons, it can now be verified that the U.S. did have a very classified emr program going back decades. The U.S. knew about the Russian emr weapons program and also developed an emr arsenal. The nonlethal weapons revealed in the 1990s were capable of causing symptoms which microwaves can induce as stated in the 1976 report.

This 1976 DIA report is also important for documenting that the U.S. State Department is on the record for lying to embassy employees about the finding of "no adverse health effects attributable to microwaves. The U.S. government has lied about scientific facts and risked the health of the Embassy employees and utilized the National Security Act to do so. The rights of U.S citizens are usurped by the National Security Act. The laws in this regard need to be changed so that the U.S. government is held accountable for illegal government experiments.

A.E Akimov's mind control work, possible cover story?

The next informative article is from Fate Magazine by Paul Stonehill, Feb. 1994. The article discussed the controversial A.E Akimov's mind control work, see Tsygankov's citation of Mr. Akimov above. This excerpt is almost verbatim.

July 4, 1991, a month before the Aug. 1991 coup in the Soviet Union, a document known as "Resolution 58 of the Committee for Science and Technologies of the Former Soviet of the USSR came from the Kremlin. The resolution condemned the "depraved practice" of financing pseudoscientific research with State funds. Particularly, it was the research into the so-called spinor torsionnic or microleptonnic fields. The research was tied to the creation of an unusual organization in the Soviet State Committee for Science and Technologies. It became known as the Center for

Non-traditional Technologies (CNT); its former director was Mr. A.E. Akimov. The research work had been going on for over 30 years. The research was based on assertions that there had been an unprecedented discovery in the science of physics. It had to do with a new class of physical fields and particles, and the influence exerted by such fields upon biological objects. The resolution stated that the Soviet science officialdom knew nothing of such discoveries, either through open publications, or closed channels. Regardless of the quasi-scientific terminology used in such reports, the information was unsubstantiated, illogical, and scientifically unfounded. The CNT itself was created without the necessary expertise.

Later, the research undertaken was legitimized by support given it by the State Committee. Because of such support, the USSR Ministry of Defense and other state agencies had enough grounds to create a special research center, VENT. Akimov became its general director. Millions of rubles had been spent as the projects of VENT received state funding. Akimov states that just the USSR Ministry of Defense had spent 23 million rubles, an impressive amount. The resolution states that the investigative committee took the conclusions of the Department of General Physics and Astronomy of the Academy of Sciences, USSR, under consideration. These conclusions qualified the research work in the areas of spinor and microleptonnic fields and their applications, as a recurrence of anti-scientific activity. One month later, the Soviet Union as shaken to its foundations and began to fall apart.

Yet the Sept 9, 1991 Komosomolskaya Pravda published an article by Mr. Volkov, and revealed what it was that the CNT had actually researched. His source was a report from the CNT "Main Directions of Research" The CNT was involved in study of remote medical and biological influences on the armed forces and people exposed to torsionnic radiation; remote influence on the armed forces and people from the same radiation"

Further information on A.E. Akimov is needed in order to draw any firm conclusions. At the least, Dr. Akimov was able to obtain very impressive state funding for mind control research and is cited by V.D. Tsygankov in the book, "Psychotronic War and the Security of Russia". VENT is mentioned in the 11-2-92 Stolita article, "The firm conducting most of the research and development in this field [mind control] is the Vent" technical center [previously called the Center for Non-traditional Technologies at the USSR Committee for Science and Technology]. As much as 500 million rubles was allocated for its project." This wording is the same as the Fate Magazine article on Resolution 58.

One side says that mind control technology was being developed at VENT by Akimov, as the general director. The government Resolution states that at least some of the research conducted there was pseudo-science. And the Internet article quoted the findings of the Commission at the Russian Academy of Sciences and stated that A.E. Akimov's science was unreliable. Both sides say that an large amount of money was spent. The controversy may be part of a mind control cover story. The Tsygankov scientific information in the Lopatin book needs to be evaluated further and contacting Tsygankov would be beneficial. There could be some truth to the VENT Akimov mind control research with the government trying to discredit the work and cover it up. Maybe the torsion field fraud is a front for mind control programs, just like the athermal/ thermal controversy was for emr weapons. Maybe this allows the scientists to continue their work and for the Russian government to discredit them, so that the extent of the mind control research will be kept out of the public eye.

Scientific summary of emr weapons corroborates 50 years of evidence

The final article is "Electromagnetic -Effect Weapons: The Technology and the Strategic Implications", 1988. This article cites a "recent'" book, no title written "under the auspices of Znanyia, a cadre organization headed by top Soviet military scientist N.D.Basov. The book discussed Delgado's magnetic field experiments. The article mentions the history of emr research in Russia and names of scientists such as Alexander Gurvich and the very famous V.I. Vernadsky whom Gurvich followed. Vernadsky's famous ideas are mentioned in the Lopatin book and from this information, the unclassified development of emr and classified Russian development of emr weapons can be traced. Here is just one excerpt on the scientist A. Gurvich who is also cited by the Lopatin book.

"Another member of the Gurvich school, Alma Ata biophysicist Inyushin, wrote an article in the Red Army paper Krasnayz Zvezda in 1984 declaring that breakthroughs of "revolutionary significance" were being made in the optical biophysics field. Since then, Inyushin's name completely dropped out of Soviet scientific literature, indicating that he is now working in a top secret program. Indeed almost the entirety of the huge Soviet effort in biophysics of the Gurvich-Vernadsky variety has "gone underground" since 1983-84."

Overall conclusions

1. The value of the Russian information to U.S. victims is in its power to argue convincingly that the U.S. would have to be developing mind control weapons also. The Russian evidence of mind control weapons is substantial in quality and quantity. Each independent source in the 20+ article verifies the other. Although there is a definite limit to the Russian mind control technology discussed and the articles all state basically the same thing, it is revealing. There is

nothing comparable in the U.S, nothing even close to this Russian body of evidence. The break up of the Soviet Union has been a unique opportunity to gather declassified evidence of a very large, very black mind control program. As the facts above show, the U.S. was aware of this program and no doubt has a comparable classified mind control program of its own.

2. Credible, independent sources are stating that Russian mind control weapons exist, are being illegally used and laws are needed to protect Russian citizens.

Numerous public officials, including scientists, journalists and lawyers stated that mind control technology exists and needs to be controlled. Emilia Cherkova was discussed in the Gurtovoj book and three Russian newspapers.

Dr. Kaaznacheev, who was mentioned in the Gurtovoj book in the Fetzer Foundation letter and Emilia Cherkova are saying that mind control weapons exist and are in the hands of the military and government.

The scientist from Kiev, Sedletsky and Cherkova say there are experiments on Russian citizens.

Lopatin acknowledges the existence of mind control technology and even states that it was "secret for so many years". He dismisses the paranoid and conspiracy label on the allegations and instead takes mind control weapons very seriously, calling for legislation to ban their illegal use.

Dr. Kudakov built the equipment and states that similar equipment was used in Afghaniztan, as does the Defense Electronics article above. The Russian journalist Vorobyovsky has studied this story for three years. A complaint was filed with the CSCE.

3. U.S. victims can use this very powerful information as a group and approach Congress, human rights groups The Russian evidence validates the claims made by victims of U.S. government mind control experiments. U.S. and Russian victims can now combine their claims which date back to the 1950s and make a strong case.

Here are a few of the articles in full length.

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The Moscow Times
July 11, 1995
SECTION: No. 750
LENGTH: 1134 words

HEADLINE: Report: Soviets Used Top-Secret ' Psychotronic' Weapons

BYLINE: By Owen Matthews

BODY:

There may be a scientific explanation for the rigid-faced inflexibility of Soviet-era border guards and soldiers, after all. Reports have emerged of a top secret program of "psychotronic" brainwashing techniques developed by the KGB and the Ministry. The techniques, which include debilitating high frequency radio waves, hypnotic computer-scrambled sounds and mind-bending electromagnetic fields, as well as an ultrasound gun capable of killing a cat at fifty meters, were originally developed for medical purposes and adapted into weapons, said journalist Yury Vorobyovsky, who has been investigating the program for three years.

"Ecology and Living Environment," an environmental and civil liberties group which claims a membership of 500 people in Moscow, has set up an association of "Victims of Psychotronic Experimentation," who have filed damages claims against the Federal Security Service, or FSB, and the government. Unfortunately, since by definition many of the victims are psychologically disturbed, there is a problem of verification.

"The Health Ministry and the FSB are doing medical experiments on over a million innocent people," said Ecology and Living Environment President Yemilia Cherkova, an ex-member of Zelenograd's local council. Cherkova wears a lead helmet in bed to protect herself against the rays she says the government beams into her flat. "They put chemicals in the water and use magnets to alter your mind. We are fighting to prove to the authorities that we are not mad." Despite these somewhat far-fetched testimonies, there is strong evidence that some kind of psychotronic warfare program did exist in the Soviet period, and that the technology may be falling into the wrong hands.

Official confirmation was first hinted at in the 1991 Soviet budget, which mentioned that 500 million rubles of the state security budget had been spent on "psychological warfare technology" over an unspecified period of years, said Vorobyovsky. Former state security and interior minister General Viktor Barannikov, sacked for supporting the 1993 coup attempt, warned in an Interior Ministry memorandum earlier that year that he had information that the mafia had got hold of the technology, though little concrete evidence has been found by police.

"We have no evidence that our local mafia has psychotronic weapons; they have enough ordinary ones," said Gennady Melnik of the Moscow Police Department. "They are not the most technologically advanced mafia in the world. It must be cheaper just to use guns." Nevertheless, the State Duma is taking the matter seriously enough to draft a law on "security of the individual," which will include regulation of subliminal advertising and pseudo-religious sects, as well as imposing state controls on all equipment in private hands which can be used as "psychotronic weaponry." The legislation brings Russia into line with Bulgaria, the only other country to outlaw such equipment specifically.

"The law is pre-emptive," said Vladimir Lopatkin, chairman of the drafting committee. "The equipment that now exists in laboratories must be very strictly controlled to prevent it from being sold to the private sector." Vorobyovsky has filmed several laboratories which are using powerful electro-magnets of the sort experts believe can be used as weapons to supposedly cure private patients of various aliments. One, the Biovolna clinic in Zelenograd, near Moscow, went private after its funding from the Defense Ministry was discontinued. The clinic has "treated" more than 7,000 people, despite not having a Health Ministry license. One of Vorobyovsky's film crew volunteered to be subjected to rays from a similar machine built by Dr. Yakov Rudakov, now a general practitioner who used to work in a Defense Ministry psychotronic research laboratory. He described feeling dizzy, lethargic and confused after exposure to certain frequencies.

The dissident writer Vladimir Voinovich described in his memoirs how the KGB used a cocktail of drugged cigarettes and electromagnets to sap his energy and induce disorientation and confusion.

"One could call this 'Black Science.' Research scientists whose funding has been cut have resorted to putting equipment costing millions of rubles to any use that will pay," said Vorobyovsky.

Another program Vorobyovsky filmed was a sound studio at the Interior Ministry's research laboratory where officers were played bursts of computer-scrambled messages encouraging them to be more decisive and fearless. Dr. Rudakov claimed that this technique was used on Spetsnaz troops in Afghanistan. The danger, says Vorobyovsky, is that similar messages can be transmitted over the telephone, television or radio to influence whoever hears them.

"Of course this project is surrounded with a lot of hysteria and conjecture," said Lopatkin, of the Duma committee. "Something that was secret for so many years is the perfect breeding ground for conspiracy theories."

LANGUAGE: ENGLISH

LOAD-DATE: July 14, 1995

Reprinted from the Lexis Nexus computer database in whole except for the bold lettering in paragraphs 2 and 3.

Mind-Altering Microwaves
Soviets Studying Invisible Ray
November 22,1976

NOTE: SEVERAL INDUSTRIALIZED COUNTRIES ARE DEVELOPING ELECTROMAGNETIC TECHNOLOGY FOR ANT-PERSONNEL USE.

Mind-Altering Microwaves
Soviets Studying Invisible Ray

A newly declassified U.S. Defense Intelligence Agency report say-extensive Soviet research into microwaves might lead to methods of causing disoriented human behavior, nerve disorders or even heart attacks. "Soviet scientists are fully aware of the biological effects of the low-level microwave radiation which might have offensive weapons application," say the report, based on an analysis of experiments conducted in the Soviet Union and Eastern Europe.

According to the study, this research work suggests the potential for the development of a number of antipersonnel applications."

Microwave beams are the electronic basis of radar and are widely used for relaying long distance telephone calls. Other common sources of microwaves include television transmitters.

A copy of the study was provided by the agency to the Associated Press in response to a request under the Freedom of Information Act. The Pentagon agency refused to release some portions of the study, saying they remain classified on national security grounds.

The report made no direct mention of the Soviet microwave bombardment of the U.S. Embassy in Moscow where despite strong American protests the radiation continues, though at reduced levels.

Up to now, the view most widely accepted among State Department officials in Washington has been that the Soviets appear to be using the microwave beams to foil sophisticated U.S. electronic intelligence gathering equipment at the embassy.

The State Department issued an administrative source on Nov. 12 declaring Moscow "an unhealthy post," but no link was officially drawn between this move and the radiation situation. Department spokesmen insist that medical tests have found no adverse health effects attributable to the microwaves.

The Soviets have denied beaming any radiation at the embassy, contending that the microwaves are simply part of the normal background radiation found in any major city.

The Pentagon agency's report, distributed within the government last March said that biological effects which could alter anti-personnel uses is the phenomenon known as microwave hearing.

"Sounds and possibly even words which appear to be originating intracranially (within the head) can be induced by signal modulation at very low average power densities," the study said. It added that "combinations of frequencies and other signal characteristics to produce other neurological effects may be feasible in several years."

The report concluded that Soviet research in this area has great potential for development into a system for disorienting or disrupting the behavior patterns of military or diplomatic personnel. It could be used equally as well as an interrogation tool.

...Soviets have also studied various changes in body chemistry and functioning of the brain resulting from exposure to microwaves and other frequencies of electromagnetic radiation.

One physiological effect which has been demonstrated is heart seizure. It said that this has been accomplished experimentally in frogs by synchronizing the pulses of a microwave signal with the animals heart beat and beaming the radiation at the chest area.

The document added that a frequency probably could be found which would provide sufficient penetration of the chest wall of humans to accomplish the same effect-heart attacks.

The report said that another potential antipersonnel use. ...microwaves could be used to effect the blood-brain barrier, which regulates the exchange of vital substances between brain cells and the circulatory system.

From Delovoi Mir, pp. 1,9 February 15, 1992 "Mind Control"by Ivan Tsarev

"Brainwashing techniques still being used in Russia, claims member of human rights commission."

"Psychological warfare is still being used by state security agents against people in Russia even after the abortive August coup, said Emilia Chirkova, a Deputy of the Zelenograd Soviet and member of the Human Rights Commission. She recalls the sandal surrounding the alleged bugging equipment installed close to Boris Yeltsin's office. KGB agents admitted then that the directional aerial in the equipment was designed for transmission, not for reception. She believes it was part of an attempt to affect the health of the Russian Pesident using high frequency electromagnetic radiation. The Human Rights Committee, Chirkova said, had warned Yeltsin about such a possibility."

"She cited several further instances of the use of similar devices. Microwave equipment had been used in 1989 and 1990 in Vladivostok and Moscow prisons, in a mental hospital in Oryol and in the Serbsky Institute in Moscow [also a mental hospital], she said. during his exile in gorky, Andrei Sakharov noticed the presence of a high tension electromagnetic field in his flat. It was reported recently in the press that Ruslan Khasbulatov, Speaker of the russian parliament, had had to move from his flat to another district of Moscow. High level electromagnetic radiation has been included among the possible couses of the discomfort he felt in his flat. During the August coup General Kobets warned publicly that psychotropic generators might be used against the White House defenders."

Purported victims of psychological warfare have writen to the papter. From Voronezh comes this letter: "They controlled my laughter, my thoughts, and caused pain in various parts of my body... It all started in October 1985, after I had openly criticized the first secretary ofthe City Committe of the Communist Party. Sometimes voices can be heard in the head from the effect of microwave pulse radiation which causes acousstic oscillations in the brain," explained Gennady Shchelkunov, a radio electronics researcher from the Istok Association. Numerous sufferers from this alleged manipulation have set up a public movement."

"In June 1991, a group of Zelenograd deputies sent an appeal signed by 150 people to President Yeltsin, demanding an investigation into the use of bio-electronic weapons. Non-official sources say that a commission charged with investigating possible use of such weapons is being set up at the Russian Government."

In two articles, Jonathan Tennenbaum describes development of Soviet electromagnetic weapons and the physics and biology behind the weapons.

Electromagnetic-Effect Weapons: The Technology and the Strategic Implications. Wiesbaden Federal Republic of Germany Jan. 16, 1988. Executive Intelligence Review.(Executive Intelligence Review Special Report. 317 Pennsylvania Ave. S.E., 2nd Floor. Washington, DC 20003 (202) 544-7010. Pg. 7. Michael Liebig.

..."This Special Report is meant to sketch the gestalt of this newly emerging Soviet threat, the dimensions of which the Western public is most dangerously unaware. There is barely any understanding in the West of the revolutionary transformations in technology and strategy associated with electromagnetic effect weapons."

Tennenbaum, Jonathan.(1988, Feb). Some ABCs of Electromagnetic Anti-Personnel Weapons. Executive Intelligence Review.Executive Intelligence Review Special Report. 317 Pennsylvania Ave. S.E., 2nd Floor. Washington, DC 20003 (202) 544-7010. Pg. 9.

Dr. Jonathan Tennenbaum is on the Board of Directors of Fusions-Energie-Forum in the Federal Republic of Germany, and an editor of its magazine, Fusion.

"Often referred to by the misleading name, "radio-frequency weapons," The most sophisticated new type of anti-personnel weapons now being perfected by the USSR for use by its Spetsnaz and regular forces, uses pulses of electromagnetic energy to disorient, paralyze, and kill human targets. Such electromagnetic pulse (EP) weapons can take a variety of forms, including the following: ...

Electromagnetic pulse anti-personnel weapons have many scientific and technical features in common with the laser weapons under development in the American and Soviet anti-missile defense programs. Both use electromagnetic radiation, propagating at 300,000 kilometers per second, to achieve their destructive effect. Both require compact power sources, generators of electromagnetic radiation (e.g., lasers, magnetrons, gyrotrons, etc.), beam radiator and focusing apparatus (e.g., optics for lasers, wave guides and phased-array antennas for microwave weapons), and computerized control systems In both cases also, the maximum effect of these weapons is obtained by "tuning" or "tailoring" the output to the characteristics of the target.

The chief peculiarity of EP anti-personnel weapons lies in their exploitation of highly non-linear effects of electromagnetic radiation upon living organisms. Typically, these weapons employ complicated pulse shapes and pulse trains, involving several frequencies and modulations which can range over a wide spectrum from extremely low frequencies (ELF) into the hundred gigahertz range. Thus, although state-of-the-art technology permits construction of mobile systems of extremely high output power (up to 10 megawatts average power, peak pulsed powers of many gigawatts), it is not the high power per se which determines the lethality of the system, but rather its ability to "couple" the output effectively into the target and to exploit non-linear biological action. While high output power may be used to obtain range and breadth of effects and penetration into enclosures and defenses, the minimum lethal "dose" on target will typically be orders of magnitude less than that which would be required to kill by mere heating, in the manner of a microwave oven.

The closest analogy to a sophisticated EP anti-personnel weapon is provided by powerful chemical weapons, such as nerve gases having rapid, fatal effects at extremely low concentration. In the latter case, the effect is mediated by molecules which enter nerve synapses and other critical areas and disrupt normal functions without massive destruction of tissue. The poison acts on the higher levels of organization of living process. Furthermore, it should be understood that molecules themselves are nothing but electromagnetic configurations. That is, the molecules (e.g., of the nerve gas) act via electromagnetic fields, by exchange of electromagnetic energy with other molecules. Hence, it should hardly be surprising to discover that the same effects can be induced by electromagnetic radiation alone-without the presence of the molecules! In principle it suffices to identify the precise geometrical characteristics of the electromagnetic action associated with the given substance, and then just "mimic" the molecular action by a carefully "tailored" signal. Once this principle is understood, biophysical research can define the most appropriate pulse forms for weapon applications, independently of any specific chemical "model." That this is by no means a mere theoretical possibility is proven by a wide variety of experiments on the biological effects of "tailored" electromagnetic radiation, carried out in the West and East over the last 40 years. For obvious reasons, experiments involving lethal effects are mostly classified. To illustrate some of the relevant research areas, we present a couple of examples of well-documented non-lethal effects.

Since the 1950s much scientific attention has been paid, in the East and West, to effects on the brain of 1) psychotropic drugs (LSD, depressants, stimulants, etc.) and 2) electrical stimulation of specific areas of the brain by implanted electrodes. Among other things, experiments showed that minute currents induced by electrical stimulation could evoke profound changes in brain function, similar to those obtained by psychotropic drugs, the latter often at extremely low concentrations. This work reveal some "deep secrets" of the physiological organization of the brain, secrets having potentially far-reaching military implications. Since the early 1970s a number of published experiments have shown that similar, profound neurological effects can be induced without the "substantial" intervention of drugs or electrodes, by electromagnetic fields applied from outside the experimental subject. Typical of these are those of Dr. Jose Delgado and Dr. Ross Adey. Delgado applied a slowly modulated weak magnetic field(several Gauss, pulsed at less than 100 Hz) to the heads of monkeys via external coils. Depending upon the precise modulation frequency used, specific effects were induced. Thus, one frequency caused the animals to fall asleep, and another triggered aggression, each time with very specific neurophysiological effects on specific areas of the brain. Adey and others have obtained similar neurophysiological effects with a modulated, low-power, radio-frequency field, with modulation frequencies in the range of the internal "brain waves" (EEG). Absorbed power levels were very low- on the order of a thousandth of a watt per square centimeter.

Related experiments have shown that internal EEG waves can be entrained and modified, demonstrating the possibility of direct information transfer to the brain via modulated radio-frequency (RF) fields. Thus, below the threshold of lethal effects, a certain potential for subtle psychological manipulation by means of "tailored" electromagnetic signals cannot be excluded.

Lethal effects have been obtained at power levels not very much higher than in behavior modification experiments. Again, it is not so much the net power as the exact form of the applied series of pulses, which makes the difference. One laboratory device, used in brain research, kills experimental animals with a single microwave pulse of 1/6 second duration.

While the neurological effects of modulated RF and microwave radiation have long been a high-priority area for Soviet research, this field has tended to be played down or even suppressed in the West. For example, Delgado's magnetic field experiments have gone nearly unnoticed in the Western scientific literature, but are a featured subject in a recent Russian book, published under the auspices of Znanyia, a cadre organization headed by top Soviet military scientist N.D. Basov.

While we have concentrated here on the brain as a key target of EP weapons, this is by no means the only target. The central nervous system more generally, and vital organs, especially the heart, are all possible targets. Moreover, a very insidious deployment of EP would be to degrade the overall health of persons in a certain area by long-term, low-level irradiation. There is evidence that the latter has already been tried by the Soviets in a number of cases.

Much more could be said about non-linear biological effects exploitable by EP weapons. In this short introduction, however, we want to move on to another key problem of these weapons; how to generate and deliver the destructive action to the target.

This Special Report presents some details on high-power RF and microwave generators, an area of highest priority in Soviet research and development. There are two essential types of devices which can be used in EP weapons; oscillators using beams of electrons or plasmas, and solid-state devices.

Solid state radar, whose development is driven by the needs of military aircraft and missiles, is one of the fastest advancing areas of electronic technology today.

Although solid state devices do not (yet!) reach the very high powers attained by electron beam devices, miniaturization makes it possible to build today complete, highly sophisticated phased-array radars of suitcase-size, with several kilowatts of average output. The principal advantage of this technology is that it permits extremely sophisticated "tailoring" of pulse shape in space and time, in a compact system, with direct coupling to high-speed computers. This is exactly what is needed in order to optimally exploit non-linear biological effects. What is lost in brute power is thus gained in efficiency.

Recent breakthroughs in what is called "high-temperature superconductivity" open up the perspective that both types of EP generation technology--electron beam as well as solid state--are going to undergo revolutionary improvements in the years immediately ahead. The impact of this revolution cannot even be estimated at this time, but it will certainly mean radical reductions in the size of devices having a given electromagnetic "firepower".

As our discussion of biological effects already indicated, electromagnetic anti-personnel weapons depend essentially on "tuning" the output signal to the target. This goes not only for the frequency and amplitude of the signal, but for its entire space-time "shape." Figure 6, for example, is drawn from thermographs of models of the human body irradiated by RF radiation of the same frequency, but with field geometries. These and other experiments demonstrate, that the areas of maximum absorption of electromagnetic energy inside the body depend on the geometry of the incident wave. By choosing the right geometry, the energy can be focused into any desired area, such as the brain.

A sophisticated EP weapon must thus be able to project a specific geometry of electromagnetic field onto a distant object, over a given terrain and in given surroundings. Without going into technical details of waveguides and various antenna types, we shall briefly present one of the relevant techniques: the principle of the phased array.

A phased-array antenna consists of an assemblage of many individually controlled emitting (or receiving) elements, placed in a fixed geometrical arrangement. The output field of the array is the sum of the waves emitted by the individual elements. By electronically controlling the relative phases of these individual signals, the output field can be given any desired "shape" and direction, limited only by the wavelength used, the number of elements and the size of the array. The huge soviet ABM radar at Krasnoyarsk, for example, contains an 83-meter diameter phased array of thousands of elements. The output can consist of a single, very narrow beam, or hundreds of independently directed beams, all depending on the "phasing" of the elements. This radar can track large numbers of missiles simultaneously, without any mechanical motion of the antenna.

The functioning of phased-array antennae is thus closely related to holography, or three-dimensional photography. In a hologram, a photographic plate records interference patterns, corresponding to the phase relationships of laser light reflected from the object. When the holographic plate is illuminated by a laser, the phase relationships are "reconstituted" and the viewer has the impression of seeing a three dimensional object.

The ensemble of elements of a phased-array antenna takes the place of the holographic plate, but at a much longer wavelength than visible light (centimeters and millimeters instead of fractions of a micrometer). When operated in a receiving mode, the phased array obtains much more information than an ordinary antenna; like the hologram, it measures entire electromagnetic field geometries, not merely a one-dimensional, electromagnetic "signal"

The holographic principle underlying phased-array systems points to a potentiality for creating any desired three-dimensional, electromagnetic field distribution around a target object, from a distance, correcting for reflections, obstacles and other interference. Moreover, the field can be transformed and shifted from one location to another in space within a fraction of a second. Thus, an ideal EP-weapon could attack many individual targets, simultaneously or in rapid succession. One or more phased arrays would be used in receiving and transmitting modes to "lock on" to selected targets, and determine the necessary geometry of the attack pulses. To fully exploit such potentialities, the weapon would require for its target-acquisition and beam-control systems, sophisticated high speed computers, able to perform complex computations of the "inverse-scattering" type. Miniaturized systems of this sort are well within the reach of 'fifth generation' computer technology. "Hybrid" digital-analog systems would be simpler, smaller, and faster still. There is much overlap in requirements between EP weapons and systems developed for strategic defense(SDI).

For concrete weapons applications, simpler devices will often suffice; trade-offs can be made among range, output power, extent of three dimensional field control, and sophistication of biological effects.

As was the case earlier with nuclear weapons, many people may be tempted to think that EP anti-personnel weapons constitute "absolute weapons" against which no defense is possible. A glance at the history of the SDI, or of military science and technology in general, shows why no such thing ever has or will exist.

An obvious aspect of defense is to detect, locate, and neutralize weapons before they can be used. Antenna structures of EP weapons are resonant structures which can be detected in various ways. Spetsnaz deployment of EP weapons can be countered by intercepting the weapons or weapons components in transport, by appropriate surveillance of the areas around potential targets, and by the whole range of countermeasures which can be taken against the Spetsnaz groups themselves. Of course, the EP weapon declares its existence as soon as it is turned on, and itself becomes vulnerable to rapid counterattack if readiness and appropriate means are at hand.

The famous "Faraday cage" and other forms of electromagnetic shielding can provide some protection against EP weapons, especially if the characteristics of the EP signal are known in advance and countermeasures are devised accordingly. Unfortunately, a sophisticated weapon can "tailor" its pulse to get through nearly any given kind of shielding utilizing non-linear, inverse-scattering techniques and a process known as "self-induced transparency." A Faraday cage under certain conditions can be transformed into an antenna, focusing the signal on the inside and even enhancing the effect for the unfortunate persons inside.

In theory, biological effects can be offset by creating a controlled "electromagnetic environment" around the target, with the effect of "detuning" the target relative to the anticipated signal of the attacking EP weapon - a kind of "immunization." To realize such potentialities will require a major research effort, but one having important spinoffs for biology and medicine.

The application of holographic principles to EP weaponry has profound implications for the future shape of warfare. The deployment of such weapons and the defense against them cannot be understood in terms of "point-to-point trajectory" concepts associated with conventional firearms and artillery. Actually, even in the past, competent military doctrine has always emphasized the geometries of "fields of fire" generated by overall deployment of mobile weapons over a given area, as opposed to mere "straight-line" action of an individual weapon. the geometrical aspect becomes much more explicit in the era of EP weaponry, in which "firepower counts as the ability to control the electromagnetic field geometry on the field of battle, through coordinated deployment and operation of mobile phased arrays and related devices.

The situation could therefore be summed up as follows: in practice, both the use of EP weapons and defense against them is a tricky, sophisticated business, if the antagonists are at comparable levels of technology, knowledge, and preparation. A surprise attack against an unprepared enemy is simpler and very devastating. In this respect, EP weapons are no exception to the general rules of warfare."

Tennenbaum, Jonathan.(1988). Soviet Work on Electromagnetic Pulse Weapons.
Executive Intelligence Review. Pg. 17

The 1987 edition of the U.S. Department of Defense review, Soviet Military Power, contains the following stern warning about the current Soviet mobilization to perfect electromagnetic pulse (EP) weapons: "Recent Soviet developments in the generation of radio-frequency (RF) energy have potential applications for a fundamentally new type of weapon system that would degrade electronics or be used in an anti-personnel mode. The Soviets already have or are working on much of the technology for such a system. In their research the Soviets have generated single pulses with peak power exceeding 1 billion watts and repetitive pulses of over 100 million watts.. No significant technological obstacles stand in the way of a prototype short-range tactical RF weapon."

In this Special Report, we shall document that the U.S.S.R. presently possesses the essential technological base, plus knowledge of advanced biophysics, to realize a wide variety of tactical and strategic electromagnetic anti-personnel weapons. We shall demonstrate this from the Soviets' own technical publications. Fortunately, we are not able to show pictures of EP weapons on parade in Red Square-if we could, it would be too late!

Figure 1 shows, on a map of the U.S.S.R., some of the known centers of Soviet work on the science and technology of EP weapons. For example, advanced high-power microwave generator work is carried out at the Applied Physics Institute in Gor'kiy near Moscow, at several institutes in Tomsk, at the Moscow Lebedev Institute, in Lengingrad, Novosibirsk, and other locations. Advanced biophysical research of military importance is going on at the Institute for Biological Physics (G.M. Franck) at Pushchino near Moscow, at the Siberian Division of the Academy of Medical Sciences at Novosibirsk, at several institutes in Alma Ata, in Vladivostok, and at a number of establishments linked to the Soviet manned space program. (There is significant overlap between space medicine and the biophysics of EP weapons effects.) The question marks on the map indicate that only a very small part of the relevant research and development ever finds its way, even obliquely, into available Soviet technical journals. Military secrecy is much stricter and all-encompassing in the East than the West.

An interesting article appeared this year by one V.M. Koldayev in the Soviet journal Biologicheskiye Nauki dealing with "The Correction of Acute Microwave Exposure by Drugs-Experimental Results." In the article a large number of pharmaceuticals are evaluated for their capability of enhancing the resistance of the human organism to microwave radiation. Both preventive treatment, before exposure, and post-exposure treatment are discussed. Koldayev stresses a point which is key to the Soviet approach to microwave and radio-frequency effects: "Intensive microwave radiation changes the membrane characteristics of cells and ion transport, generates electrical breakdown at the boundaries of phase regions and other effects causing a destruction of living processes. Research in recent years has shown that the 'thermal conception' of microwave effects is inadequate."

Kolayev points to a major stumbling-block of Western biophysical research: the absurd, but stubborn insistence on the part of the Western research "establishment", that electromagnetic radiation could have no other effect on a living organism than to increase its temperature (I.E., in Koldayev's words, the "thermal conception"). As a result of this blind spot, many Western specialists still refuse to accept the existence of precisely those kinds of effects upon which the most lethal Soviet EP weapons depend.

The Soviets presently lead the world in research into a crucial, but not much publicized field called "optical biophysics," sometimes referred in the West as "bioelectromagnetics," which deals with the electromagnetic organization of living processes. Although modern research into this area goes back to Louis Pasteur, the most consistent and sustained efforts were launched in Russia by V.I. Vernadsky (1863-1945), the physicist biologist, geologist, and architect of the Soviet atom bomb project.

Vernadsky's scientific training focused on the works of Pasteur and radioactivity pioneer Pierre Curie, and included visits to the Pasteur Institute and other leading European science institutes. Vernadsky initiated the systematic search for reserves of uranium and other technically crucial minerals throughout the Russian empire, and was a key organizer of the pre-World War I economic mobilization in Russia. As founding director of the State Radium Institute in Leningrad, Vernadsky launched in 1926 a crash program of fundamental research into the "physical geometry" of living processes, which would include a comprehensive study of their interaction with electromagnetic radiation:

"Only a few of the invisible radiation's are known to us at present. We have hardly begun to realize their diversity and the inadequacy of our knowledge of these radiations which surround us and pass through us in the biosphere, and to understand their basic role in the processes going on around us, a role which is difficult to comprehend by those accustomed to other conceptions of the Universe...We are surrounded and penetrated, at all times and all places, by eternally changing, combining and opposing radiation of different wavelengths--from 10 millionths of a millimeter to several kilometers."

Out of Vernadsky's program came the Soviet military slogan: "He who controls the entire electromagnetic spectrum will dominate the world." It was Vernadsky who coined the now-common term "biosphere," emphasizing the fact that the totality of living matter on the Earth forms a coherent process in powerful mutual interaction with the climate and geophysical conditions of the planet. This work was the basis of the concept of "planetary war" advocated by Marshal Ogarkov, according to which all available scientific knowledge concerning the biosphere is to be mobilized in war in order to crush the enemy. This includes development of means of weather modification, manipulation of the ionosphere and other layers of the atmosphere, large-scale biological warfare, triggering of natural disasters, as well as global electromagnetic warfare.

Vernadsky's efforts provided the scientific atmosphere for the launching of the most powerful current of Soviet biophysical research, that associated with Alexander Gurvich(1874-1954). Gurvich was the first to systematically demonstrate that absorption of minute amounts of "tuned" electromagnetic radiation, down to individual quanta, can decisively influence the course of biological events. This is now known in the Soviet literature as the "informational role of electromagnetic radiation in biological systems."

In connection with this research, Gurvich developed that first "field theory" approach to the geometry of living processes, and discovered the universal ultraviolet light emission of cells called "mitogenetic radiation". He was the first to point to the capability of biological molecules such as proteins and DNA, to absorb energy at long wavelengths and reemit the stored energy at much shorter wavelengths-phenomena which are intensively studied today under the name of "multiphoton processes in non-linear spectroscopy."

Gurvich was thereby a pioneer in the area of advanced research which is decisive for the most devastating forms of electromagnetic anti-personnel weapons.

Gurvich's student G.M. Franck founded the Institute of Biological Physics in Pushichino, which still bears Franck's name, and is today a key center of military-related research on electromagnetic pulse effects on biological systems. Another Gurvich disciple, Prof. Vlail Kaznacheev, heads the Medical Division of the Soviet Academy of Sciences in Novosibirsk, with close ties to the military space establishment. Kaznacheev carried out a decade-long series of experiments on the electromagnetic basis of the pathogenic action of viruses and poisons. Another member of the Gurvich school, Alma Ata biophysicist Inyushin, wrote an article in the Red Army paper Krasnaya Zvezda in 1984, declaring that breakthroughs of "revolutionary significance" were being made in the optical biophyscis field. Since then, Inuyushin's name completely dropped out of Soviet scientific literature, indicating that he is now working in a top secret program. Indeed, almost the entirety of the huge Soviet effort in biophysics of the Gurvich-Vernadsky variety has "gone underground" since 1983-84.

One indicative area of continued Soviet publications is on the "non-thermal" effects of low-level microwave radiation in the millimeter wavelength band. Since at least the late 1960s, a U.S.S.R.-wide network of more than 21 institutes has conducted research into this field, led by Prof. N.D. Deyatkov of the Soviet Academy of Sciences. This research is continuing to this day. Late last year, for example, the Soviet microwave technology journal Radioelektronika published two long papers on biological effects, written by known members of the Deyatkov group. These papers discussed the mechanisms by which millimeter radiation interacts with internal electroacoustical oscillations, notably in cell membranes, to generate the resonant, frequency-dependent effects documented in a large number of experiments.

The significance of these sorts of publications is not that they give a direct "peek through the window" at weapons-development; rather, they indicate an orientation of "civilian' basic research programs to the type of phenomena of relevance to weapons applications.(It is unlikely that electromagnetic anti-personnel weapons would work with pure millimeter waves. Millimeter-band "harmonics" would be included in complex pulse forms, however.)

Unfortunately, Devyatkov's area of research was all but closed down in the U.S., following the conclusion of "biological warfare accords" between the U.S. and the U.S.S.R. in the early 1970s-another concession from which the Soviets have extracted great strategic profit.

The capability to generate controlled high-power pulses of electromagnetic energy has long been a top priority area for Soviet applied physics research and development. It even has its own name in the Soviet literature, for which no direct equivalent term exists in the West: sil'notochnaya elektronika. It includes things like explosive cathodes and other technology for high-current relativistic particle beams, energy storage and pulse compression technology, non-linear plasma devices such as the plasma focus, "explosive" MHD power generation, EMP simulators, etc.

Significant parts of this R&D are being carried out in "purely peaceful" programs, such as controlled fusion energy and accelerators for elementary particle research. So, Soviet development of gyrotron devices for ultra-high-power microwave generation has the "official purpose of providing means for heating plasmas in experimental fusion reactors. And, in fact, gyrotrons can do exactly that. But, the technical advances thus made-or acquired from the West-under "civilian" fusion research programs with international cooperation, can immediately be transferred to secret military programs. Thus, Rudakov's huge "Angara V" electron beam pulse generator, allegedly constructed for fusion research, was obviously motivated by some other reasons than just the publicized ones.

Soviet development of high-power magnetohydrodynamic (MHD) generators is another interesting example. For many years, Vice-president of the U.S.S.R. Academy of Sciences E.P. Velikhov has directed a large program to perfect this technology for direct conversion of chemical combustion energy into electricity, for a variety of "peaceful" applications.

These are figures from 1977, ten years ago. Given intensive Soviet work in this field in the intervening period, we must assume that they can obtain the same or better output with much smaller devices. These and the famous "Pavlovskii" pulse generators play an important role in the Soviet's own version of the SDI, as power sources for beam weapons. They provide enough power for very devastating types of mobile anti-personnel weapons.

The heart of an EP anti-personnel weapon is the system for generating and emitting the electromagnetic radiation. Here the Soviets can draw from their vast experience with all types of military radars, including the large phased-array installations at Krasnoyarsk, Pechora and elsewhere, as well as advanced research into relativistic electron beam devices for ultra-high-power EP generation. The article by Robert Gallagher documents how the Soviets have led the world in development of pulsed gyrotrons and related EP devices covering a wide frequency range. This new hardware is being "spun off" in great quantity and variety as a product of the sil'notochnaya elektronika thrust. Nor have the potentialities of solid-state been neglected. While the Soviets may lag in some of the most exotic microchip technology, they are quite familiar with solid state radar systems applicable (among other things) to miniaturized EP weapons. "Briefcase size" EP weapons for "close-in" Spetsnaz assasinations and related missions, are well within Soviet technological capability.

Recently, it was announced that the U.S.S.R. intends to use its new, heavy space-lift system Energiya, with five times the payload of the American space shuttle, to station some very large structures in orbit. Besides a larger version of their present space station, one of the plans is for a huge "solar power station" which would relay its energy to Earth via a high-power laser or a beam of microwaves. (A similar project was considered by the U.S. NASA, but rejected because of the of inadvertently irradiating populated areas.) With a proposed several gigawatts of continuous power at its disposal, such a station could carry out weather modification as well as electromagnetic warfare on a large scale. Of course, compact nuclear reactors (which the Soviets are already using in radar reconnaissance satellites), especially in a pulsed mode, and MHD devices, could be much better energy sources for a military system. given a sufficient supply of energy, a large, phased-array EP system in orbit could attack entire cities, with loss of life comparable to nuclear weapons, but without collateral damage.

However, it is not necessary to station EP weapons in space in order to have firepower on a "strategic" scale. The Soviets have been early masters at combining their knowledge of geophysics and non-linear wave propagation to develop novel types of over-the-horizon radar. Using combinations of phased-array installations with a very large effective aperture, it is theoretically possible to project lethal electromagnetic signals over thousands of kilometers. At shorter ranges, incoming missiles and aircraft might be destroyed using EMP-like effects. Soviet activities should be closely watched in these respects, especially in view of the potential "dual purpose" exploitation of certain facilities.

(The following list is not intended to be comprehensive, but merely exemplifies extensive Soviet scientific efforts in fields relevant to EP weaponry. The interested reader will find further literature through the cited publications.)"

All-Union Conference on High-Current Electronics, Novosibirsk 1986 (conference proceedings, in Russian).

O.V. Betsky, A.V. Putvinsky, "Biological Effects of Millimeter Waves of Low Intensity" (Russian) and M.V. Golant, T.B. Rebrovak, "The Analogy between Certain Systems of Living Organism and Technical UHF between Certain Systems of Living Organisms and Technical UHF Devices," (Russian in Radioelektronika 29, Nr.10, 1986.

G.I. Budker, "The Gyrocon: An Efficient Relativistic High-Power VHF generator," Particle Accelerators 10, 1979.

N.D. Deyatkov, E.A. Gel'vich, M.B. Golant, "Radiophysical Aspects of the Use in Medicine of Energetic and Informational Action of Electromagnetic Radiation," (Russian), Seria Elektronika SVC (UHF Electronics), Nr. 9(333), 1981.

A.G. Gurvich, Mitogenetic Analysis of the Excitation of the Nervous System, Amsterdam 1937; "Une theorie du champ biologique," Bibliotheca Biotheorectica, Ser. D, II. See also Michael Lipkind, "Gurwitschs Theorie vom Biologischem Feld," in the German-language magazine Fusion, 8.Jg., 1987, Nr.4.

V.M. Inyushin, D.R. Chekurov, Laser Biostimulation and Bioplasma, (Russian), Alma Ata 1975.

S. Kassel, "Soviet Development of Gyrotrons," RAND Corp. Report R-3377-ARPA, May 1986.

V.P.Kaznacheev, L.P. Mikhailova, Ultraweak Radiation in Intercellular Interactions, (Russian) U.S.S.R. Academy of Sciences, Novosibirsk 1981.

V.M. Koldayev, "Pharmacological Correction of Acute Microwave Effects," (Russian) Biologiecheskiye Nauki, 1, 1987.

V.I. Vernadsky, The Biosphere, 1926 (Russian and French editions).

Editor's note. Here are more substantiating articles in support of Tennenbaum's information. It is in list format.

Liebig, Michael.(1988).Radio-Frequency Weapons: Strategic Context and Implications. Executive Intelligence Review. Pg. 42.

Michael Liebig is Managing Director of EIR nachrichtenagentur GmbH in Wiesbaden, Federal Republic of Germany. The following paper was presented at conferences in the Federal Republic of Germany, France, and Italy.

"...It is obvious that the whole complex of RF technologies, precisely because of the vast potential for military application, is highly classified. Detailed information on RF systems is extremely scant in the public domain. Yet we do know the scientific-technological basics of RF systems and their interaction with biological and other soft targets. While operational RF weapon systems may not yet exist as such, it can be stated categorically, that not just research, but development work towards operational RF weapons, is underway in the East and West, especially in the East.

Pg. 40. "Radio-frequency weapons" is a misleading name, carried over from a pragmatic understanding of earlier stages of electronic warfare. For example, it was thought, mistakenly, that the use of microwaves as anti-personnel weapons depended upon the heating effects of such waves upon targeted material. Today, it has been shown that properly tuned electromagnetic pulses have mortal effects at levels of energy-deposit as low as two or three orders of magnitude below those required to kill cell-tissue by means of induced thermal effects. This comparison illustrates the importance of the term "non-linear effects."

The most important of the near-term applications of non-linear electromagnetic effects are in the domain of optical biophysics, either as strategic or tactical anti-personnel weapons, or to produce global effects within the biosphere surrounding those personnel. However, there is also the prospect of disintegrating non-organic material, as well as the disruption of apparatus, through the same class of technologies. In applying the notion of technological attrition to all such electromagnetic-pulse weapons as a general class, it is the principles causing all of the indicated range of effects which must be considered as a unit for purposes of shaping strategic doctrine.

All of the weaponry based upon "new physical principles," including lasers, particle beams, and non-linear electromagnetic-pulse effects, belong, together with the role of high temperature superconductivity, to the domain of sub-atomic physics. Modern high-energy physics, especially that focused upon so-called "force free" status of plasmas, shows that sub-atomic phase-space has a distinct, Kepler-Gauss sort of inherent curvature. It is also shown, that non-linear effects of coherent electromagnetic pulses, as phenomena of the macro-scale, are rooted in the non-linear physics of the curvature of "force-free," least-action states in the sub-atomic domain.

One of the most important lines of inquiry to this effect today, is modern optical biophysics' attention to the decisive role of precisely tuned, inherently coherent electromagnetic pulses in living processes.

Conceptually, this new work belongs to the tradition of Pasteur's work on optical biophysics and the definition of living processes presented by Luca Pacioli and Leonardo da Vinci nearly 500 years ago. Essentially, modern instruments permit us to detect and measure localized coherent pulses in the range of quanta of emission, leading into what is called today "non-linear spectroscopy" of living processes. The comparison of the results obtained in this way in biological research, with lessons learned from high-energy physics of force-free plasma states, is the key to design of strategic and tactical anti-personnel assault weapons and related applications."

Frazer, James W. PhD and Frazer, Joyce E.(1988, Mar.Apr.)How Radiofrequency Waves Interact with Living Systems.21st Century.Pg. 50.Dr. Frazer, adjunct professor of pharmacology, University of Texas Health Science Center San Antonio. Dr. Frazer was featured as a weapons expert on CNN's Special Report,1985 and discussed his ten year Air Force career and on electromagnetic effects. His conclusion that "radiofrequency weapons could be the wild-card in the arms race."

"The nonthermal effects of electromagnetic radiation on living cells offer clues as to what is life, as well as to understanding Soviet research on the possibility of controlling human thought and emotional experience." Pg. 54. "In earlier work, Adey's group had shown a modulation sensitive effect on calcium efflux from chick brains. These findings created considerable controversy, but were completely substantiated by work done in Environmental Protection Agency(EPA) laboratories at Research Triangle Park in North Carolina. The subsequent history of their group is of interest. Adey's group continued with practical and theoretical studies of nonlinear response of biological systems to low-intensity fields-but with nearly annual cuts in funding levels. The federal agencies monitoring that work have been fragmented and the people either left or transferred to other fields of endeavor. Price, Frazer, Mori, and all of the people performing the original lymphocyte experiments have resigned, been victims of reductions in force, gone into other areas of research, or retired. Thus, an area of research of great interest to theoretical biology has been very effectively choked off."

Wellborn Stanley & Daniloff, Nicholas.(1984, Oct. 1`). Can U.S. Hold Its Lead Over Soviets in Science Race? U.S News and World Report.Pg 53.

"The Soviets, for example, experiment extensively in parapsychology and psychic warfare," in modification of weather and in the biological effects of microwave and other electromagnetic fields. Much of this research is given high priority.

Commission on Security and Cooperation In Europe 102nd Congress First Session. The Moscow Meeting of the Conference on the Human Dimension of the Conference on Security and Cooperation in Europe 10 Sept.-4 Oct.1991. Pg. 9.

"Many individual Soviet citizens also attended, seeking help in redressing grievances against the Soviet system after decades of lawlessness and arbitrary administration of justice. Complaints ranged from unjustified loss of employment and placement in psychiatric hospitals to subjection to space-based rays launched and maintained by Soviet security organs. The U.S. delegation was able to do little more than listen to these individuals and forward their complaints to the Soviet delegation or the relevant republican authorities, suggesting to the Soviet delegation that it address the problems of these individuals."

From Fate Magazine, Feb. 1994, p 70. "Soviet Psychic Warfare" by Paul Stonehill

"In 1991, an article entitled "Once More About Psychic Weapons" was published in the Ugolog Ukraine newspaper (Isue 3, 1991) by Mr. A.V. Kalinets-Bryukhanov (K.B.), president of the All-Union Scientific Research Association for the Study of Psychophysical Problems of Nature. ...K.B. state that the "much buzzed about psychic weapons' do exist. In April 1983 he participated in the development of one of the most classified projects of the Soviet Sate Committee for Science and Technologies. ...K.B. ended his artcle starngely. Haveing observed the brain as a receiving and transmitting device, the researchers had discovered certain wavelengths. Using them, it is possible to influence various sectons of the brain directly, reporduce cerebral tissue, and then provoke unusual changes int eh qualities of individual psyches. Then one can program anything into the brains of experimental subjects."

"On Jly 4, 1991 a month before the August 1991 coup in the Soviet Uion, a curious document known as Resolution 58 of the Committee for Science and Technologies of the ...USSR came from the Kremlin. The resolution condenmed the "depraved practice" of financing pseudoscientific research with State funds. The research in question was of `non-traditional technologies," and had been conducted in teh scienfic research centers of the Academy of Sciences of the USSR, Academies of Scienes of several Soviet republics, and a number of State ministries and departments. Particularly it was research into the so-called spinor torsionnic or microleptonnic fields."

"The research was tied to the creation of an unusual organization in the Soviet State Committee for Science and Technologies. It became known as the Center for Nn-traditional Technologies (CNT); its formere director was Mr. A.E. Akimov.

Akimov said that, "The research was based on assertions that there had been an unprecedented discovery in the science of physics. It had to do with a new class of physical fields and particles, and the influence exerted by uch fields upon biological objets, inorganic nature, instruments, and equipment."

"The resolution stated that Soviet science officialdom knew noting of such discoveries, either through open publications, or closed channels, that there had been only one private publication of the subject (by then refuted). The information presented by CNT's officials (henter through reports, presentations, or publications) had, in essence, contradicted conceptions established by modern science."

"Regardless of the quasi-scientific terminology used in such reports, the information was unsubstantiated, illogical, and scientifically unfounded. The CNT isself was created without necessary expertise."

"Pseudo-science blossoms"

"Later, the research undertaken was legitimized by support given it by the State Committee. Because of such suport, the USSR Ministry of Dfense and other state agencies had enough grounds to create a special research center, VENT. Akimov became its general director. Mllions of rubles had been spent as the project of VENT received state funding. Akimov states that just the USSR Ministry of Defense had spent 23 million rubles, an impressive amount. Total funding for WENT (according to Akimov)frm the USSR Military-Industrial Commission of the Cabinet of Minister, and the KGB, was 500 million rubles."

The resolution states that the investiative committee took the conclusions of the Depeartment of General Physics and Astronomy of the Academy of Sciences, USSR, under consideration. These conclusions qualified the research work in the areas of spinor and microleptonnic fields, and their applications, as a recurrence of anti-scientific activity."

The committe blamed the irresponsible approach taken by state agencies toward scientific expertise for the wast of state funds allocated for "anti-scintific activities." his was a clear abuse of the secrecy regime in Soviet academic institutions. The latter, as well as some colleges, had been involved in the whole mess."

"The "blossoming of pseudo-science"was assisted by teh circulation of unclear information about similar research efforts abroad, but no convincing confirmation ever existed. The committee finally requested several things:

1) expert reports before funds would be allocated

2) control over completed or planned work in non-traditional fields

3) and mildly asked the KGB, the military, and the nuclear R&D establishment to report the sums spent, and the sources for the financing used for microleptonnic and other projects."

"One month later, the Soviet Union was shaken to its foundations, and began to fall apart. Yet, on Septemgber 9, 1991, the Komsomolskaya Pravda newspaper published an unusual article. It's author, M. Volkov, revealed what it was that the CNT had actually researched. His source was a report from the CNT, Main Directions of Research."

"The CNT was involved in the study of remote medical and biological influences on the armed forces and people exposed to torsionnic radiation; remote psychophsical influence on the armed forces and people from the rame radiation; and, finally, the fefense to exposure in torsionjic radiation."

"In the fall of 1991, a two-part article in issues 34 and 35 of Molodaya Gvardia magazine was writeen by Emil Fedorovich Bachurin in the Soviet city of Perm. The information demonstrates the kinds of weapons tht fall under the heading of "psychotronic weaopns." ...The weapons are dreadful. A human eing becomes a slient cog in a hellish machine of all-devouring fear. An individual's brain can be suppressed, activities curtailed, and such an individual will submit to any wish of the operator."

"The Zombies of the Red Czars", a documentary by Jerzy Sadkowski, 1998, shown on German TV channel ZDF

`The Zombies' refers to the victims of secret psychiatric experiments in Russia. This documentary, shown on ZDF, a mainstream TV channel in Germany, explores the evidence surrounding the allegations of the Zombies, psychotronic victims in Russia. The opening statement describes a new crisis in Russia, ..."crushed as much by the economic collapse...", The break up of the Soviet Union and the resultant economic crisis is the probable explanation for the extensive amount of Russian mind control information available for the first time in mainstream and international media. This documentary included five examples of previously classified information on mind control technology. Dr. Igor Smirnov demonstrated the `psycho-acoustic correction technology that he developed. He is described as "one of the most important Russian psychiatrists". See 20+ section, several articles on Smirnov and his classified work and his consultations with the FBI.

The importance of this documentary is that the victims describe the same cluster of symptoms reported by U.S. victims, including mail and phone tampering, familiar tools of intelligence black bag operations. The documentary shows the extreme conditions that victims live with daily; they line their apartments with foil and wear electronic gear to ward off the harassive signals. The film says that there are `"thousands of such people in Moscow." Nicolai Ivanitsch holds meetings for victims and claims over a thousand members. Alleged victims protest in Moscow Square.

This documentary shows five clips from secret Russian government training films. The films confirm the existence of psychotronic generators. One film features Dr. Smirnov demonstrating his equipment to top government officials of North Korea. Another film shows the militia leader V. M. Soniko during the war in Afghanistan in which he helped pilots overcome stress and fight ruthlessly.

Andre Slepucha, (spelling could be incorrect), was a prisoner of the Stalinistic camps and the KGB and claims that he received psychotronic treatment there in 1953. He is author of several publications and is recommended as a credible victim by the documentary producers.

Conclusions

1. Dr. Smirnov is a well-known psychiatrist and treats the claims of the victims as plausible. The documentary discloses just how comprehensive the alleged Russian mind control experiments are.

2. This documentary adds support to the theory of a large mind control weapons program.

3. Parallel documentation by the victims of U.S. mind control experiments supports the theory of a large, very similar, but still very classified program in the U.S.

MC Russia Part 1

Russian MC video Part one

SECRET RUSSIA (2) :

MOSCOW :

THE `ZOMBIES' OF THE RED CZARS

TRANSLATED INTO ENGLISH BY :
Jan Wiesemann
Unterm Schrick 31
4 4 7 9 7 Bochum-Stiepel
West-Germany

CREDITS :

Second part of a three-part German documentary, titled : "Geheimes Ruáland. Moskau -- Die Zombies der roten Zaren" [translation : "Secret Russia. Moscow -- The zombies of the red czars"] Part (1) and part (3) of this documentary do NOT deal with Mind Control or Psychotronic Weapons & techniques.

CREDITS for part (2) of the documentary translated here :

A documentary by Jerzy Sladkowski, edited by Agnieszka Bojanowska, camera by Nikolaj Sidortschenko, producer Horst Kalbus, a production by Besta Film, Warschau, Stanislaw Krzeminski. Financed by (the German TV channel) ZDF and (the ??? TV channel) TVP, in close coperation with (the French/German TV channel) Arte. The documentary aired on the German ZDF Tuesday evening, December 22, 1998, from 10:15pm until 11:00pm. A VHS copy of the documentary is available from the German TV-station ZDF for the equivalent of 80 DM (approximately 40 Euros) plus shipping & mailing charges. To order, be sure to mention the title and the precise date the documentary was shown on German TV (see above).

The address is:

ZDF Programmverwertung
Postfach 4040
55100 Mainz
West-Germany

NOTE CONCERNING THE ENGLISH TRANSLATION OF THIS DOCUMENT:

The spelling of all Russian names, places, locales and words is to be regarded as "experimental" and possibly incorrect.

The translator.

SECRET RUSSIA : MOSCOW -- THE ZOMBIES OF THE RED CZARS

SPEAKER :

The Kremlin. Until shortly the symbol of absolute power. The dream of the red czars was a disciplined society they could completely control. This dream once inspired George Orwell to write his darkly futuristic novel, "1984". Autumn 1998, and [now] there is a new crisis in Russia. Years after the collapse of communism the citizens are crushed as much by the economic collapse as they are crushed by the aftermaths of the more than seven decades lasting old system. It was like a net of blunt force and secret control which constrained the citizens. Some of these methods, like the Stalinistic camps, were reported all over the world. Others even its victims only report very rarely. In this country, many see themselves as victims : Victims of armed conflicts or political repression. Victims of secret psychiatric experiments or the constant fear of the "big brother".

[A young man is shown. He is in a wheelchair and has bandages all over his head. An old lady, presumably an assistant to Dr. Smirnov, attaches electrodes to various parts on his head and body.]

SPEAKER :

This young man is a victim of the war in Tschetschenia. A soldier who could escape from the surrounded Grosnie.

MAN IN WHEELCHAIR :

"Mama has cried. She thanks you for everything you have done for us."

SPEAKER :

Only a year ago, due to his war trauma, Sasha could neither talk nor move on his own. He had eye and hearing disturbances. Traditional psychiatry had given him up as a hopeless case and condemned him to vegetate in a closed asylum.

OLD WOMAN [asks Man In Wheelchair] :

"Is it conformable for you like this ? You can sit calmly this way and rest your head." [The man in the wheelchair is seated in front of a computer screen].

SPEAKER :

Soon yet another session of a treatment will start which eventually will completely heal the young man. The instrument of this treatment is a computer program which has been individually tailored to each patient. Over a system of impulses it directly acts on his subconscious. Its inventor refers to this treatment as `Psycho-Correction'. With this therapy the ruins of the psyches of a human are patched up again, a human who has experienced more than he can handle. The numbers on the screen are meant to engage the conscious (part of the mind) to divert attention from the real communication between computer and subconscious.

CLOSE-UP OF MAN IN THE WHEELCHAIR AS HE STARES AT THE NUMBERS FLASHING ON A COMPUTER SCREEN. (His eyes flicker)

CLOSE-UP OF A COMPUTER SCREEN UPON WHICH A SERIES OF NUMBER SEQUENCES FLASH BY.

SPEAKER :

This technique, which is healing Sasha, has been developed by Dr. Igor Viktorovitsch Smirnov, (spelling ???) member of the Academy of Sciences, grandson of a famous [representative] KGB chief, born in a Stalinistic prison. Today, he is one of the most important Russian psychiatrists and famous not only in Russia. His services were even employed by the FBI, which Russian television proudly reported in spring 1993.

REPORTER (Different Speaker) :

Waco, Texas : Law enforcement authorities have surrounded the compounds of a fanatic cult of David Koresh who did not want to surrender. The negotiations have reached a stalemate. The FBI turns to Moscow scientist Igor Smirnov. This respectable bureaucracy took his ability to directly influence the subconscious of the cult members very seriously. At the location Dr. Smirnov introduced a plan by which the cult members were to be "softened up" before the final confrontation.

DR. SMIRNOV :

I wanted to use an appeal by close relatives, from (the cult member's) children and parents. Such as, "Mama come out. We love you very much and are waiting for you." In this fashion I wanted to directly reach [target] every known member of the cult individually in this building. With the help of computer programs these appeals were to be turned into a sound-like signal. While the conscious mind will not recognize these signals the unconscious will react to it. This was to minimize the danger of preventing extreme situations from developing, including a tragic outcome.

SPEAKER :

Via radio, television and telephone lines, the cult of David Koresh was to be subjected to subliminal psychological pressures. But the FBI was also under pressure. Smirnov was not able to carry out the plan.

DR. SMIRNOV :

Three days after our agreement with the chief of the technical services of the FBI, the Americans suddenly changed their decision to wait for one week, which I had asked for so everything could be installed. And they used only one of the agreed upon components, that is, the appeals of close relatives. But in a completely open manner. They installed loudspeakers and began to broadcast everything openly [i.e., in the normal audio mode]. And then the tragedy happened. [The burning of the David Koresh's compound in Waco, Texas, is shown.]

SPEAKER :

This is when the public found out for the first time what the mysterious professor occupies himself with. In addition to hundreds of new patients from all over Russia, clients with completely different needs also started to contact him.

INTERVIEWER (asks Dr. Smirnov) :

Are you or have you ever been contacted by politicians to help them get elected ?

DR. SMIRNOV :

But of course. Just now a new wave of approaches has began. There are going to be presidential elections soon. Our Russian politicians are uneducated and uncivilized. That's why they are such a ruthless and manipulative pack. They don't recoil from attempting to exploit the entire population with technical means, such as ours, only to reach the desired office. I do not advocate supporting this pack. I will never do that under any circumstances.

INTERVIEWER (asks Dr. Smirnov) :

Is this even possible technically ?

DR. SMIRNOV :

Yes. We have conducted experiments with groups of young volunteers. In situations where an immediate decision has to be reached, the group behavior can be changed with a high degree of probability.

[CUT TO : Two men, outside : One in a jeans jacket, another in a suit. Both are nervously smoking a cigarette.]

SPEAKER :

The man wearing the jeans jacket views himself as an unwitting victim of considerably less harmless experiments : Nicolai Ivanitsch Anisinov (spelling ???), a former dissident and prisoner of the KGB. Today he is the representative of the "Moscow Zombies". These people have the habit of constantly watching over their back. They often change their address. They do not trust anyone, whether with or without reason. On their shoulders rests the shadow of the Soviet past.

SPEAKER (continued) :

There are thousands of such people in Moscow. This includes victims of "secret experiments", as they say, and victims of the fear of the allmight of an Orwellian "thought police". These victims are represented by Nicolai Ivanitsch (spelling ???). This is the site where the office of this organisation used to be. One year ago, the Soviet authorities withdrew their permit.

[Close-up of the man in suit smoking a cigarette]

SPEAKER (continued) :

The man with the cigarette watches to make sure they no longer enter the building. This organisation has over a thousand members and receives letters from all over Russia. A few dozens every week. Nicolai Ivanitsch now holds his meetings every Wednesday on this street corner. But only a few show up at these meetings. Many are still afraid. And many simply do not have the strength. The authorities ignore the problem of the Zombies. Comments [information ; details] were refused. For the majority of the population it remains a somehow uncomfortable [undefinable] secret.

[Cut to a science laboratory]

SPEAKER :

Secrecy also surrounds this Moscow research laboratory of which it is not known who finances it. This film was recorded three years ago for a Russian documentary which the Russian television station was suddenly ordered to withdraw without being given a reason. The scientists here do not exactly push themselves in front of the camera. The laboratorist introduces herself as Vera".

[A man lying on his back is being rolled into a huge sphere. Vera, a female laboratorist, speaks to the camera :]

VERA :

So, our machine corrects the human biofield. It not only corrects it but heals it as well. For every patient we put together an individual therapy program.

SPEAKER :

In every case Vera refers to the experimental volunteer as a "patient", even though the laboratory is not a scientifically [recognized] establishment.

VERA :

Currently with this device, AL-015-T, we can transfer every known medication to the patient.

RUSSIAN INTERVIEWER (asks Vera ):

The walls of this room are so shielded. What physical processes occur here ?

VERA :

Yes, we shield every human which does not have anything to do with our therapy or our illnesses from the effects of this machine. Because everything has its own radiation. We protect both the humans as well as ourselves.

RUSSIAN INTERVIEWER (asks Vera ):

You refer to this cassette as a program. But there's some type of a fluid inside it ?

VERA :

This is the programator.

RUSSIAN INTERVIEWER (asks Vera ):

What is that ?

VERA :

Hmm, we will reveal this once it has been patented.

RUSSIAN INTERVIEWER (asks Vera ):

In other words, a type of fluid which contains some kind of information ?

VERA :

Correct. This is an information programator.

RUSSIAN INTERVIEWER (asks Vera ):

And this will then be transferred [(?) inserted electronically (?) ] into the body of the patient ?

VERA :

Yes.

INTERVIEWER (asks Vera ):

Could you explain this again ?

VERA :

With your permission, I will not do that. [i.e, explain it again]

[CUT to man lying under a huge hemispherical device.]

SPEAKER :

This type of research was once controlled by the communists. Today the same scientists operate in a lawless environment for the free (unregulated) market.

CUT TO DR. SMIRNOV

[wearing a black suit and tie]

DR. SMIRNOV :

What we do here and have implemented for some time, could from a certain point of view, appear as a weapon. In most countries this is heavily regulated and prohibited. In Russia, until now you can do everything you want. The only barrier is the ethic of those who possess this technology.

CUT TO AN APARTMENT

SPEAKER :

In Russia, the methods by which the human soul and body can be manipulated by electronic means, even from a distance, are called `Psychotronic treatment". [A cheaply constructed headgear is shown.]

SPEAKER :

This is a self-fabricated headgear against low electromagnetic frequencies. Tenants of these apartments have voiced complaints which are said to be symptomatic of victims of psychotronic experiments. One of them is Yirena Koslova (spelling ???). We visit her together with the electronic engineer Andre Slepucha (spelling Subj: MC Russia 2

SPEAKER (continued) :

He alleges that the KGB already experimented on him during the 1950's. Fact is, at that time Andre was a prisoner of the Stalinistic camps and the KGB. Yirena Koslova sleeps in this cage to protect herself against the exterior effects of psychotronic influences. When she notices our expressions of disbelief she shows us an attestation from the International Center of Psychiatry which certifies that she is psychologically perfectly healthy. Yirena used to work for the Moscow district attorney. She was fired after she protested against the suppression of politically sensitive evidence.

YIRENA :

Without this technology, I would already be lying in the cemetery. When they start to pound your brain, you feel as if you are weightless, for a few days thereafter. If you move your head too fast and abruptly, you become dizzy.

ANDRE SLEPUCHA :

In the first two, three years, you don't particularly notice the effects of a psychotronic treatment. But only then the organism gets shaken up and a strong reaction of all organs begins. (to YIRENA :) What is wrong in your case? Is it the kidneys, the heart? Do you have heart problems ?

YIRENA :

Well, they do it so that everything is swinging. It starts to hammer and flutter.

ANDRE SLEPUCHA :

An arrhythmia. This is typical.

YIRENA :

Either they cause a sharp pain or it starts to flutter.

ANDRE SLEPUCHA :

This is a reaction to a radiation of approximately 3 MHZ. This affects the centers which control the heart functions.

YIRENA :

It causes a state in which the heart becomes [feels] very heavy and you can't do anything anymore. Everything falls out of your hands. Suddenly it hurts here and there. But when you go see a doctor he doesn't find anything. Strange things.

ANDRE SLEPUCHA :

Anything possible can happen.

YIRENA :

You are completely incapacitated and completely unable to do anything. But then you go see a doctor and there is nothing.

CUT TO THE OUTSIDE OF THE APARTMENT BUILDING(S)

SPEAKER :

As we leave Yirena's home we are apprehended with the question whether it is even possible to cause such considerable strong reactions of the body by manipulating the psyches from a distance. We ask Professor Smirnov whether he ever encountered such a case during his long years of clinical practice.

[CUT TO DR. SMIRNOV, SITTING BEHIND A DESK]

DR. SMIRNOV :

I once watched a 52 year old (female) patient, who was a very well known doctor with academic degrees and titles. Within one week she suddenly lost her hair, nails, eyelashes, eyebrows and teeth. She completely lost her ability to move, except for her right hand. She started making unarticulated sounds which remotely sounded like language. Using her [partially unaffected right] hand to communicate by making small notes onto a paper she was able to explain to us that this was the result of a violation [attack] of a psychotronic weapon. Officially she was diagnosed as suffering from a destruction of the vessels in the cerebrum [frontal lobe] of the brain. But [such vessels] did [do] not exist there. And by which means did their destruction occur so suddenly ? Here we seriously have to consider the possibility whether there might not be someone evil who is secretly radiating, perhaps the neighbors next door, with radioactive Cobalt.

CUT BACK TO ANDRE SLEPUCHA'S APARTMENT

SPEAKER

Andr, Slepucha demonstrates the means by which he tries to protect himself against unwanted outside influences. The authors of the documentary hired by the Russian television [station] referred him to us as a credible victim of psychotronic abuse. He is also the author of several publications on this subject.

ANDRE SLEPUCHA

These are so-called elements [parts] for the personal protection against psychotronic treatments [ psychotronic weapons]. Here on the arms I have certain sensors. Also, on this hand, and also, here at knee level. They are all connected together to an electrical system. This box is the size of a transistor receiver. The thing is, the psychotronic treatment of the brain is being carried out with radiowaves of a specific frequency and a very wide bandwidth. A psychotronic generator is often directly connected to the [consumer] supply outlets, especially onto the telephone network, the radio network, and similar networks. In this case you must, to simplify this, connect certain filters for these arriving messages. I can show them to you.

SPEAKER :

Andr, shows us his home which he has transformed into a fortress to defeat psychotronic signals. With the means available to him he has constructed filters for all entrances of the supply networks, for the telephone [networks], radio [networks] and electricity [networks]. Experts have confirmed that one can indeed protect oneself with such means [devices / instruments] against extreme, low-frequency electromagnetic waves [ELF's], which may have possible negative effects on the organism. The question remains : Who could be interested in harassing this old man ? Is he today really the victim of secret [psychiatric] experiments or [rather] the victim of an exaggerated paranoia which has its roots in his persecution during the days of Stalin ?

ANDRE SLEPUCHA :

This here is my laboratory, or more specifically, my workshop. Here I try to construct the devices I told you about to help those people who have grievances [complaints] due to psychotronic treatments [psychotronic weapons].

SPEAKER :

Andr, Slepucha explains to us which changes have to be made on a simple transistor so it can be used as a measuring instrument for extremely low frequency electromagnetic waves [ELFs]. He connects it to a metal band on his wrist so that it forms a closed circuit and turns it on to discover if a source of a so-called psychotronic treatment is nearby.

[A nondistinctive rushing sound it heard in the device]

ANDRE SLEPUCHA

There is a psychotronic generator at work !

SPEAKER :

Let us assume this is really so. Who is then behind it ?

CUT BACK TO INTERVIEW WITH DR. SMIRNOV

DR: SMIRNOV :

Russia holds the first place with regards to the annually produced [created] computer viruses. This implies that we have colossal numbers of scarily active and very inventive brains for whom there is no demand and who find their self-fulfilment in producing evil.

DR. SMIRNOV (continued) :

The unrestrained development of the psychotronic technology can today be compared to the condition of, lets say, the nuclear research [when it was still] in its very infancy.

CUT TO A GROUP OF TRAINEES WATCHING A FILM

SPEAKER :

We are searching for explanations in secret film material made available to us. They are information and teaching films which were produced under orders from the Russian Interior Ministry. [CUT to close-up of the film] These films confirm the existence of psychotronic generators as well as their dangers.

1st Russian Speaker from Russian Interior Ministry Film :

Time and again, the development [construction] of different psychotronic generators has proved fatal for their inventors. Not in every case, but certainly often enough to be relevant statistically.

2nd Russian Speaker from Russian Interior Ministry Film :

There are four main stages [in the symptoms suffered as a result to the exposure to a psychotronic generator [device]] : The first is a general feeling of unwellness, a weakening of the functions [of the organs/of the brain (?)]. The second is the loss of logic. The third is the loss of spacial orientation. The fourth is the loss of consciousness.

CUT TO A DIFFERENT FILM

SPEAKER :

Another archive film shows a deserted laboratory for psychotronic experiments in the town of Selenoga (spelling ???). The commentator explains that in this case, it was not the crazy experimenters who became victims of their own work but a family with four children who [had] lived in a neighboring [adjourning] home. All of them [suddenly] got ill and died. The only lead which remains of the scientists who are now wanted by the police are a Buddha figure and photos from a study excursion [trip] to Tibet. The identity of those who financed their research is also unknown.

CUT BACK TO ANDRE SLEPUCHA'S APARTMENT. CLOSE-UP OF A PANORAMA PHOTO SHOWING THE COAL MINES OF VORKUTA (spelling ???) :

SPEAKER :

The coal mines of Vorkuta (spelling ???) from the days of the Stalinistic persecution. This panorama reminds millions of Russians of the worst moments in the history of their country. Andr, Slepucha owns yet another souvenir from his days in the [Stalinistic concentration] camps.

ANDRE SLEPUCHA :

In November 1954 I came into contact with what today is referred to as [a] "Psychotronic Treatment" for the first time. Back then they took me out of the concentration camp where, under Stalin, I had been imprisoned as a political prisoner, and brought me into an isolation cell in the KGB prison which was located in the Lubyanka.

After an approximately two week long continuous occupation of the cell I suddenly experienced in the morning strong sounds in the head, very strong acoustic and visual hallucinations.

SPEAKER :

Since the 1970's it is no longer a secret that the Soviet Intelligence Services experimented with the psyches of its imprisoned dissidents. But Slepucha also points out a more recent example of a possible psychotronic manipulation which involved top [Russian] government officials.

ANDRE SLEPUCHA :

The former chief of [Boris] Yeltsin's bodyguards, Alexander Vasilivitch Korjakov (spelling ???), said in February 1991 on the radio, [that] they were outraged, because next to Yeltsin's office they had discovered a room with a great number of electronic devices. When they moved the panels, they also discovered in Yeltsin's office certain specific antennas [related to psychotronic generators and weapons].

CUT TO PUSHKIN MEMORIAL, OUTSIDE, IN MOSCOW :

SPEAKER :

At the Pushkin memorial, in the center of Moscow, some who believe themselves to be victims of psychotronic treatments try to arouse the attention of the passerbys. But hardly anyone pays attention to the posters with the dramatic displays which purport to document the plight of alleged fatal victims of psychotronic experiments.

Russia Part 3

CUT TO PUSHKIN MEMORIAL, OUTSIDE, IN MOSCOW :

SPEAKER :

At the Pushkin memorial, in the center of Moscow, some who believe themselves to be victims of psychotronic treatments try to arouse the attention of the passerbys. But hardly anyone pays attention to the posters with the dramatic displays which purport to document the plight of alleged fatal victims of psychotronic experiments.

SPEAKER (continued) :

In light of the severity of the existential problems prevailing in Russia today, such questions do not appear as important. Psycho-Fascism is the charge made on the poster[s]. The photos show Nikolai Ivanitsch (spelling ???) during several stages of psychotronic treatments which he alleges also left [him with] physical traces. Sometimes one of the older people want to know the details. For the younger [generation] this is a totally strange subject. Basically, only the perpetrators, and perhaps also their victims know more details concerning questionable experiments with/on the human psyches [brain].

[CUT TO DR. SMIRNOV'S LABORATORY : Closeup of a computer monitor upon which a harmless appearing film of a Buddhist ceremony is shown]

SPEAKER :

This film was produced for demonstration purposes by Russian scientists for top government officials of North Korea. One of those [Russian] scientists was Dr. Smirnov. Today he unveils in our presence the secret of the manipulation. To make it visible in this innocent picture, you have to know the correct [computer] code [of the computer software which encrypted the unseen subliminal message/picture and hid it in the visible picture of the Buddhist temple.]

DR. SMIRNOV :

This film was produced in order to demonstrate how to insert a thought, a picture, a suggestion, into a totally different context. Someone who looks at such material will consciously only notice the disguising picture, such as, for example, any given TV show or commercial.

DR. SMIRNOV (continued) :

In fact, however [at the same time the viewer] also receives a secret information [which is] not accessible to the conscious. Let me [now] show you the picture which has been inserted by code into this video.

[Smirnov punches a code into his computer which makes the picture visible]

DR. SMIRNOV :

There it is. [Now we see a photo of U.S. President Bill Clinton with the message : "YANKEE GO HOME !" ]

SPEAKER :

We are no longer dealing with a briefly inserted, unencrypted film picture, a technique which had been tested and prohibited years ago in [for] American commercials. The difference [between the older subliminal technique of briefly inserting an unencrypted picture into a commercial and Dr. Smirnov's new technique] is that the [subliminally] encrypted technique demonstrated here is almost impossible to prove.

DR. SMIRNOV :

Try to comprehend the danger if this were to be produced by a government-controlled television [station] so that millions of people would be repeatedly exposed to the [subliminal] message for, let's say, each day for at least a month. Slowly but ever so gradually it [the subliminal message] would penetrate the brains.

[WE CUT TO RUSSIAN PEOPLE, OUTSIDE]

SPEAKER :

The first Russian generation which has come of age without Communism is now confronted with this danger. [This generation] competes for the once forbidden fruits, and in the intoxication of the newly won freedoms doesn't care for any prohibitions or restraints. [A CLOSE-UP of a Russian Nazi insignia is shown] This is naturally a fertile ground for modern gurus of different origins.

SPEAKER (continued) :

One of them is this man : The militia leader Vijatscheslav Mikhailovitsch Soniko (spelling ???). During the war in Afghanistan he helped pilots to overcome their battle stress. Today he heads a center for psychophysiology in which members of the Special Forces are being instructed. Here too, they treat the human subconscious. But rather than healing [psychological] illnesses, as Dr. Smirnov [does], this treatment instead seeks to reduce the patients' susceptibility to stress and improve their will to execute orders obediently and consistently, in other words, ruthlessly. The patient in this top-secret instruction film of the Interior Ministry is a perfectly healthy officer of the Special Forces [shown] here during [his] psychological preparation for Special Missions. This could be regarded as a genuine Zombie Factory.

[CLOSE-UP of a computer monitor displaying various rhythms (heart, breathing & perspiration rates, etcetera) as well as of the face of the man undergoing the treatment, hooked up to a variety of electronic devices, and the face of the man now speaking]

Speaker of brainwashing operation :

There is a feeling of calmness in every conceivable circumstance. In every conceivable situation. In every conceivable circumstance. You will keep your self-control. Your organism will function reliably and solidly. In every circumstance, even in the most difficult. In every muscle, in every cell of your organism you will feel, now and forever, a pleasant clam energy in every single cell. [A video of a drug bust is shown while the treatment continues] This condition will remain with you in every conceivable, difficult situation. Calm self-assurance. Calm self-assurance in even the most difficult situation.

Russia Part 4

the face of the man now speaking]

Speaker of brainwashing operation :

There is a feeling of calmness in every conceivable circumstance. In every conceivable situation. In every conceivable circumstance. You will keep your self-control. Your organism will function reliably and solidly. In every circumstance, even in the most difficult. In every muscle, in every cell of your organism you will feel, now and forever, a pleasant clam energy in every single cell. [A video of a drug bust is shown while the treatment continues] This condition will remain with you in every conceivable, difficult situation. Calm self-assurance. Calm self-assurance in even the most difficult situation.

Another Speaker of the laboratory addresses the TV audience :

I believe if this is done only for good, then even the forces of the Almighty, to the extent that they exist, will not be angry at us with regards to the experiments we conduct, and the methods we are developing which help the human to keep his sanity.

[A Member of the laboratory responds to the questions of the interviewer] :

Member of the laboratory :

Up until today we have collected enormous statistical data on more than ten thousand humans, and we never noticed [came across] any cases of negative side-effects.

SPEAKER :

In the same archive film, we discover even more evidence dealing with the concern for the psychological health of the human being.

(Same) Member of the laboratory :

[The laboratory member explains a drawing of a building complex on a wall] This fantastic experimental-technical development was [conducted/carried out upon] the orders of the [Soviet/Russian] Defense Ministry. This movable complex is a container which is made up of a bioresonance room, a machine room, a hospital room, and a [very] special bio-manual treatment room. With a length of 12 meters, a height of 3 meters, and a width of 3 meters it satisfies the general European standards. This is a transporter which can be put up anywhere, with automatic aircondition. It can be placed on the Northpole or at the equator, wherever you want.

INTERVIEWER :

And why was especially the military so interested in this ?

Member of the laboratory :

Why the military ? They are investigating the possibilities of rehabilitation of troops under combat conditions [in the field].

CUT TO :

[A diagram of numbers and figures flashing on a computer screen is shown]

SPEAKER :

What remains of the Russian soul once it has gone through such a container in which a computer programmed for the cleaning of the subconscious changes feelings and human excitements into numbers and [mathematical] diagrams, which can then be "corrected". [A diagram of wavy lines is shown]

SPEAKER (continued) :

This is one of Professor Smirnov's recorded computer displays of a human subconscious, a graphic illustration of the [human] soul. Every one who has access to the computer and knows the [software] program has access to this soul. To rule the [human] souls, one only has to put them into the area of effective vicinity of the apparatus. Or, there is already a method to transmit hidden information over long distances. According to Smirnov [such a method] does exist :

DR. SMIRNOV :

You can input a suggestive "equation", a "consciously not noticeable fable", as we like to call it, into every conceivable low-frequency sound, for example, into the background sound you can hear in the telephone, even into the sound of a sledge hammer, not to mention the fact that this can be even more easily done with the radio or pieces of music. It works like this :

[Dr. Smirnov speaks into a microphone which is hooked up to his computer]

DR. SMIRNOV :

[Into the microphone :] "Attention. Attention. This is Germany. In five minutes, Hitler will be finished." [To the TV audience :] We now have recorded an audio database which can then be played back from the computer.

[Dr. Smirnov plays his own voice back : "Attention. Attention. This is Germany. In five minutes, Hitler will be finished."]

There is nothing special about this. But now we change this [audio] database into an undecipherable format. We receive a database which produces a sound. [Dr. Smirnov plays the changed database of his voice back which now sounds only like background noise rushings].

Only the rhythm is the same as that of the originally recorded database, but my words are no longer recognizable, right ?! Still, the brain will not rest until it has decoded [the message]. We too can decode [the message] if we change it back [to its original form]. I have recorded this changed-back database. Now we'll open it. [Dr. Smirnov does this on the computer]. There it is. Let us listen to it again. [The same rustle-rushing sound is heard]. Yes, there is that sound [again]. And now we'll decode it. Even if my voice will [now] be a little distorted, I hope that it can [still] be recognized.

[The recording of Dr. Smirnov's voice is played once more : "Attention. Attention. This is Germany. In five minutes, Hitler will be finished." ]

If a great number of people would be exposed to all of this, for example through the TV, or the movie theatres, or radios, then, I believe, that there exists a certain danger for our security.

WE CUT BACK TO THE APARTMENT OF A LITTLE OLD LADY

MAN :

Again the telephone doesn't work as it is supposed to. It dials all by itself.

SPEAKER :

The leader of the "Moscow Zombies" believes [that] the malfunctions of [the problems with] the telephone are due to the effect of a psychotronic generator.

MAN :

Veronika was [is located in] the `Middlevar' (spelling ???). Again it is dialling a different number. I wanted to call the `Tekovar' (spelling ???).

OLD WOMAN :

And it doesn't dial the number ?

MAN :

No, it dials the time announcement, which you called the last time, as if [the numbers] had been stored.

OLD WOMAN

And I call the security services of my apartment, but [instead I] receive the time announcement. I try it again and nothing gets dialled.

MAN

When I called the Terkovar yesterday, I got connected to the cemetery.

OLD WOMAN

At the cemetery ? So they sent you to [connected you with] the cemetery.

SPEAKER

Nikolai Ivanovitsch (spelling ???) pays no rent. He also has no money for food. The old woman, a retired biologist, supports [both] him and herself from her meagre social security proceeds.

SPEAKER (continued) :

She does that out of solidarity with the "Zombie"-movement because she has spent many years in the [Stalinistic concentration] camp herself and has basically been persecuted politically for her entire life.

MAN :

I just [simply] wanted to tell you that the contact with me can bear various conflicts. Therefore, I always tell you : Talk less.

OLD WOMAN

You know this better than I do.

MAN

It doesn't necessarily have to come down to a conflict. But it may give [result in] provocations [enmities] and such. It is better not to talk.

SPEAKER :

Nobody knows in how many homes in Moscow, or [even] in all of Russia, there are people who up until today are afraid to talk freely. People who are afraid of their own shadow. And nobody knows how many of them are really the victims of dubious [psychological] experiments with [on] the human psyches. And how many are victims of the fear of such manipulations.

WE CUT BACK TO DR. SMIRNOV WHO IS SEATED BEHIND A DESK :

DR. SMIRNOV :

What, in my opinion correctly, is feared the most in the entire world, is an invasion into the soul. This couldn't be any other way. After all, it is better to lose the body than [to lose] the immortal soul. It is easily conceivable that some Russian "Satan", or, let's say an Iranian or any other [Satan], as long as he owns the appropriate means and finances, can [could] inject himself [intrude] into every conceivable computer network, into every conceivable radio or tv broadcast with relative technological ease, even without disconnecting [any] cables. You can intercept the [radio]waves in the aether and then [subliminally] modulate every conceivable suggestion into it. If this transpires over a long enough time period, it accumulates in the heads of the people. And eventually, they can be artificially manipulated with other additional measurements to do [exactly] that which this perpetrator wants [them to do]. This is why [such technology] is rightfully [correctly] feared.

CUT BACK TO ANDRE SLEPUCHA'S APARTMENT

ANDRE SLEPUCHA :

Many who view these pictures might think, this man alleges to have been [psychotronically] treated for fifteen years, yet at the same time his arguments are sufficiently logical and analytical. And for his almost seventy years, he doesn't look so bad. But [the fact is] I have been clinically dead three times, due to the effects of special electronic vibrations, which led to very strong internal bleedings and a great loss of blood.

ANDRE SLEPUCHA (continued) :

I was simply lucky with the ambulance so that I, as they say, could be saved. And [the] second [reason is] that for at least seven years I have successfully employed these protective measurements which I have demonstrated to you.

WE CUT TO OUTSIDE, RUSSIA, EVENING

SPEAKER :

We are driving to the Bolsheia Pirogovka, Russia's oldest psychiatry, the Korsakov clinic. Here is also the Institute for Psycho Technology which Dr. Smirnov founded ten years ago. Since then, more than ten thousand people have contacted him to volunteer for the technique he developed, an operation on the "open subconscious". One of them was also Olga.

OLGA :

I took drugs for approximately three years, and tried in the past one and a half years exceedingly to stop. I've been in all kinds of [drug abuse] hospitals for rehabilitation [purposes]. But none of the therapies [I tried out] were successful. This [Dr. Smirnov's] treatment applies a medication which does not directly produce hallucinations, but you somehow "see" your subconscious, your own life from beginning to the end. [After completing Dr. Smirnov's treatment (and taking the medication)] I had a genuine feeling that I could not possibly return, as if, although I'm not dying, but nevertheless am removing myself to someplace. The procedure takes only approximately one minute. But it feels like three to four hours. I subjected myself to this treatment about a month and a half ago. And since then, I feel good. I can say that today I feel like a free person, because I can [now] say "no" to the drugs.

[WE NOW CUT TO THE CLINIC OF DR. SMIRNOV: A YOUNG MAN IS BEING PREPARED FOR AN OPERATION ON HIS SUBCONSCIOUS]

SPEAKER :

In the clinic of Dr. Smirnov : This narcotized young man also has been a drug addict for four years. Soon he will begin a unique, unbloody operation after which he will wake up cured of his fateful drug addiction. [CLOSE-UP of the patient as he watches a sequence of numbers flashing on a computer screen]. From the computer loudspeakers, coded instructions are intruding into the subconscious of the patient which force him to confront the worst experiences of his life. Therein lies the hidden cause of his drug addiction. The sensations [emotions ?] [the patient experiences] during [this procedure] are so strong that sometimes the heart stops beating. This is the reason for the narcosis and the [presence of] a specialized team of doctors which is able to revive the patient in case of [an] emergency. The [subliminal] instructions are being encrypted into the sound of the [patient's] heartbeat. The operation lasts only a few minutes. Usually the patient continues to repeat one word which for him has a [personal] key meaning.

PATIENT :

Mama. Mama. Mama.

SPEAKER :

The subconscious, the soul of the young man, now lies exposed to the surgeon. Only Smirnov practices such procedures on the subconscious today. Sergei's [the patient's] pulse increases to two hundred beats per minute. In this moment, the drug addiction is literally being surgically removed.

[A noise of an increasing pulse beat is heard]

SPEAKER

Brainwashing per computer !

[The sound of the pulse becomes louder and faster]

PATIENT

Mama. Mama. Mama. Mama. Mama. Mama. Mama. Mama.

DR. SMIRNOV :

Finished ?

SPEAKER :

Now the pulse frequency decreases again. The "cavity" [hole] created in his subconscious is now being replaced ["filled"] with positive motivation. It [the positive motivation] will help him to live without the [drug] addiction.

[The patient sighs and breathes deeply.]

One could feel enthusiastic. Would there not be a [rather] disturbing thought : If it is possible to remove "evil" from the soul of a human being, and have it replaced with "good", is this also possible the other way around ? Can anyone in Russia today guarantee that this is never going to happen ?

DR. SMIRNOV :

There is a famous bible verse which is [usually] interpreted incorrectly :

"I am the Lord." [ alternative translation : "I am the Master."]

Everyone assumes automatically that this is a word of God, right ? He is the Lord [Master]. In fact, "I am the Lord [Master]", means "I am God", "She is God", or "They are God". "God", this is the Holy Spirit, this is us. The general population does not realize this second meaning. And although we psychiatrists operate with relative material objects, computers, programs, semantic structures and such, which can be measured, weighted, and be understood and expressed in numbers, we treat this [Holy] Spirit in a pretty mediocre way. Because this is not something so metaphysical, immaterial and irrational as [was] once thought.

F L ---- J ---- L E

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### *Section II*

The Second and Equally Convincing Argument For the Existence of U.S. EMR Mind Control Weapons: The East/West Controversy over Thermal/Athermal effects of Emr Ends With the Exposure of a U.S. Cold War Cover Story

1. Freedom of Information Act excerpts from Harlan Girard, released 2001

2. 1983 Washington DC Conference on Psychological Strategies sponsored by the "Intellectual Father of Star Wars", Dr. Stefan Possony, discussing Russian emr mind control based on athermal emr effects.

3. BBC TV 1984 documentary, "Opening Pandora's Box", highlighting Dr. Becker's theory of large, classified U.S. emr weapons program based in part on evidence of the thermal/athermal controversy.

4. 2000 Video by Council on Wireless Technology Impacts, "Public Exposure", www.emrnetwork.org. More evidence of athermal controversy

Freedom of Information Act Request thanks to Harlan Girard, 2001

This series of unclassified FBIS documents verifies, in detail, the information in the Lopatin book and Russian articles. This fact indicates that information on the mind control issue in the public domain is limited in scope. Some of the authors of the articles are scientists and Russian military personnel. Some articles were translated for government staff. A major theme of the articles is the concern about the dangers of the technology and the need for international controls.

Member of the Russian Federation of Space Exploration Scientific and Technical Council, Anatoliy Ptushenko describes spaced-based energy systems ...that are "capable of driving millions of people crazy".

The first articles an in-depth account written by a member of the Russian Federation of Space Exploration Scientific and Technical Council, Anatoliy Ptushenko. He discussed "for the first time in our press in Rabochaya Tribuna ...about psychotropic weapons...spaced-based energy systems ...that are "capable of driving millions of people crazy.... which started to be developed in the sixties--" The article continues with a discussion of space-based energy systems and the need for the world community to establish an apriori permanent, preventive monitoring of the development and deployment of space-based energy systems. He then described the demonstrators on the streets of Moscow "with banners saying "stop developing psychotronic weapons."

Moscow Rabochaya Truibuna 11-26-94. "But people at the time were most interested in microwave systems. ...However, the most important thing was deemed to be the psychotropic effect created by these systems under certain conditions. That was why they were officially called psychotropic rather than psychotronic weapons. It turned out that it was all a matter of frequency... Generally speaking, most readers are probably familiar with superhigh frequency radiation: Few people with a head cold or a sprain have not sat in a clinic between the two black plates of a "UHF generator." There are frequencies that are beneficial to people. But naturally there are also those which are hazardous. At certain frequencies (I think that only professionals are interested in knowing precisely which ones) microwave radiation creates that very same psychotropic effect. That is, it has a direct physical effect on the human brain."

"So a microwave system can easily be tuned into a psychotropic weapon--formidable in that it has a direct effect on the human brain...just by retuning the generator." Ptushenko stated, "The terrible danger of psychotropic weapons is the possibility of their simultaneously and unequivocally affecting large masses of people over huge areas." He writes "Moskovskiye Novosti, the Komsomolka, Golos, Moskovskiy, Komsomolets, and many other papers have been frantic to tell us all about "psychotronic" weapons (as if they had conspired!). " ...they are talking about something completely different: about hypnosis, "verbal zombification," the effect of ultrasound signals on the human subconscious (on the lines of Ilona Davydova). The subject of the articles is always associated with an acoustic address system. Involving suggestions, for instance i.e. verbal (oral) pressure on a person--albeit using inaudible ultrasonic frequencies."

Ptushenko then mentions Dr. Smirnov, the Russian psychiatrist who is famous for his mind control equipment, see 20+ section. "Smirnov has it that `psychotronics" are easily blocked-...But these childish tricks will not work with psychotropic weapons. It resembles the effect of a psychotropic drug, which is why the weapons were called psychotropic: An imbalance occurs, a fundamental change in a person's psyche, he loses self-control and becomes easily led, and his mind moves from the real world to a world of hallucination." Ptushenko then distinguishes psychotropic drugs from psychotropic weapons.

"But there are fundamental differences between them. All pharmaceutical psychotropics are temporary-acting. While microwave radiation is variable: It can affect a person (or an Army) temporarily or possibly forever. It is all determined by the mix of frequency and the power of the radiation. These systems were called "psychotropic weapons" in official secret documents 30 years ago. It was these systems that we began to appreciate in the sixties."

Ptusenko ends the article with a warning.

"They may quite well have actually been tested. It was not for nothing that at that time some graduates of the Moscow State University Biology Faculty were sent to Ministry of Radioeelctronics Research Institutes... So let us leave the notorious science of psychotronics to the conscience of psychiatrists, psychics, and hypnotists. Nevertheless, faced with such a terrible danger as psychotropic weapons (and other kinds of space-based weapons), it is our duty to ensure that the development and operation of space based solar energy system receive popular and above all mass media scrutiny."

The above article describes the tremendous amount of information on psychotronics in Russian newspapers and agrees with the concerns of Lopatin and Tsygankov and the need to control these weapons. Ptushenko questions the psychotronic weapons school of thought and whether hypnosis will work on unwilling subjects. Hypnosis does work on unwilling subjects, see Dr. Scheflin's book "Mind Manipulators", 1978 and Dr. Colin Ross, "Bluebird", 2000. Both books document government involvement in hypnosis research and disinformation surrounding this issue. Ptushenko too questions the information available on psychotropic weapons claims concerning "hypnosis, `verbal zombification', the effect of ultrasound signals on the human subconscious..." Ptushenko states emphatically that psychotropic weapons,

"do not enable the individual human mind to be controlled in a precise and purposeful way. They simply "jam" any internal connections responsible for a person's self-control, and he becomes easily controllable "according to mob law" in line with commands form a space-based station. He can be controlled either from earth or from a command center lost in space."

These are considerable statements coming from a prominent space expert. Ptushenko has obviously given the matter serious consideration and believes that there are terrible dangers from psychotropic weapons and public debate is necessary. Further research is needed.

The following article written by Russian military experts discuss information warfare Lopatin extensively discussed the threat of information warfare in his book. In the U.S., the Learning Channel TV program "War 2020"" produced by Beyond Productions in 1998 is a good representation of information warfare. The program included Dr. Persinger of Canada's Laurentian University and his discussion on magnetic signals and how signals could be beamed from television, microwave and telephone towers and systems to targeted populations for mind control purposes. The program narrator stated, "The ultimate weapon in the info war would be the human brain. ...Mind control will be the ultimate nonlethal weapon ." Mind control weapons are categorized as information and nonlethal weapons, according to these sources.

This article describes space weapons, including targeting of populations anywhere in the world with behavior control.

The article supplies details to prove that behavior control weapons are feasible, that the U.S. is concentrating research in this area and warns about possible American information and space warfare.

From: Moscow Armeyskiy Sbornik in Russian, Oct 96 No 10, pp 88-90, Article by Major General Valeriy Menshikov, doctor of technical sciences, and Colonel Boris Rodionov, "Along with ordinary wars, states have waged "information wars" since time immemorial, and are doing so now. But while previously they were given only an auxiliary role, lately their significance has grown immeasurably, and new technologies are "guilty" of this. Armeyskiy Sbornik regularly publishes articles on this topic. Today leading specialists of the RF Armed Forces tell about achievements in this area."

"The Teledesic Advanced low-altitude global satellite communications system is of special interest. It will have 15 times more satellites than Iridium--840. With other conditions being equal, the low orbit of small, lightweight craft (no more than 700 km) permits increasing the power of their radio emission on the Earth's surface 2,500 times or more and performing a wide range of military missions. It is unprecedented: the numerical size of the Iridium orbital grouping enables as a minimum simultaneously irradiating any point on Earth from two spacecraft. This provides double redundancy and increased reliability of communications, as for military systems. The band of radio-frequency emissions (20-30 GHz) also has not been used previously in commercial communications."

"An analysis of the enumerated features indicates that the Teledesic system can be used for irradiating ground, sea and airborne facilities with high-power modulated emissions, which in various automated control systems permits initiating computer viruses such as "sleepers," triggered by a special signal. This can become a real threat to security for countries whose command and control systems are oriented on foreign equipment."

"A psychophysical effect on people also is possible for the purpose of altering their behavior and even controlling the social aims of regional or even global sociums. Fantasy? But the fact is that today the United States is spending as much money on developing psychophysical weapons as on the most complex space programs, and such a correlation cannot be accidental. The Americans began such research back in the prewar period and continued it after the war within the scope of programs known as MC-Ultra mind control, MC-Delta--remote alteration of human behavior, and also Bluebeard and Artichoke. Such an effect also is possible via the mass media by creating special audio signals in music hits, key video images in television programs and so on. The Teledesic space system also can be used for this same purpose. Suffice it to recall numerous statements to courts by U.S. citizens that cellular communications is the cause of various ailments, including brain cancer. U.S. scientists from the National Cancer Institute and the Food and Drug Administration recommended limiting use of such communications systems. Similar effects also are possible from the new systems. True, for this the output of its satellites has to be increased a thousand times more that what was announced, but technically it is fully feasible."

"Thus, the new space systems are potentially dangerous from the aspect of unfolding a wide-scale "information war" and even creating a global systems for controlling people's behavior in any region, city or locality, including one's own. A country possessing them will gain an enormous advantage."

The next two articles from China confirm that the Chinese military are aware of emr weapons. Research on infrasound began during the 60s and 70s in some major military countries and is capable of producing fear and hysteria and even mental illness, according to the first of two articles.

From: "New Weapons, Medical -Related Problems'. Beijing Remain Juny: (People's Military Surgeon) In Chinese Vol 40 No 9 Sept 97 pp. 587-588 Mori DocID: 587142

"New-concept weapons refer to weapons whose basic principles, construction and killing and wounding mechanism are entirely different form those of traditional-concept weapons. ..."

"Infrasound Weapons. Infrasound refers to sound waves with frequency lower than 20 Hz, which can cause malfunction of heart blood vessels, and of respiratory, digestive and central nerve systems, disorientation and emotional disorder. Take these infrasound functions as casualty factors and apply them to weapons systems, are called infrasound weapons."

"One kind of infrasound weapon, through bomb explosion, produces high-intensity infrasound wave impacting directly on human bodies. Another kind of infrasound weapon, installed and mounted on a vehicle, directionally radiates infrasound wave indirectly acting on human bodies with an effective distance reaching several hundred meters. When transmitted in water, air, or on ground, infrasound wave has the special features of slight attenuation, rapid speed, long effective distance, strong power of penetration, and being hard to defend and protect against."

"Some major military countries started research on infrasound weapons during 60's to 70's. Infrasound was proven capable of damaging human sensory and internal organs and disabling people. A small amount of output power can induce immeasurable fear and cause mass hysteria. A large amount of output power can cause unstable mental state and body malfunction, or even symptoms of mental disease. Infrasound can deal effectively with personnel in camouflage and battlefield equipment. An advanced infrasound generator targeting personnel has been designed and tested, with amount of energy of generated infrasound wave adjustable to cause personnel disorientation, nausea, vomiting, and incontinence. Research indicates that such reactions are temporary. Once wave generation stops, symptoms disappear with no lasting side effects."

"At present time, infrasound weapons are still at the stage of experimental research, with existing technical problems of miniaturization of weapon size. It is predicted that troops will not be equipped with infrasound weapons within fifteen years."

"....All main military major countries have engaged in research on microwave weapons, with rapid progress in recent years."

Continued in Mori DocID; 587142.

"5. Incoherent Light Source and Super-high Frequency Weapons. Study from experts in foreign armed forces think that bright incoherent light source can cause blindness and Super-high frequency weapons can interfere with human nervous system activities, temporarily disable people, cause unbearable noise and sense of whistling sound, or even damage nervous systems leading to death. The existing problems with these weapons are short launching effective distance, high cost and need for miniaturization of weapon size."

"...At present time, weapons generating interference and causing blindness have become practical to use. Foreign armed forces already have corresponding prevention and protection measures, standard, and diagnostic techniques, and have conducted further research. .Bijing Remain Junyi in Chinese --monthly journal of the PLA General Logistics Department Health Department, carrying many technical articles on military medicine..."

This article from China was important for it's statement on nonthermal effects of emr weapons being capable of producing psychological damage to personnel.

From "High-Energy Microwave Weapons, known as Superstars", Beijing Jiefangjun Bao Chinese 25 Dec. The following is supplied by the Publications Translation Section of the U.S. Consulate General in Hong Kong. Mri DocId: 587137.

"High-Power microwave beam energy technology has been utilized in developing weapons, and it is thereby that the high-power microwave frequency weapons have been produced. ...Its "non-thermal effects" can produce psychological damage to personnel and a decline in the functions of all sectors. Its "thermal effects" can produce scorching of human skin, cataracts in the eyes, and even fatal burns. This sort of weapon is characterized by a large target attack area and a long operating distance, and it is little affected by the weather. Military experts thus praise it as the "superstar" of directional weapons."

This last article is included because it is about the HAARP Project. Dr. Rosalie Bertell, (see Cahra website under `study') is a respected Canadian biometrics expert who led the Bhopal and Chernobyl Medical Commissions and "claims HAARP could disrupt human thought-processes." From British tabloid, The Big Issue, 10-2-2000, "Strike Force".

Also note the mention of the EU and Grattan Healy's work on HAARP issues in this article. Healy was instrumental in the 2000 EU resolution to ban weapons that `manipulate behavior'. See Cahra website International Campaign, under Progress.

The article states that medical emr research has been blocked by the HAARP Project patents, see last paragraph. This information supports the fact that emr athermal effects research in mainstream science is underfunded and suppressed in the US, (Reppert, AP, 1988) and is far behind the Russian emr research in the open literature. Given its value for weapons use and the fact that the military has developed their nonlethal emr weapons program for over 40 years, according to U.S.News, 1997, there are no doubt, beneficial uses of emr that have been suppressed in the process.

Since Eastlund applied for the patents, all research in the area of electromagnetic energy--for, say medical purposes-- has been blocked. As a result a vast and highly promising field of science and medicine has been monopolized by interests with ties to the US Army. (passage omitted)"

Here is the factfilled and revealing article in its entirety from the FBIS.

From Brussels Telemoustique in French 5 Nov 97 pp 40-43, "EU Worries Over US HAARP Project Noted, Mori DocID: 587140. Article by Alain Gossens: "Apocalypse Now? `HAARP or How the US Military Is Playing the Sorcerer's Apprentice"

"Are the Americans currently developing a vast weapons system capable of scanning the entrails of the earth to seek out secret bases, jamming any form of radio communications, influencing human behavior, modifying the weather, zapping airplanes in the sky just like your microwave zaps your soup, and causing earthquakes or explosions as powerful as an atomic bomb? With " HAARP the US Army is reportedly reinventing, in a more economical and even more dangerous form, its defunct Star Wars Project. There is just one difference: This time it is a land-based installations."

"A number of scientists, weapons experts, and members of the European Parliament are concerned --and that is putting it mildly-- about the development of this project. This is why energy expert Grotan Healy, an adviser to members of parliament, is now collecting accusatory evidence of this Armageddon project. Magda Aelvoet, a Belgian member of the European Parliament and leader of the Green group in the European Parliament, is in charge of the dossier. She is the one responsible for officially following up the requests for explanations made by members of her group. She will take steps to ensure that the European Parliament exerts pressure, via NATO, to make the United States answer all the pertinent questions. As can be read in her interview, Magda Aelvoet is worried. She even goes so far as to say that, apart from the disastrous environmental consequences it could have, this kind of weapon (nonlethal weaponry) can jeopardize individual liberties and democracy." Nothing less.

"30$ Million"

"HAARP stands for High-frequency Active Auroral Research (research in the area of high frequency applied to the aurora borealis). First of all, behind the somewhat esoteric initials lies a project costing $30 million per year which the US Army is presenting as innocent research into the ionosphere. The project promoters are not sparing any effort or money in their public relations and advertising campaign. Never the less, if one is aware of the fact that the real sponsors are the Navy, the Air Force, and the Department of Defense, then it is hard to believe that it is not a project for military purposes."

"What does HAARP look like on the ground? It is a massive installation covering several hectares in Gkona, a small town northeast of Anchorage, Alaska. It is not that much a backwater since the installation lies alongside the immense gas and oil reserves belonging to the Arco company, which also holds the patents on the technology comprising the HAARP and is the "cover financier" for the equipment. In addition, HAARP is linked to one of the world's most powerful computers, located in the University of Alaska's perimeter cleared of trees with 48 20-meter-high antennas, each linked to a transmitter of just under 1 million watts. In the long run, the number of antennas and the power of the transmitters will be set up in such a ways as to achieve a phenomenal power of 1 billion watts transmitted by a network of 360 antennas. The transmitters are powered by six 3,600-hp turbines burning some 95 tonnes of diesel fuel every day. At this point, it should be noted that the entire installation is rather harmful to the immediate environment since it emits more than 7 tonnes of pollutants every day."

"What Is It Used For?"

"Officially, the scientists working on this megalommaniac transmitter want to study the ionosphere. Unofficially, HAARP will use the ionosphere, turning it into an energy weapon. The ionosphere is the layer located above the stratosphere and consists of highly energized ionized particles. It begins at an altitude of 48 km and ends at an altitude of 600 km above the Earth. This layer, with its high energy density, is crucial for our planet because it plays a key role as a shield, like the ozone layer. IT protects us from the Sun's harmful emissions. The ionosphere "captures" the electrically charged particles born out of solar and galactic "winds and storms." It is also known that the research carried out for the past century by a series of scientists has highlighted the fact that this "energy mantel" protecting the Earth could, using the right technology, become a strategic weapon of crucial importance."

"HAARP is based on the research of Bernard Eastlund, who was himself inspired by the work of Nikola Tesla, a Croatian scientist. (passage omitted)"

"Just under a century later, Bernard Eastlund simply adapted Tesla's initial work in the he area of electromagnetic energy. Between 1987 and 1994 he applied for 12 patents, serving as the structure of the HAARP project and the weapons technology derived from it. The real owner and operator of these patents is no longer Eastlund (who ended up getting kicked off the project for obscure reasons), but the Atpl-Arco Company-- an oil consortium serving as a front for the Navy, Air Force, and US defense Department. Since Eastlund applied for the patents, all research in the area of electromagnetic energy--for, say medical purposes-- has been blocked. As a result a vast and highly promising field of science and medicine has been monopolized by interests with ties to the US Army. (passage omitted)"

Overall Conclusions

1. Beneficial medical research has been suppressed as a result of emr weapons development.

2. Military experts are discussing classified emr space weapons to control behavior because of the need for public accountability.

3. The information on mind control weapons is limited. All of the open sources state repetitive facts. The Soviets admit to athermal weapon effects and the existence of mind control weapons. The U.S. position in all of the sources is that the Soviets have mind control technology. The U.S. admits to nothing else.

Short Comments

Dr. Stefan Possony was a Stanford Hoover Institute fellow and was called "the intellectual father of `Star Wars" and "one of the most influential civilian strategic planners in the Pentagon" (Guardian, 1995, obituary).

The following significant article was written by Dr. Possony, who was the founder of International Strategic Studies Association and former psychological warfare expert with the Office of Naval Research.

Dr. Possony was an influential scholar and public figure. He openly discussed Russian mind control and its importance as a weapon. In this article, he publicly asks the questions that few people `in the know' would ever dare to discuss in public. Dr. Possony asks his readers, "Who is so rash as to doubt that technological breakthroughs of this general type would not be put promptly to psyops use? More importantly who would seriously assume that such a technology would not be deployed to accomplish political and military surprise?" Given the history of the cold war, information on emr mind control weapons and the growing list of scientific and public figures seriously discussing emr mind control weapons, this article is a clear indicator of large, classified mind control programs in the east and west.

Dr. Possony describes the feasibility of communicating directly with the brain using emr and developing emr weapons.

Dr. Possony discussed the microwave bombardment of the Moscow Embassy and inferred that the State Department lied about athermal health effects from the microwave irradiation. Dr. Possony states that molecular vibrations caused by a stimulating extracellular electromagnetic field are non-linear and that this is the basis of new technology that will be extraordinarily significant in medicine, communications, intelligence and psychological operations and permit deliberate physiological impairment. Dr. Possony states that the "KGB is known to be interested in the program...and the USSR has a lead of approximately 25 years".

The science described in the article can be substantiated by the athermal weapons theory, the basis of the Pentagon's 1990s nonlethal emr weapons program. Looking back, the denials by the State Dept. about athermal emr health effects were lies for national security reasons, as Dr. Possony indicated. Looking back almost twenty years, Dr. Possony's article is too historically factually true to be propaganda or rumor. Given Dr. Possony's credentials, and the verified scientific facts regarding mind control weapons, this article is very serious and believable evidence. It is an extremely important point to emphasize as victims are constantly faced with denials that mind control technology exists, let alone the fact that it is developed as a weapon and tested illegally on people.

Here are a few highlights from the article.

Then the entire article, with its many research leads is presented in its entirety.

"Suppose it becomes feasible to affect brain cells by low frequency waves or beams, thereby altering psychological states, and making it possible to transmit suggestions and commands directly into the brain."

"A few years ago there was much excitement about the Soviet microwave "bombardment" of the US Embassy in Moscow. ...the KGB must have wished to harass US diplomats and cause them to worry about their health. This theory was never convincing."

"The question was raised whether the Soviets had discovered a technique of using microwaves for psychological purposes, and whether they were experimenting with this technique on US specialists on the USSR unwittingly pressed into Soviet service as guinea pigs. Impossible replied the State Department, the waves cannot break through the blood-brain barrier, and thermal effects are so negligible that the body would not be affected. Nevertheless, embassy personnel were indemnified for health damage."

"By 1979, it was known that electromagnetic fields raising body temperatures less than .1 degrees Celsius may result in somatic changes. It was most surprising that such a trivial temperature rise was having any effects, and even more astonishing that those effects were significant. Chemical, physiological and behavioral changes can occur within "windows" of frequency and energy continua. Another is at the level of the human electroencephalogram (EEG), which is in the range of extremely low radio and sound waves, around 20 Hertz."

Conclusions

1. Dr. Possony is an academic and public policy analyst who stands behind his statements. Dr. Possony stated scientific facts that have stood the test of time, that emr athermal effects are the scientific basis for mind control weapons. He also states that Russians are interested in mind control and challenges the reader to make the conclusions that will never be revealed given that mind control is a national security issue.

Here is the full article by Dr. Possony.

Possony, Stefan.(1983,July). Scientific Advances Hold Dramatic Prospects for Psy-Strat. Defense & Foreign Affairs. P.34.

Associate Editor Dr. Stefan Possony discusses how scientists are facing the prospect of messaging directly into a target mind. Whither psy-war?

The history of psyops technology is about 200 years old, and it will continue to progress. Hence it is most important to look into the future. It is no longer really difficult to send messages to the targets; that is, the persons who are to be influenced. The target cannot be reached if he is not interested in the originator, nor in his message, or if his interest is perfunctory. He is unattainable also if he is bored, and if he finds it more pleasurable to listen to competitors, who are multiplying.

The target cannot be persuaded to listen. It is the other way around; he may listen if he already is fully or partially persuaded, and if the program is attractive in addition to informative, and if it helps him in his activities.

Psyops technology is more or less in hand. Its better utilization is at present precluded in most instances by political ineptitude and by international opposition. The importance of better programming is recognized as a theory, but new ideas and fundamental improvements are rare. Hence success often is a matter of hit or miss. At this point, let us forget about history and current events, and let us resolutely turn to the future; I want to alert you that psyops technology may advance from communicating to direct signaling. Some developments in this reqard are already taking place.

X-rays and gamma rays are located at the upper end portion of the electromagnetic energy frequency spectrum. What is at the lower end? The most important of all of nature's phenomena.

Suppose it becomes feasible to affect brain cells by low frequency waves or beams, thereby altering psychological states, and making it possible to transmit suggestions and commands directly into the brain.

Who is so rash as to doubt that technological breakthroughs of this general type would not be put promptly to psyops use? More importantly who would seriously assume that such a technology would not be deployed to accomplish political and military surprise?

A few years ago there was much excitement about the Soviet microwave "bombardment" of the US Embassy in Moscow. Why did the KGB, then under Yuri Andropov's leadership, embark on this seemingly scurrilous -- and very prolonged --effort? There was no answer to this question, except that the KGB must have wished to harass US diplomats and cause them to worry about their health. this theory was never convincing.

The question was raised whether the Soviets had discovered a technique of using microwaves for psychological purposes, and whether they were experimenting with this technique on US specialists on the USSR, unwittingly pressed into Soviet service as guinea pigs.

Impossible, replied the State Department, the waves cannot break through the blood-brain barrier, and thermal effects are so negligible that the body would not be affected. Nevertheless, embassy personnel were indemnified for health damage.

By 1979, at the latest, it was known that electromagnetic fields raising body temperatures less than .1 degrees Celsius may result in somatic changes. It was most surprising that such a trivial temperature rise was having any effects, and even more astonishing that those effects were significant.

Chemical, physiological and behavioral changes can occur within "windows" of frequency and energy continua. One of those windows is connected with navigation in marine vertebrates and with biological rhythms of humans. Another is at the level of the human electroencephalogram (EEG), which is in the range of extremely low radio and sound waves, around 20 Hertz.

Those findings remain unexplained. they seemed to require energy amplification of the initial stimulus by some 12 orders of magnitude. No such amplification was deemed to be feasible, and none was discovered.

Let us cut the story to the minimum. The original model, according to which the blood-brain barrier cannot be broken, was derived from the axiom that electromagnetic waves interact with tissue in a linear manner. However, it turned out that the molecular vibrations caused by a stimulating extracellular electromagnetic field are non-linear. Utterly unexpectedly, they take the form of soliton waves which can transfer energy along long molecular chains.

By 1982 the term "soliton" finally made it to the technical dictionaries. Here is a definition from the 1982 McGraw-Hill scientific-technical dictionary: "A soliton wave...propagates without dispersing its energy over larger and larger regions of space." As I understand it, it would be more correct to say: "A soliton wave propagates suddenly acquired energy, or energy imparted by shock, without dispersing it."

Significance? Extracellular disturbances such as acoustic or electromagnetic bursts can be propagated across the cell membrane. In this, non-linearities in molecular dynamics rather than chemical kinetics are the key. Put differently, the 12-magnitude energy deficit is overcome, not by brute force, but by the formation of solitons.

Visualize the brain and its environment as structures of waves, and assume that shock waves create solitons. Then imagine that modern electronics with their flexibility, accuracy and speed are put to work.

In addition, the range of resonances probably will be increased. Hence many frequencies, and several options for the transmission of energy across the membranes of brain cells may become available. This may imply that the brain cells will be reachable diversely and flexibly, and perhaps routinely.

The discovery of cross-membrane coupling may be compared to the discovery of oxygen in 1772, which allowed the proof that phlogiston, the supposed element of fire, does not exist. Once the phlogiston idea was buried, chemistry and the chemical industry began their triumphal march across the world.

The exploration of the cross-membrane phenomenon is only at the beginning, and it is not yet possible to anticipate practical applications. As of now a new phenomenon has been discovered, probably. Nothing is as yet known or is known publicly, on how the soliton can be aimed to produce desired effects. Only a hypothesis can be stated: If the phenomenon can be utilized, this will in due time have crucial bearing both on the body and on the brain, and on defense.

The theory of cross-coupling was formulated by A.S. Davydov who, it seems, published the first purely theoretical version in 1976, and followed this up with a study on "Solitons as energy carriers in biological systems". By 1979 Davydov appeared to be linked to the Ukrainian Academy of Science.

It should be noted that Russian mathematicians were concerned with solitons before US scientists ever got interested. It is therefore conceivable that Davydov achieved his results long before publication, and also that the experiments which involved the US Embassy, produced findings which led to subsequent progress.

In the US, the pioneering work seems to have been done by Albert F. Lawrence and w. Ross Adey, writing in Neurological research, Volume 4, 1982. the Max Planck Institute for Biochemistry in Munich also discovered that cell membranes can be crossed. Eberhard Neumann and Guenther Gerisch found that a shock wave passing through an electric field may create ultra-quick processes within the membrane, and that through such "jumps in the field" (Feldsprfinge:this probably means solitons) senes can be transmitted and cells fused.

There is a differential in the tension of the inner and outer membrane which averages 1/70,000 of a volt. This corresponds to 70,000 volts per(theoretical) membrane thickness of one centimeter.(The real thickness of a membrane is0.1<-8> centimeter.)

The discovery was made unexpectedly in the course of research on electric fields in membranes and their impact on vital processes. This research requires measurements of events lasting not more than one nano-second(one billionth of a second), and it suggested that solitons generally increase the permeability of membranes. Thus, new perspectives on genetic "engineering" were suddenly opened. Moreover, it was possible to fuse no less than 50 cells into one supercell with 50 nuclei and one single membrane. We might as well forego assessing this monstrous novelty.

The Max Planck Institute broke into the membrane, so to speak, either without knowing about Davydov, Lawrence and Adey, or after learning about them while pursuing a different goal. In either event, a fundamental innovation, a breakthrough discovery or invention will be made several times, at different places, and be persons working independently from one another.

It is futile to speculate on who stands where in a race which has barely begun. But it can be postulated that the USSR probably has an ambitious research program, whereas in the US, while work is being done, no program --let alone a crash program--is in existence.

It is predictable that in the wake of Andropov's upgrading of psyops, the relevant programs in the USSR will be given an early and powerful boost.

Future psyops will have to be planned for perspectives which cannot be formulated before the US embarks on a major and totally novel research and development program. Meanwhile, it must be assumed that psyops will grow world wide, in strategic importance and in new forms.

The following report appeared in "Defense & Foreign Affairs Daily" on June 7, 1983:

On May 20, 1983 US newspapers printed an Associated Press story from the Veterans Hospital at Loma Linda, California that the Soviets developed a device, called Lida, to bombard human brains with radio waves. The radio beams and expected to serve as a substitute tranquilizers, and to treat sleeplessness, hypertension, and neurotic disturbances.

It is not yet determined whether Lida affects the immune and endocrine systems. Lida is reported to change behavior in animals. At the present, the device is on loan to Dr. Ross Adey, chief of research at Loma Linda. Adey started testing the machine three months ago, and hopes to complete his investigations within a year.

According to Dr. Adey, who repeatedly visited the USSR, the Soviets have used the machine on people since at least 1960. The machine is technically described as "a distant pulse treatment apparatus". It generates 40 megahertz radio waves which stimulate the brain's electromagnetic activity at substantially lower frequencies.

Dr. Adey was quoted as saying: "Some people theorize that the Soviets may be using an advanced version of the machine clandestinely to seek a change in behavior in the United States through signals beamed from the USSR." No reference was made to the protracted microwaves bombardment several years ago of the US Embassy in Moscow.

On April 29, 1983, Associate Editor Dr. Stefan Possony, addressing the Defense 83 meeting sponsored by Defense & Foreign Affairs, reported on Dr. Adey's work and on the work by Dr. A.S. Davydov of the Ukrainian Academy of Sciences. Davydov discovered how the blood-brain barrier can be penetrated by low frequency beams and directly affect cells in the brain. Possony's remarks were delivered to a panel studying psychological warfare. [Part of that paper is printed below--Ed.]

In the US research on direct brain waves has scarcely begun, and the USSR has a lead of approximately 25 years. Once it is matured the new technology will be extraordinarily significant in medicine. It also may have major impacts on communications, intelligence, and psychological operations, and permit deliberate physiological impairment.

The KGB is known to be interested in the program. It is not known whether the US and other Governments are trying to determine whether their countries have become targets of clandestine brain waves beamed from the USSR. Nor are there indications that work on countermeasures is being contemplated, except perhaps in the USSR.

"Opening Pandora's Box"

"Opening Pandora's Box", 1984, produced by David Jones for Fulcrum Central Productions, aired on BBC Channel 4. This is a summary of main points of an exceptionally insightful and succinct documentary, not a verbatim account. Many thanks to Harlan Girard for finding a copy of this video.

Project Pandora: The U.S. government explores whether the Soviets are using emr as a weapon

The Soviets started bombarding the American Embassy in Moscow in 1953 and the U.S. government funded Project Pandora to find out why. Project Pandora was "a top secret multimillion dollar program". Top scientific experts were consulted by the American Government "about the meaning of microwaving" of the Moscow Embassy. "Five presidents kept it secret". President Johnson complained to the Soviet Premier Kosygin who claimed that he was unaware of the signal and would be sure that it was turned off. Officially the Soviets did not admit that they were microwaving the Embassy. But the bombardment of the Moscow Embassy continued. It began in 1953 and in 1975 the signals changed. Two new transmitters were added by the Soviets.

Dr. Robert Becker was an eminent scientist and was asked if central nervous system, CNS disturbances occur by microwave radiation. The Pandora Project found that the microwave radiation interferes with decision making capacity, causes chronic stress and low efficiency. The white blood count of Embassy workers was 40% higher than normal. Monkeys exposed to microwave radiation showed a marked decreased performance of simple tasks. Making embassy personnel function less efficiently would obviously be a benefit to the Soviets.

Dr. Becker stated that the U.S. couldn't say anything about it because safety standards for the U.S. were higher than the microwave signals used by the Soviets on the Moscow Embassy. He stated that you do affect cns (central nervous system) by microwave exposure. But if the U.S. admitted bioeffects or athermal effects, meaning not heating effects as from a microwave oven, but other biological effects from the radiation, such as a high white blood count, it would throw into doubt the U.S. standard set "rather arbitrarily " in the 1950s. It would be an embarrassment to the Americans who chose to keep the public in the dark about the microwaving of the Moscow Embassy from 1953 to 1975.

Aluminum screens were put on the Embassy windows so the U.S. government had to discuss the irradiation with the employees. The U.S. public position was that there were "no hazardous levels" of microwaves being irradiated at the Embassy by the Soviets. Questions were raised and complaints made by employees in 1975. At that time, the U.S. State Department consistently lied to Embassy employees and Henry Kissinger replied with a homily about national security and trust and confidence among government employees.

Brief history of U.S./Soviet safety standards set for emr

The safety standards for electromagnetic radiation, emr, were set higher in the 1950s to allow the military to have unlimited use of emr technology. At the time, American science reports suggesting emr health effects of brain tumors, heart conditions, leukemia, cataracts and more, were ignored. The military was a major source of funding and reports were not followed up. The government safety levels for emr were challenged in courts all around the world. Microwave News, a journal on nonionizing radiation, for example, reported that radar men opposed microwave tower emr health dangers. Air traffic controllers and police officers filed complaints. These court cases revolved around the validity of the safety standard. Dr. Milton Zaret, another Pandora scientist explained that most government committees who set the safety standards around the world were set up the in the same way as in the U.S.. Members of the committee did not want to impede or put restraints on progress by tightening the safety standards for emr.

Joe Towne, who repaired radar on spy planes filed a lawsuit against Lockheed for health damages from the radar, for eye damage, cataracts and two heart attacks. Twenty five flyers also sued and won out of court settlements. Towne's case was settled out of court for 75,000$. There was no admission of guilt by Lockheed.

Meanwhile, in October 1982, members of the radar industry met in a Hot Springs, Virginia resort in secret for three days and talked about how to stop the steadily increasing injury claims of service men.

As part of Project Pandora, the U.S. government conducted Operation Big Boy on Navy ships to find any health effects from radar equipment on the ships. Although effects were found, the government terminated the project.

Dr. Becker stated that there was tremendous growth of the communications and power industries and a complete lack of information or even consideration of emr health risks. Industry didn't consider bioeffects of emr until the mid seventies. There was a "complete lack of consideration" of any biological effects from electromagnetic radiation and the repeated dogma was there are "no possible biological effects."

Then there were concerns over complaints and the subsequent study results on computer VDTs and miscarriages and birth defects and powerline exposure and leukemia in adults and children living near them. Studies reported a high incidences of suicide in people living near power lines. Other studies reported that electrical workers were at risk for leukemia. Meanwhile, the U.S. standard had been virtually unchanged since the 1950s.

The Soviet standard was 1000 times lower than the U.S position and their armed forces were exempt from the Soviet standard. The Soviets were aware of biological effects of emr in the 1950s. For example, the top Chech scientist, Dr. Karl Mahra defected to the U.S. in the 1970s. In 1958, he had discovered rats killed by pulsed emr only showed spleen damage when they were autopsied. Dr. Mahra was amazed that other rats recovered fully when exposed for an astonishingly slightly lesser amount of time than the rats who died. Dr. Mahra discovered that the rats did not die of thermal effects of emr but of the athermal emr effects. Dr. Mahra devoted a lifetime of study to the nonthermal biological effects from pulsed emr exposure.

The Controversy over Nonthermal Effects of EMR

Nonthermal effects of emr used as psychological and biological weapons by U.S./Soviets

There is a 1976 Soviet document which stated that microwaves could cause seizures in animals. [See 20+ section for newspaper articles on the document] [A microwave frequency] could be found in human beings, to disorientate a person and a specific frequency could cause a heart attack.

David Jones stated, "Recent intelligence reports say the American army is developing emr weapons programs and predict by year 2000 armies could use them. There will be microwave weapons to disorient and immobilize opposing troops. Psychological attack is particularly effective on air pilots. There is no doubt about the potential of emr [weapons] in the Soviet Union."

Nonthermal emr effects controversy is born. U.S denies effects, Soviets disagree

Dr. Becker commented that the U.S. safety standard presented a dilemma for U.S. military planners. Dr. Becker explained that the problem was that the U.S. population was currently being exposed to the same athermal effects level of emr that the U.S military was using to develop classified emr weapons. This athermal level of radiation is not biologically active, according to the U.S. safety standard. But the dilemma was, how could the U.S. government develop an emr weapon system based on the athermal effects of emr when currently allowing exposure of their own people to the same athermal effects level of emr in their environment from TV and radio towers and microwave ovens, for example? It was a conundrum.

Dr. Becker stated, "A good,...the best cover story is that, based on best American scientist's [opinions],.... the [U.S.] nation has discarded [the theory of athermal] health effects from emr, entirely."

David Jones asked Dr. Koslov; "In terms of science there seems to be two possibilities, one is that behavior and health are affected by emr and the second is the creation of a new genre of weapons and that its conceivable that it is a totally black area of research. Dr. Koslov replied that back in 1965, there was alot of conjecture and hypothesis about that. That's why it led to Project Pandora. Since then, I don't think there is very much possibility, that there is, at this point in time, there doesn't seem to be.

Dr. Sam Koslov, director of Project Pandora continued, [We] thought about it, don't get me wrong,... but nothing was found, it doesn't look like[there is]...militarily at this time, there is no emr weapons potential. There is nothing to the biological effects claim. There is an amount of power problem."

David Jones asked Dr. Koslov why he thought that the Soviets were microwaving the Embassy. Dr. Koslov replied that "I would rather not discuss it [because] it would get into security areas."

[Today, with the nonlethal program unveiled in the 1990s and the Soviet evidence of emr nonthermal effects available today, it is clear that Dr. Koslov was lying in the name of national security. At the least, Dr. Koslov would have been aware of the classified emr nonlethal program which began in the 1960s, see US News, 1997)]

The 1950s, the Lida Machine and Korean Brainwashing

In the 1950s, intelligence agencies were interested in changing mental states. The theory is that brain waves can be tuned to a different emr frequency and can change moods and character. The CIA sponsored LSD experiments and the MKultra Project for 10 million dollars in the early 1960s. A CIA memo stated that they were looking for behavior control to enhance consciousness. The Soviets had realized the same thing. Dr. Ross Adey, famous emr researcher at Loma Linda Veterans Hospital, examined the Lida machine, from the Soviet Union. It was described as a machine to "rearrange consciousness". The Russians claimed to use it for treatment of emotional disorders in the 1950s. Dr. Adey stated that the Lida machine is now obsolete. It used coiled wire inside ear muffs which acted like an antenna and emitted 1/10 sec pulses of emr. Dr. Adey demonstrated that excited animals rapidly quiet down when exposed to the Lida emr frequencies. There was one account that the Lida machine was used during the Korean War for brainwashing American Prisoners.

Since the Korean war, the art of brainwashing has improved significantly, says David Jones

Dr. Becker was asked by the CIA in early 60s to determine whether pilots shot down and captured by Soviets in the 1960s could possibly have been exposed to emr without them realizing it and would that have caused personality change. The pilots were tested psychologically before and when they came home. A dramatic change in test results was found. The question posed was, can you change, entrain brainwaves with an external source? "Pilots did not report bad treatment and were not aware of any emr exposure by Soviets during debriefing sessions." They were interned by the Soviets for two to six week and returned with "considerable personality alterations". The CIA wanted to know if there was a relationship between the Moscow Embassy and flight crews that would cause personality alteration? Dr. Becker stated "yes, there is a distinct possibility, we don't know at this time for sure."

Dr. Robert Beck's (not the same person as Dr. Robert Becker) classified experiments of behavior effects of emr on human subjects for weapons use.

The mechanics of this source of personality change ( Dr. Becker's pilot study above) "fell into an area of science shrouded in the greatest of secrecy". "It is at the center of mind control programs in both the east and west." Dr. Robert Beck, an electronics engineer, is one former member of an elite corp of scientists recruited by his government to work in this area. His published work talks of "specific frequencies that cause anxiety, fear, confusion". His unpublished work include "bizarre experiments in which would disorientate other scientists and is said to include changing moods from elation to depression. He described an experiment in which electromagnetic pulses emitted from a device that looked like a wristwatch caused other diners in a restaurant to talk more loudly or quietly, depending on the em pulse emitted by the wristwatch device."

"What is technically possible?" asks David Jones. "There, I would rather not discuss some of the work that I've seen. It has been done, replicated. Replicated experiments simply done. That subject is totally dark. I've done some of that myself and I'll never do it again. There is no mystery to it. There are ethical considerations. It's part of the physical universe. Changing people's behavior by low levels [of emr], that subject is totally dark."

Dr. Beck continued, "It's possible to replicate experiments, simply, I don't approve of it, a tool to manipulate. But moral considerations are invariably not considered by governments. The Soviets are ahead [in emr research]."

David Jones asked, "As far as affecting human behavior, what is possible? Dr. Beck said, "It's possible, it's been replicated. It's a dark area of research."

The Moscow microwave bombardment is a prototype weapon of the 1977 Soviet Woodpecker Emr signal: Soviet emr weapons go public

Dr. Beck stated, "[the 1976] Russian woodpecker signal is the most powerful man made emr source ever. 10 pulses per second, 40 million watts per pulse, it is psycho active." It is generated in the Soviet Union and permeates everything in the U.S.. It was picked up by power grids and irradiated into homes."

The question is why are the Russians doing this? Dr. Becker said that there are three theories. First, that the Woodpecker signal is an over the horizon radar. No, Dr. Becker stated that a satellite is better available surveillance. Second, the woodpecker signal is for submarine communication. Dr. Becker could not answer that. Third, that the Russian woodpecker is biologically active and will have an effect on populations in U.S. and Canada. In 1976, the Soviets increased the signals and now have seven transmitters. "They are the most expensive and powerful in the world." "Dr. Becker said there are persistent rumors that the U.S. is doing the same to the Soviet Union, powerful U.S. transmitters beaming 16 cycles per second to produce the same effect as the Soviets, into the Soviet Union.' "We are in the middle of electronic warfare aimed at citizens of both countries."

The Woodpecker has been beamed for six to seven years and can't be heard in Soviet Union but can be heard in Britain, Western Europe, Australia and Far East. Dr. Beck, [the electronic engineer] stated that the magnetic component can penetrate anything. "We have decoded intelligence on the signal. The 10 Hz signal is a benign frequency and we know it can be psycho active. 30% of the population will exhibit neuronal manifestations. Soviet scientists know about psychoactive effects in animals. Soviet scientists knew well before 1950s. The Soviets published research on long term effects of microwaves, extreme fatigue, loss of coordination and sensory control. A group in American Intelligence believed that one can alter brainwaves of staff of Moscow Employees and the Moscow signal was a prototype of the Russian Woodpecker."

Dr. Beck continued, "If you drop frequency down a few hertz, it is known to be neuronally psychoactive and you could have basket cases. [This is] more terrifying and frightening than the atomic bomb. It's a brand new concept, we haven't adapted to this concept. Having done a number of experiments, one can't imagine the destructive power of these things. There were no National Institute of Health, NIH guidelines in the experiments I conducted. I know what some of these things can do to the nervous system. Most wars are fought over real estate. [It will be] better to use psyop weapons than atomic bombs- alot cleaner, more terrain left, it could just kill people. There is no defense that I know of."

Twenty years later: Passage of time reveals cold war secrets

Nonthermal effects of emr were used as a basis for weapons and is a national security issue

The main point of this documentary for victims is that the controversy over athermal effects of emr is described as a national security issue by top emr scientists such as Dr. Becker, Dr. Beck and Dr. Zaret, all of whom were consulted by the CIA about the irradiation of the Moscow Embassy. While the emr related industries and the military wanted to avoid lawsuits and have unlimited development of emr technology, that does not fully explain why the U.S. used the athermal controversy as a national security cover story for fifty years.

U.S. cover story of no provable athermal effects can no longer be credibly maintained by U.S.

In the 1990s, the nonlethal emr weapons program based in part on athermal effects of emr was unveiled by the Pentagon, (US News, 1997). The U.S. cover story can no longer be credibly maintained. With the U.N. documents, the 20+ Russian articles and the Lopatin book, Dr. Becker's theory of a classified U.S. emr mind control weapons program is now well supported. The 1979 UN Russian documents state that athermal effects are used for developing weapons. The 20+ articles discuss emr mind control weapons after the break up of the Soviet Union and Lopatin is a very high Russian government official who has advocated banning mind control weapons in Russia for the last ten years.

According to Dr. Becker, consultant to the CIA in the early 1960s, the Soviets irradiated the Moscow Embassy and U.S citizens with the Woodpecker signal at great cost and for decades. See 1988 AP article which states that microwave bombardment of Moscow Embassy and the Russian Woodpecker signals were being irradiated as of 1988. In "Opening Pandora's Box", Dr. Becker discussed the U.S. public silence about the Soviet irradiations and the rumored U.S. efforts at irradiation of the Soviet Union. Dr. Becker described these aggressive acts by the Soviets and the U.S. as an electronic war on the citizens of both countries.

In addition, the Harlan Girard articles from Russia and China on emr nonlethal weapons is further support of the fact that athermal effects of emr are the basis for nonlethal weapons. Now there is enough evidence to refute the U.S. position that there are `no provable nonthermal biological effects from emr.

U.S. government knew of athermal emr effects at least in the 1960s

Now it can be proven; the U.S. knew of the biological athermal effects of emr at least in the 1960s, when the secret Pandora Project began (see Brodeur, Zapping of America, 1977). For further evidence of the U.S. knowledge of athermal effects, see also the thorough and well documented history of this period, written in "Electromagnetic Man" by Cyril Smith, 1989 and "Body Electric" by Dr. Becker and Gary Selden, 1985.

The U.S. made the decision to risk the health of U.S. citizens rather than to deal with the situation in another way. The U.S. did not lower the emr safety level even though they knew athermal health effects were confirmed at this time. Rather, the U.S. government perpetuated the dogma. In the mid 70s, Kisssinger and the State Department held that there were no health risks from emr exposure at the Moscow Embassy. Apparently, to the U.S. government, the national security issue was more important than the health of its citizens.

U.S. government is on the record for lying about scientific facts in the name of national security and risking the health of U.S. citizens

By basing the U.S. safety standard for emr exposure on politics rather than scientific evidence, the U.S. government knowingly risked the health of U.S. citizens. The U.S. government is on the record for lying about scientific facts in the name of national security.

Evidence supports a `Manhattan Project' mind control program based on emr athermal effects

Scientific evidence

A serious problem for validating the claims of victims of government mind control experiments is that even today the general public does not know of the little publicized athermal emr effects controversy or mind control weapons. The good news is that it does not take a rocket scientist to put the facts together because after fifty years, the motives and actions of the military becomes clear. Dr. Becker was right. Echoing Dr. Becker twenty years later, Dr. Louis Slesin, Microwave News editor was quoted in U.S. News, 7-7-97 article entitled "Wonder Weapons'. "...the human body is essentially an electrochemical system, and devices that disrupt the elctrical impulses of the nervous system can affect behavior and body funcitons. But these programs- particluarly these involving antipersonnel research- are so well guarded that details are scarce. "People [in the military] go silent on this issue ...more than any other issue. People just do not want to talk about this." Based on Dr. Becker and Dr. Slesin's comments, there was and is a classified nonlethal weapons program that targets the brain with emr. The U.S. News article clearly states that athermal effects of emr are the basis of the nonlethal weapons. "...scientists, aided by government research on the "bioeffects" of beamed energy, are searching teh electromagnetic and sonic spectrums for wavelengths that can affect human behavior."

The argument can now move to the extent that athermal biological emr weapon effects are capable of controlling the human body and behavior.

The extent of the mind control arsenals may be less difficult to prove than the athermal controversy because there is no need to wait fifty years for unclassified historical evidence. The U.S. or Russian government will never admit to classified mind control weapons, therefore one way of answering this is through open literature theories on neurology. The athermal effects of emr the biological basis for brain function is described in current neurology research. Refer to Cahra website, "As Powerful as the Atomic Bomb for citations, www.dcn.davis.ca.us/~welsh.

Thanks to mind control researcher Margo Cherney, here is one stunning example of many available examples to support the theory that mind control weapons are extremely advanced. Note the cover story that the Soviets have mind control research, that brain research for weapons purposes is classified and that emr athermal effects are the basis of the brain weapons. The stunning information is that the government is funding research to produce a device that can "inject information into the brain via electromagnetic waves".

U.S. News, 1-3-2000. John Norseen. Reading-and changing-your mind. Rodolfo Llina's. A grand unification theory of the brain.

[Lockheed Martin neuroengineer in Intelligent Systems Division] Norseen's interest in the brain stems from a Soviet book he read in the mid-1980s, claiming that research on the mind would revolutionize the military and society at large. [He] coined the term "Biofusion" to cover his plans to map and manipulate [the brain] leading to advances in ...national security... and ...would be able to convert thoughts into computer commands by deciphering the brain's electrical activity. BioFusion would reveal the fingerprints of the brain by using mathematical models, [Smirnov's computer program uses mathematical models also]. It sound crazy,...The National Aeronautics and Space Administration, the Defense Advanced Research Projects Agency, ...have all awarded...research contracts to Norseen. Norseen is waiting to hear if the second stage of these contracts-portions of them classified- comes through. Norseen's theories are grounded in current science. ...By MRI, scientists can tell what the person was doing at the time of the recording...Emotions from love to hate can be recognized from the brain's electrical activity. ...Norseen predicts profiling by brain print will be in place by 2005. ...Norseen would like to draw upon Russian brain-mimicking software and American brain -mapping breakthroughs to allow that communication to take place in a less invasive way. A modified helmut could record a pilot's brainwaves. "When you say right 090 degrees...the computer would see that electrical pattern in the brain and turn the plane 090 degrees. If the pilot misheard instructions to turn 090 degrees and was thinking "080 degrees," the helmut would detect the error, then inject the right number via electromagnetic waves."

U.S. News, 1-3-2000. Rodolfo Llina's. A grand unification theory of the brain.

Dr. Rodolfo Llinas, New York University of Medicine, "believes consciousness has to do with timing, and the thalamus-rather than being a mere relay station-also functions as the brain's clock. Using an instrument called a magnetoencephalograph, or MEG-a technology Llinas helped develop-he has been studying the brain's electromagnetic waves. What he has found in broad paraphrase is that the thalamus is in constant dialogue with the brain's higher processing centers: An electromagnetic loop sends pulses from the thalamus to the cortex, but the different sensory centers of the brain also message the thalamus in return. Consciousness exists when these oscillations are in sync-pulsing at the same rate--so smells, sounds, and so forth assemble in a kind of electromagnetic symphony. ...If the theory holds up to future testing, it would point toward the possibility ...implants-neurological pacemakers-to correct the out-of-wack timing of the thalamic messaging system. Preliminary clinical work has already demonstrated the therapeutic value of thalamic stimulation in treating Parkinson's disease and depression.

Historical evidence

According to Dr. Becker, great efforts were expended by the U.S. to cover up the emr nonthermal effects while the Soviets expended huge sums of money and time targeting the Moscow Embassy with microwaves. The Russians also targeted the United States with the Russian Woodpecker signal. Dr. Becker stated that there were persistent rumors of U.S. beaming a signal over the USSR.

The Russians publicly denied the microwave bombardment and the official, transparent reason for the Russian Woodpecker signal was an over-the-horizon radar. An electronic battle of emr signals which targeted the citizens of both countries was raging without their knowledge while the U.S. remained silent and the Russians publicly asserted athermal effects of emr in UN documents and scientific literature in order to embarrass the U.S. government. Fifty years later, the Russians finally succeeded in their attempts to ruin the credibility of the Americans over the athermal controversy. But most U.S. and Russian citizens are unaware of this fact because the military and the cell phone industry still use the standard to avoid lawsuits and use emr based technology that could be limited if a more stringent standard were in place. Therefore the athermal argument is rarely publicized.

In 1984, Dr. Koslov, director of Project Pandora stated that there were no military weapons programs based on the athermal effects of emr. Then in the early 1990s, The U.S. unveiled the nonlethal emr weapons program. Dr. Koslov had to be lying, since U.S. News, 1997 reported that the nonlethal weapons programs had begun over 40 years ago. Since the break up of the Soviet Union, Russian public figures such as Lopatin, scientists such as Tsygankov and military experts are publicly discussing mind control weapons as a very serious threat. Now, in Russian and U.S. newspaper accounts, the symptoms of independent reports from U.S and Russian alleged victims of illegal experiments are being compared and match up. Hundreds of victims worldwide describe an illegal global experimentation program using an array of highly developed and powerful mind control technology.

The U.S. government is on the record for lying about this issue. The cell phone industry is on the record for upholding the athermal effects theory. The motives of money and national security are clear. Fifty years later, the truth is out. Given the body of evidence in this compilation, it is logical to conclude that there is a mind control program more secret than the Manhattan Project, as Dr. Becker theorized and that brain function is based on an athermal emr biological effects. Given the motive of national security, it is hard not to believe that very sophisticated technology has been developed to control the mind, comparable to the atomic bomb.

An Electronic War starting with the Moscow Embassy: Serious Implications for the World

Dr. Becker described the microwave bombardment of the U.S Moscow embassy for over 20 years and the Russian Woodpecker Signal for over 10 years as an electronic war on the citizens of both Russia and the U.S. See 1988 AP article which states that microwave bombardment of Moscow Embassy and the Russian Woodpecker signals were being irradiated as of 1988. Given Dr. Becker's discussion of U.S. pilots and their behavioral changes after being shot down by the Russians, there is no doubt many more electronic battles that are entirely out of the public view.

Dr. Michael Persinger was featured on the 1998 Learning Channel, War 2020 program describing emr mind control possibilities. The announcer stated that the next war may be won without so much as a shot being fired or even a whimper. By putting the evidence together, a picture emerges of governments who ignore human rights, cover up criminal acts and conduct battles out of the public eye. Dr. Becker stated in his 1991 book, "Crosscurrents", that it may be too late. Besides the need to stop illegal government emr weapons experiments, it is important to educate the public because of the far-reaching global effects surrounding this issue.

HAARP, the U.S. transmitter of the 1990s, EU experts fear a vast weapons system capable of modifying the weather, influencing human behavior and more.

The article, "Apocalypse Now? HAARP or How the US Military is Playing the Sorcerer's Apprentices", by Alain Gossens, Bussels Telemoustique, 22-5-97 was translated by FBIS from french,(see foia section for whole article). The article describes the controversy surrounding the HAARP project. "Unofficially, HAARP will use the ionosphere, turning it into an energy weapon." Similar to the Moscow Embassy microwave bombardment and the Russian Woodpecker, the public is never told what is really going on. It is difficult to not believe that these are powerful weapons because both countries continue for decades to develop them. According to Dr. Becker and now other experts such as Dr. Bertell, (see foia section, last article) and the numerous articles on HAARP, there is a scientific basis for mind control.

Here is an article to show how the health standards for emr controversy continues.

March/April 2001
Views on the News: Weapons Development and Public Health Should Not Mix

The Pentagon's new microwave weapon has been brought to you by the U.S. Air Force and Raytheon. These are the same organizations that control the IEEE's SCC-28 committee that writes the standard for exposures to RF and microwaves.

Dr. John Osepchuk, the chair of SCC-28, worked for Raytheon for most of his professional career. And three of the other five members of the SCC-28 executive committee work either at Brooks Air Force Base or for Raytheon.

In the 1980s, during the last major revision of the IEEE standard, Osepchuk was among those who argued for doubling the limit, from 5 to 10 mW/cm2, for frequencies above 3 GHz (see MWN,J/A86). The rationale -which we never understood- was to make it consistent with the infrared standard all the way up at 300 GHz. This change, though challenged, was adopted.

At the time it appeared to be somewhat of an academic concern, given the paucity of radiation sources above 30 GHz. But few were privy to the designs of military contractors. The loosening of the IEEE standard must have facilitated the development of the military's new zapper at 95 GHz.

It seems obvious, but it's worth repeating: Health standards should be written by medical and public health professionals, not those who make weapons for the military-industrial complex.

2000 Video by Council on Wireless Technology Impacts, "Public Exposure" More evidence of the athermal emr health effects controversy

Thanks goes to Betsy Manning a behind -the-scenes mind control researcher who is always coming up with new leads. Betsy found this excellent 2000 video, "Public Exposure, DNA, Democracy and the Wireless Revolution" by the Council on Wireless Technology Impacts,

(website at www.ccwti.org. A website link provided ordering information on the book "The Electric Wilderness" by biophysicist Andrew Marino and Joel Ray, forward by Dr. Robert Becker, San Francisco Press, 1986. The book details the 25 year battle over emf effects and the politics of science in the four year New York State hearing on a 765 TV power line, 1974-1978.)

This video exposes emr industry abuses similar to the tobacco industry. For example, the cell phone industry has billions of dollars at stake and this is the explanation for the industry's complete lack of concern for the health of consumers. Marin's rate of breast cancer is the highest in the world, (Northern California Cancer Center, 1995) and this motivated the Marin Breast Cancer Watch to sponsor an epidemiolodgy study to see if there is an association between and reported cancer cases and cell phone towers, military radar and other sources of emr. There is a study by another group to determine if there is a connection between emr exposure and the 300% increase in brain tumors worldwide.

Explosion of EMR sources in last hundred years

The video began with the fact that in the last one hundred years, exposure to emr has increased 10,000 times. "Human cells of the body are like antennas; they receive and emit emr and are extremely sensitive " The video continued with a short history on the explosion of emr development, beginning with WWII. Military personnel such as radar workers experienced abnormalities in blood count, mutation, headaches and cataracts. This data was ignored by the U.S. government mainly because there was a war.

Dr. John Goldsmith, an epidemiologist from Israel described the Soviet microwave bombardment of the Moscow Embassy from 1953 to 1976. He said the that the Soviets could have been trying to produce radio frequency sickness in the U.S. embassy staff by causing interference with the "ability to think, to concentrate and to sleep". The Soviets conducted scientific studies of workers who were exposed to emr emissions in the 1940s and 1950s and found detrimental health effects such as the above. The Soviets called the set of symptoms `Radiofrequency sickness syndrome'. Dr. Goldsmith believed that the Soviets were experimenting and testing radio frequency radiation as a weapon. The U.S. government's epidemiologist documented high white blood counts, leukemia in two of the Ambassadors and other health problems in the embassy employees. Then the U.S. government ignored the findings.

The wireless revolution now continues with the fast growing cell phone market worldwide. The Council on Wireless Technology Impacts asked the question, what are the environmental effects of the wireless revolution?

How the U.S. safety limit for emr exposure puts the U.S public health at risk.

The next segment was filmed at an April 2000 California Senate hearing sponsored by Senator Tom Hayden on cell phone safety. The U.S. safety limit does not take into account athermal health effects of emr which are occurring below the U.S. safety level. The cell phone industry completely disregards scientific studies of cell phone emission levels falling below the government safety standard. Cell phones are placed on the market as a safe product when in reality there may be health risks from their use.

Cindy Sage, a California environmental policy consultant explained that reliable studies show detrimental health effects from exposure to radio frequencies way below the safety standard set by the U.S. government. The cell phone industry spokesman testified at the California Senate hearing that the cell phone industry was in compliance with FCC and other government standards and there were no health risks associated with cell phone use. But using a chart, Cindy Sage explained that the cell phone industry claim did not include research of cell phone emissions in the nonthermal range, which is below the safety level established by the FCC. This is the cause of the controversy.

Dr. Jerry Phillips, Research Biochemist, Colorado testified that Motorola was suppressing research. Dr. Phillip's research for Motorola found DNA damage associated with cell phone emission levels. He also stated that the brain was exquisitely sensitive to RFR or radio frequency radiation. Motorola was not happy with the results and told Dr. Phillips how to write abstracts, conduct his work and finally urged him not to publish. Dr. Phillips published the study in 1998.

Now Dr. Phillips recommends caution because no money is available for research except from the cell phone industry. He has no faith in their results. The cell phone industry earned $20 billion in 1996 and $475 billion in 2000. Senator Hayden commented that the "buying of science" was what caused him the greatest concern. He had a strong opinion for the "corrupting influence of money on science". Hayden stated that the FDA have not been able to scientifically certify cell phone technology as safe or not safe and therefore, he urges caution.

Analogy to tobacco industry and health risks of smoking

California Senator Tom Hayden stated that an association between the exposure to emr from cell phones and the risk of detrimental health effects is established. A direct cause and effect, as in scientific proof has not been established but like the `cigarettes do not cause cancer' scientific controversy, there is enough proof to warrant a warning to the public.

Cindy Sage described three levels of proof, the scientific level of proof, which is the highest level, almost 100%, the legal standard of proof, or 51%, the more probable than not standard and the environmental law standard, in the 10 to 30% range. Ms. Sage stated that the environmental law standard is the level at which public decision making on environmental issues takes place, i.e., at the potential level for a significant impact. Ms. Sage believes that the emr controversy should be judged by the environmental law standard of proof and she mentioned the California Environmental Quality Act. [Note, I took an environmental law class in summer 2001 and the 2001 environmental law text book listed emr under toxic substances and described it as a controversial topic.]

Business tactics include conscious disregard for health risks of consumer products.

Science author B. Blake Levitt wrote "Electromagnetic Fields", 1995 and stated that the cell phone industry "cynically knows" it will take twenty years for scientific evidence to prove damaging health effects from cell phone emr exposure. Brain tumors are beginning to show up in cell phone users. It will probably take ten to fifteen years for brain cancer to show up in people who live near cell towers. It will take two years to gather data, three years for peer review and four years to end up in journals. In the meantime, billions of dollars are pocketed by the cell phone industry. This is similar to the business tactics of the tobacco companies in which many smokers died of lung cancer, while the companies suppressed clear scientific evidence of an association of health risks to smoking and also the addictive qualities of nicotine in cigarettes. The emr controversy is following the same pattern. Two brain tumor victims whose emr exposures occurred in the cell phone industry were interviewed.

Telecommunications Act bars consideration of health factors in local government decisions on cell tower location.

Another highlight in this video were the protest marches around the country against section 704 of the Telecommunications Act of 1996. Linda Evans, TV star of "Dallas" explained. Section 704 states that local governments are banned from taking into consideration the health effects of microwave, TV, radio and other emr towers that are to be located in their area.

"People just didn't know, like myself, I was ignorant and we have lost our rights." The laws need to be changed.

Conclusion

In conclusion, the U.S. safety standard is too high to protect the U.S. public. The standard is outdated and needs to include the well-established athermal health effects. It is critical that impartial research into nonthermal health effects is funded adequately. Public safety is at stake and politics and money do not belong in science.

The cigarette industry used the scientific standard of proof, saying there is no link between smoking and lung cancer. The cell phone industry is using the same tactic. Environmental issues are decided at the 10-30% level of potential harm in order to protect public health. The cigarette industry's scientific standard of proof did not protect the public. Today, it is a proven fact that many smokers died from lung cancer as a result of smoking and the addictive qualities of nicotine. Therefore the environmental standard of proof should be used in the emr research evaluations in order to protect the public.

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## Section III

Conclusion: What this information means to victims of nonconsensual government experiments

1.

Where does the Russian translation Project fit in to the evidence?

A. A Few Conclusions

B. Short overview: The scientific basis for emr mind control weapons, athermal effects of emr. Plenty of evidence in mainstream press

1. Davis Enterprise, 3-1-2001 "Frankengenes': The Dark Side of Biotechnology" by Lee Bowman

2. Parade Magazine, Dec. 29, 1996, Reuters: "Best News for Mortals" "British scientists say they're working on a "Soul-Catcher" memory chip, which would record human memories and thoughts, and expect it to be workng within 30 years." Open literature discusses scientists interested in futuristic technology.

3. New York Times Magazine, Sept 29, 1996, "The Altered State" by Elizabeth Rotte. "Michael Persinger, a psychologist and neuroscientist at Laurentian University in Ontario, ...solenoids, which create gently fluctuating fields ...The impulses move through ...the brain, where they interfere and interact with the complex electrical patterns of the subject's neural fields. Persinger aims...switches ...they sense a sexual arousal.. negative presence, a benevolent force , opiate effects,..."

4. Bulletin of Atomic Scientist, Sept/Oct 1994 by Barbara Hatch Rosenberg, "The Soft Kill Fallacy". "Many of the non-lethal weapons under consideration utilize infrasound or electromagnetic energy...These weapons are said to cause ...interference with mental processes, modification of behavior and emotional response,...severe pain... The current surge of interest in

electromagnetic and similar technologies makes the adoption of a protocol explicitly outlawing the use of these dehumanizing weapons an urgent mater."

5. US. News Jan 3/10 2000 by Douglas Pasternak, "John Norseen, Reading your mind and injecting smart thoughts" "BioFusion would be able to convert thoughts into computer commands, predicts Norseen, by deciphering the brain's electrical activity. ... Norseen's theories are grounded in current science. Mapping human brain functions is now routine..."

C. American victim's accounts match Russian accounts

1. U S District Court Eastern District of CA No Misc. 94-097-WBS John M. Ginter, Plaintiff, v. California Department of Corrections, et al., Defendants. John Ginter, San Quentin prisoner with high school education described in his 1967 court case that Dr. Schmidt, the San Quentin psychiatrist called the equipment used on John, "M.I.N.D. or Magnetic Integrated Neuron Duplicator".

2. Los Angeles Times, 3-28-88 part 2 page 1, "A Fearful Fix Grips Figure in Kickbacks" by Kim Murphy, Rex Niles, an FBI informant in a defense contractors kick back case in Los Angeles, CA. Photo caption stated, "His aluminum foil hat has tiny holes in it, says Rex Niles, proof that the government is bombarding him with microwaves in an attempt to kill him." He had detected microwave signals but was still labeled mentally ill."

3. New York Times Magazine, Aug. 31, 1997, "Atomic Guinea Pigs" by Michael D'Antonio "At the Department of Energy, which oversees America's nuclear-weapons research, these people [radiation experiment victims] were referred to collectively as "the Crazies." But the opening of the cold-war archives has brought the Crazies in from the fringe." The mind control victims in Russia and the U.S. are both labeled mentally ill.

A Few Conclusions

Victims have two strong arguments for demanding an investigation into their allegations. If the Russians have mind control weapons, the U.S. undoubtedly has a mind control arsenal.

The evidence in this compilation spans 50 years, includes several independent, mainstream sources, and credible professionals, all stating that mind control in Russia exists. The historical and scientific evidence also supports a very long-term, large and classified emr weapons program in Russia and the U.S. The U.S government is on record for lying to the U.S. public about lack of proof of nonthermal effects while the Russians claim that nonthermal effects of emr are being used for weapons. Now in the 1990s, the U.S. reveals the nonlethal weapons program and claims in U.S. News and World Report, 7-7-97, that "scientists, aided by the military research on the `bioeffects' of beamed energy are searching the electromagnetic and sonic spectrums for wavelengths that can affect human behavior." The translation of the 1999 Lopatin book is the best evidence yet, a top Russian politician and scientist claim Russian mind control weapons exist and should be under international control.

Second, the athermal controversy is equally convincing historical evidence of a classified U.S. mind control program.

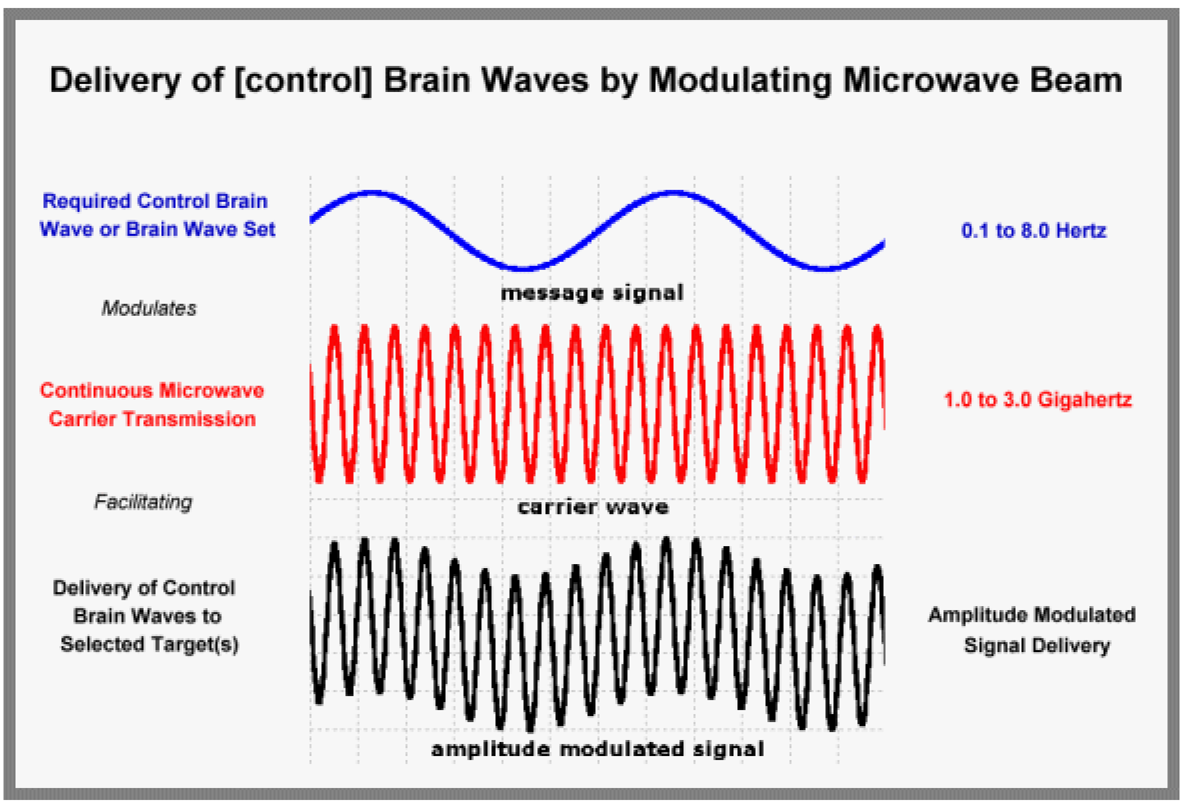
The number of victims in the U.S. and Russia, not to mention other countries is growing. For the first time, victims as a group can now organize and go to their congressional representatives, human rights groups, lawyers and investigative reporters and present an adequate level of proof of their claims, never before possible. The evidence now meets the standard of proof required for mainstream journalism, public knowledge and investigations such as a GAO investigation or a congressional hearing or a human rights investigation. Please see below for evidence and citations.

Electronic warfare since 1953, without public knowledge

In "Project Pandora", Dr. Becker, an emminent scientist consulted by the U.S. government on emr national security issues has warned of the electronic war on the citizens of the U.S and U.S.S.R. Many experts including Oppenheimer have warned that the Orwellian dangers of mind control are worse than the atomic bomb,(American Psychological Association). Information warfare using the mind as a target was described in the tv program, War 2020. War would be fought without even knowledge of a war taking place, (See Cahra International Campaign section).

In his 1990s book, "Crosscurrents", Dr. Becker wrote that it may be too late to stop the ongoing weapons programs. Unlike peace, electronic warfare resembles another cold war with its resultant high costs. Experts and public officials from the east and west warn of the dangers of psychotronic weapons or nonlethal emr weapons, the need for international control and of the need for open public debate.

What can be done?



--- overview plus 12 page summary

A. Russian Experts state mind control weapons exist and warn of dangers of psychotronic weapons and war
B. Chart of scientifically proven victim symptoms
C. Table of contents with citations

Section I
The best argument for the existence of U.S. EMR Mind Control Weapons: The Russian evidence
1. Cahra Website posting, "Russian Book Translation Project Has Begun"
2. U.C Davis students translate sixty-two pages of the Russian book "Psychotronic Weapons and the Security of Russia" by V.N. Lopatin and V.D. Tsygankov,1999 Moscow
A. Lopatin on Russian TV, 1995 asking for duma legislation banning mind control weapons.
B. Three lexis-nexis articles on Lopatin
1. Defense and Security, Feb. 14, 2000, "The Riders of the "Psychotropic" Apocalypse" by Andrei Soldatov. Lopatin discusses his ten year effort to ban mind control weapons.
2. Interfax Russian News, August 16, 1999, "Duma to Debate PM's Confirmation, Dagestan on Monday" Lopatin's duma work discussed.
3. Xinhua General Overseas News Service, Oct. 11, 1990, "U.S. Defense Secretary to visit Moscow", discusses Lopatin's trip to U.S., meets U.S. Defense Secretary Cheney, Lopatin speaks at National Press Club.
C. Biography of Vladimir Nikolaevich Lopatin
D. Biography of Vladimir Dmitrievich Tsygankov
E. Table of Contents-D. Milks, translator
F. From the Publisher
G. Chapter 3 The Physical-Biological Basis of PSW, p. 42-48
H. Chapter 6 State Defense Initiative and Concept of Arms By V.D. Tygankov
I. Chapter 7. Legal Problems of Defense From Informational Weapons by V.N. Lopatin
J. Conclusion
K. Literature
3. Translation excerpts from second book "Psychotronic War, From Myths to Facts" by Igor Vinokurov and Georgij Gurtovoj", Moscow 1993, Translated by Mojmir Babacek
A. Kalamazoo Gazette, 4-14-89, "Western, Soviet scientists full of energy" by Bill Krasean. On Russian scientist Vlail Kaznacheev, mentioned in Gurtovi book and cited in Russian article below, Stolitsa, No.43, p. 40, "MC-Ultra Program" by Alexei Myasnikov.
4. Several corroborating Russian newspaper articles on mind control
A. Defense and Foreign Affairs, Nov. 1983 Publisher's Note, on Russian "electronic systems "to "beam" messages directly into the brain."
B. Defense News, Jan 11-17, 1993, "U.S., Russia Hope to Safeguard Mind-Control Techniques" by Barbara Opall
C. Moscow News, March 12, 1994 Science No. 12., on Smirnov and psychotronic weapons.
D. Newsweek, 8-22-94, "Subliminal Dr. Strangelove" by Dorinda Elliott, John Barry, on Smirnov and Waco, FBI meetings.
E. Moscow News, March 25, 1994 "when asked noiselessly, answer silently", on Smirnov's mind control work.
F. Moscow Times, "Computers may hope Key to Subconscious" No. 505, on Smirnov's pyschotronic work
G. Charleston Gazette, March 4, 1994, "FBI Rejected Mind Control With Koresh"
H. Defense Electronics, July 17, 1992, "DOD, Intel Agencies Look at Russian Mind Control Technology" by Mark Tapscott
I. The Glasgow Herald, May 26, 1993 "Brainwash killers `still in use'", on alleged Soviet military use of psychotronic weapons.
J. Washington Times, May 24, 1995 "Reputed Rasputin advises Yeltsin; Ex-KGB officer dabbles in occult", by Martin Sieff, on allegations by Kremlin officials of use of mind control by KGB.
K. Sacramento Bee, May 28, 1995, "The Kremlin's Back Magician", by Miranda Anichkina
L. Stolitsa, N. 43 p. 40, "MC-Ultra Program" by Alexei Myasnikov, on human rights groups alleging government mind control experiments.
M. Moscow Times, July 11, 1995, N. 750, "Report: Soviets Used Top-Secret' Weapons by Owen Matthew's with comments by V.N. Lopatin.
N. Delovoi Mir, pp. 1,9 "Mind-Control" by Ivan Tsarev, with complaints filed with Russian government by victims of emr mind control experiments.
O. Los Angeles Times, 1976? "Russia Testing Radiation to Cause Disease, Control Minds and Kill", by Paul Bannister

P Los Angeles Herald-Examiner, Nov. 22, 1976, "Mind-Altering Microwaves, Soviets Studying Invisible Ray"
Q. Fate Magazine, Feb, 1994, Vol. 47, No. 2 Issue 527, "Soviet Psychic Warfare", by Paul Stonehill
R. Executive Intelligence Review Special Report, 1988, "Electromagnetic-Effect Weapons: The Technology and the Strategic Implications"
5. 1998 German TV, ZDF, "Secret Russia: Moscow--the Zombies of the Red Czars", documentary on Russian victims of psychotronic experiments, obtained by Blanche Chavoustie
Section II
The Second and Equally Convincing Argument For the Existence of U.S. EMR Mind Control Weapons: The East/West Controversy over Thermal/Athermal effects of Emr Ends With the Exposure of a U.S. Cold War Cover Story

Freedom of Information Act excerpts from Harlan Girard, released 2001
A. Moscow Rabochaya Tribuna Nov. 26, 1994 pp 1-2, "Psychotropic Arms Potential Must Be Monitored', by Anatolily Ptushenko, Member of the Russian Federation of Space Exploration Scientific and Technical Council. "While microwave radiation is variable: it can affect a person (or an army) temporarily or possibly forever. It is all determined by the mix of frequency and the power of the radiation. These systems were called "psychotropic Weapons" in official secret documents 30 years ago. It was these systems that we began to appreciate in the sixties. ...Nevertheless; faced with such a terrible danger as psychotropic weapons (and other kinds of space-based weapon), it is our duty to ensure that the development and operation of space-based solar energy systems receive popular and above all mass media scrutiny."
B. Russia National Information Security, Moscow Armeyskiy Sbornik, Oct. 96, No. 10, pp 88-90 "National Information Security: Opinion of the Subject", by Major General Valeriy Menshikov, doctor of technical sciences and Colonel Boris Rodionov, discussed satellites, remote mind control.
C. Beijing Renain Junyl [People's Military Surgeon] Vol 40, No 9 Sep 97, pp 507-508. Discusses infrasound weapons to induce immeasurable fear and unstable mental state...or even symptoms of mental disease."
D. People's Military Surgeon, Vol 40 No. 9 Sep 97 pp 507-508, discusses Incoherent Light Source weapon that can cause blindness and disorientation, and can also lead to symptoms of mental illness.
E. Beijing Jiefangjun Bao Chinese, 25 Dec. 1996, "High-Energy Microwave Weapons" Known as "Superstars", article stated, ""non-thermal effects" can produce psychological damage..."
F. "ATTN Wire Select, Belgium, by Alain Gossens, "Apocalypse Now? `HAARP' or How the US Military is Playing Sorcerer's Apprentices", stated, "all research in the area of electromagnetic energy -- for say, medical purposes-- has been blocked. As a result a vast and highly promising field of science and medicine has been monopolized by interests with ties to the US Army."
1. British tabloid, The Big Issue, Oct 2, 2000, "Strike Force", Dr. Bertell [a respected Canadian biometrics expert who led the Bhopal and Chernobyl Medical Commissions]"claims HAARP could disrupt human thought-processes."
2. 1983 Washington DC Conference on Psychological Strategies sponsored by the "Intellectual Father of Star Wars", Dr. Stefan Possony, discussing Russian emr mind control based on athermal emr effects.
A. Defense and Foreign Affairs Daily, 6-7 83 "Psy-War: Soviet Device Experiment" Article stated, "Dr. Adey was quoted as saying: "Some people theorize that the Soviets may be using an advanced version of the machine clandestinely to seek a change in behavior in the United States through signals beamed from the USSR."
3. BBC TV 1984 documentary, "Opening Pandora's Box", highlighting Dr. Becker's theory of large, classified U.S. emr weapons program based in part on evidence of the thermal/athermal controversy.
A. AP Extra by Barton Reppert, May 21, 1988, "The Zapping of an Embassy: 35 Years Later, The Mystery Lingers"
B. November 6, 1953, "Destroying American Minds-Russians Made it a Science" Dr. Charles W. Mayo to the Political Committee of the United Nations about methods of torture used by Communists on American prisoners.
C.. Federal Times, Dec 13, 1976, "Microwave Weapons Study by Soviet Cited", From GPO, 1976 "Surveillance, Technology, Policy and Implications" Staff Report Subcommittee on Constitutional Rights, Committee on Judiciary, US Senate, Second Session.
D. Modern Electronics, Sept 1985, "Combating the Russian Woodpecker", by Glenn Hauser
E. UN, July 10, 1979, Committee on Disarmament by V.L. Issraelyan, Representative of the USSR, discusses development of new weapon of mass destruction based on `non-thermal' effects.
F. Letter to Cheryl Welsh from NSA,CIA, May 19, 1997, "Soviet mind control system...is classified..."
G. NBC Magazine with David Brinkley, July 16, 1981, No. 47592, discussing Russian Woodpecker Signal and mind control.
H. U.S News and World Report, July 7, 1997, "Wonder Weapons, The Pentagon has a huge classified program to build sci-fi arms that won't kill the enemy. ..." By Douglas Pasternak

4. 2000 Video by Council on Wireless Technology Impacts, "Public Exposure", www.emrnetwork.org. More evidence of athermal controversy
A. Microwave News, March/April 2001 "Views on the News: Weapons Development and Public Health Should Not Mix"

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2. Parade Magazine, Dec. 29, 1996, Reuters: "Best News for Mortals" "British scientists say they're working on a "Soul-Catcher" memory chip, which would record human memories and thoughts, and expect it to be workng within 30 years." Open literature discusses scientists interested in futuristic technology. Scientists conducting classified research, given the evidence in this compilation, have developed very sophisticated mind control weapons.
3. New York Times Magazine, Sept 29, 1996, "The Altered State" by Elizabeth Rotte. "Michael Persinger, a psychologist and neuroscientist at Laurentian University in Ontario, ...solenoids, which create gently fluctuating fields ...The impulses move through ...the brain, where they interfere and interact with the complex electrical patterns of the subject's neural fields. Persinger aims...switches ...they sense a sexual arousal.. negative presence, a benevolent force , opiate effects,...
4. Bulletin of Atomic Scientist, Sept/Oct 1994 by Barbara Hatch Rosenberg, "The Soft Kill Fallacy". "Many of the non-lethal weapons under consideration utilize infrasound or electromagnetic energy...These weapons are said to cause ...interference with mental processes, modification of behavior and emotional response,...severe pain... The current surge of interest in electromagnetic and similar technologies makes the adoption of a protocol explicitly outlawing the use of these dehumanizing weapons an urgent mater."
5. US. News Jan 3/10 2000 by Douglas Pasternak, "John Norseen, Reading your mind and injecting smart thoughts" "BioFusion would be able to convert thoughts into computer commands, predicts Norseen, by deciphering the brain's electrical activity. ... Norseen's theories are grounded in current science. Mapping human brain functions is now routine...
B. Russian and American victim's symptoms match.
1. U S District Court Eastern District of CA No Misc. 94-097-WBS John M. Ginter, Plaintiff, v. California Department of Corrections, et al., Defendants. John Ginter, San Quentin prisoner with high school education described in his 1967 court case that Dr. Schmidt, the San Quentin psychiatrist called the equipment used on John, "M.I.N.D. or Magnetic Integrated Neuron Duplicator".
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3. New York Times Magazine, Aug. 31, 1997, "Atomic Guinea Pigs" by Michael D'Antonio "At the Department of Energy, which oversees America's nuclear-weapons research, these people [radiation experiment victims] were referred to collectively as "the Crazies." But the opening of the cold-war archives has brought the Crazies in from the fringe." The mind control victims in Russia and the U.S. are both labeled mentally ill.
C. Conclusions

## Ernest Glen Wever (1902-1991)

Glen Wever was born October 16, 1902 in Benton, IL. He received an A.B. degree from Illinois College in 1922, and the MA and PhD degrees from Harvard University in 1924 and 1926. he was married in 1928. After a year as an instructor at U.C. Berkeley (1926-1927), Wever moved to the Department of Psychology at Princeton University where he remained. During 1936, he worked on a fellowship at the Otological Research Laboratory at Johns Hopkins University with Stacy Guild and S. J. Crowe. He was named the Dorman T. Warren Professor (1946-1950), and the Eugene Higgins Professor (1950-1971) at Princeton. He was a consultant to the National Defense Research Committee on anti-submarine warfare during World War II. He was a Research Associate at the Lempert Institute of Otology in New York (1947-1957) and served as Psychology Department Chair at Princeton from 1955 to 1958.

Wever had three careers in hearing research: First, with Charles Bray, Merle Lawrence, and Jack Vernon he discovered and further investigated the cochlear potential (referred to the as the "cochlear microphonic" by some), and used it as a tool for investigating the biomechanical function of the outer, middle, and inner ears. This work culminated in Physiological Acoustics (E.G. Wever and Merle Lawrence, Princeton University Press, 1954). This book was a "bible" in its time, and few volumes of its scope has been attempted since. Second, Wever reviewed, evaluated, and developed contemporary theories of hearing, including his well-known volley principle which he combined with a place principle to account for frequency analysis (the volley theory). This work was published as Theory of Hearing in 1949. This book remains today the most ambitious, complete, and well-written book on hearing. He once remarked to me that his initial work leading to a formulation of the volley principle was done to obtain evidence against temporal representations of frequency in the mammalian ear. Third, Wever founded, and for several decades maintained the modern field of the evolutionary biology of hearing. It is clear from his bibliography that he was interested in evolutionary issues from the start (early '30s), and began studies on both vertebrates and invertebrates. These interests in comparative and evolutionary issues in hearing brought forth The Reptile Ear in 1978 and The Amphibian Ear in 1985, both from Princeton University Press. These books are unparalleled treatises on the comparative study of the ear. Beginning in the 1960s, Wever's comparative interests came to dominate his work and thinking for three decades. It is characteristic of Glen Wever that when reporters from Newsweek Magazine asked him in 1970 why a psychologist would be studying the structures and physiology of reptile ears, he answered, "It's where the questions took me."

Wever was elected to the National Academy of Sciences and the National Academy of Arts and Sciences, and was a fellow of the Acoustical Society of America and the Society of Experimental Psychologists. He had received the following additional honors: Howard Crosby Warren Medal from the Society of Experimental Psychologists (1931), the George Shambaugh Prize in Otology (1957), The Gold Medal and Certificate of Merit from the American Otological Society (1959), Honors of the Association from the American Speech and Hearing Association (1967), The Beltone Institute for Hearing Research Award (1969), and was the Guest of Honor at the 104th meeting of the American Otological Society (1971). In 1981 he received the Silver Medal in Psychological and Physiological Acoustics from the Acoustical Society of America, and in 1983 received the Award of Merit from the Association for Research in Otolaryngology.

Wever and Georg von Bekesy became good friends during the '50s following a period during which Wever was rather critical of von Bekesy's work. Von Bekesy cherished the new friendship but regretted loosing his most valuable critic when relations turned personally warm.  Wever translated from the German and edited all von Bekesy's papers published up to 1948 to produce the book, Experiments in Hearing. This scholarship on Glen's part probably played a role in von Bekesy's winning the 1961 Nobel Prize in Physiology and Medicine.  Some additional information about E.G. Wever, including photographs, can be found in Hearing and Other Senses: Presentations in Honor of E.G. Wever, R. Fay and G. Gourevitch (Eds.), Amphora Press, Groton, CT, 1983, a volume reporting the presentations at a meeting of former students and present colleagues on the occasion of Wever's retirement. In 1982, a video tape was made of Frank Geldard interviewing Glen about his earliest years in research. The symposium "Evolutionary Biology of Hearing" (1990), and the volume arising from it (D.B. Webster, R.R. Fay, and A.N. Popper, Eds., Springer-Verlag:New York, 1992) were dedicated to him.

Those wishing more information about Wever should contact The Director, Archives of the History of American Psychology, University of Akron, Ohio, where many of Wever's notes, books, and papers are collected. Scholars wishing to study Wever's vast and well-organized histological slide collection of the heads and ear regions of reptiles and amphibians, should contact the Division of Reptiles and Amphibians, U.S. National Museum of Natural History, the Smithsonian Institution, Washington, DC. Some carcasses are also conserved for species identification. Additional anatomical material from Wever's research collection can be found at the Carnegie Museum, Division of Amphibians and Reptiles.

## Georg von Bekesy (1899-1972)

Georg von Bekesy was born in Budapest where his father was a diplomat. After moving successively to Munich, Constantinople and Zurich in his early years, he traveled to Berne for his university education where he concentrated on chemistry, a field he believed would soon become part of physics. His first interests were in mathematics and physics, especially mechanics. From the very start, he found work in the lab or machine shop preferable to lectures. He learned mechanics first from Swiss watchmakers whom he admired and emulated in his first dissections of the human temporal bone. After graduation, he began his Ph.D. work in Hungary in experimental physics with a dissertation on a rapid way to determine molecular weight. His subsequent career in the field of hearing began when he decided to work in the best-equipped laboratory in Hungary, the Hungarian Government Communication Laboratory (a division of the Post Office). The laboratory had responsibility for maintaining the telephone cables that crossed Hungary to connect western and eastern Europe. One of von Bekesy responsibilities was to test the telephone cables using a series of long-duration sinusoids. He instituted the practice of testing more rapidly using impulses, or clicks, for which both amplitude and phase distortions could be easily measured, sometimes just by listening to them. Deciding that future improvements in telephone service were to be most profitably approached by working on receiver and transmitter design, he began a comparative study of the transmission characteristics of the telephone transducers and the human ear drum, so as to approach technologically the superior performance of the ear. For this, he obtained cadaver heads from hospital autopsy rooms, and developed new methods for dissecting the middle and inner ears and observing their mechanical responses. He remained at this laboratory until 1946, and during this time he made his most important observations and analyses of the traveling waves of the cochlea's basilar membrane. He once related to me that his goal was to obtain evidence against resonance of the basilar membrane as the mechanism underlying a place-principle of frequency analysis. Site-specific resonance was first hypothesized in the previous century by H. von Helmholtz. Von Bekesy considered resonance to be highly unlikely because the rapid temporal response of the auditory system seemed to be impossible for a resonating system.

In 1946 he was a visiting scientist at the Karolinska Institute in Stochholm where he developed and evaluated an adaptive, recording audiometer, since known as the Bekesy audiometer. In 1947 Bekesy moved to the Psycho Acoustic Laboratory at Harvard University's Memorial Hall, under the leadership of the psychophysicist S.S. Stevens. One of his major projects at Harvard was the development of a mechanical model of the cochlea to which he added the "nerve supply" of the skin of the forearm. His principle observations were that when the mechanical model was driven by a large vibrator at one end, a broad traveling wave was set up along the length of the simulated basilar membrane. Changing vibration frequency caused the peak of the motion to move to different regions of the membrane. Most interesting were the observations that, while the entire simulated membrane vibrated to some extent, the sensations from the skin of the forearm resting on the membrane were punctate, giving the feeling that there was stimulation at only one point. Bekesy hypothesized that this spatial sharpening of the sensations was due to lateral inhibition of the type already demonstrated for the retina of the eye. Thus, he came to investigate inhibition in processing by several sensory systems, including in vision, hearing, cutaneous sensation, and later, in smell and taste. Following the publication of Experiments in Hearing, comprised of many earlier research papers translated and edited by E.G. Wever, von Bekesy was awarded the 1961 Nobel Prize in Physiology and Medicine.

Von Bekesy retired from Harvard in 1966 and moved to the University of Hawaii, Oahu, where a new laboratory was built for him (The Laboratory of Sensory Sciences, now called the von Bekesy Laboratory of Neurobiology), in part supported by Hawaiian Telephone. He enjoyed Hawaii due to its cultural and environmental diversity. He especially loved the components of Asian culture there, something he had become interested in by collecting Asian art objects. He became a well-known expert in Asian art, and built a large collection that is now owned and displayed by the Nobel Foundation in Stockholm. One of his few criticisms of Hawaii was that young scientists there were likely to "go to the beach" (here he meant "dropping out," Hawaiian style) and not return to the laboratory with the same energy that he, himself, had developed and maintained from an early age. When I arrived at the laboratory as a post-doc in 1972, he directed me to repeat the classic experiments of Kreidl on "crabs," as he called all crustaceans. I was to use computer-controlled magnetic fields rather than permanent magnets to simulate the gravity vector for statocysts that had the usual sand replaced by iron particles. I began this work but never got to the ultimate experiment he wanted replicated. His "right-hand man" at the lab was Walter Karplus, a talented machinist and former dairy farmer from Massachusetts. In spite of the growth of computer technology at this time, von Bekesy felt more comfortable with Karplus-built mechanical contraptions for generating and applying his visual, auditory, gustatory and olfactory stimuli.

# "The Rediscovery of Audio-Visual Entrainment"

A chapter from the book entitled by Dave Siever/1997

Most people believe that brainwave entrainment (BWE) brought about by the repetitive pulsing of light and sound (audio-visual entrainment) is a new technology, however the history of brainwave entrainment through photic or visual can be traced as far back as the dawn of man. When our ancestors made a fire to keep warm, they enjoyed watching the flickering flames which led them into reverie and spiritual or mystical experiences. Michael Hutchison, author of "Megabrain", summed it up well by stating that "the knowledge that a flickering light can cause mysterious visual hallucinations and alterations in consciousness is something that humans have known since the discovery of fire." Early scientists used the comforting, mesmerizing light of the fires in their fireplaces to draw them into lucid states of mind, then commonly referred to as "reverie." They would use reverie to help them solve many of their puzzling questions regarding science, life, and the universe. Even today, people enjoy sitting by a fire, not for the warmth so much, but mostly for the relaxing effect we feel from the flickering flames. With the development of modernized home heating, few of us get the chance to gaze absent-mindedly into a fire. Only a few urbanites manage to retreat to the woods to enjoy the warmth and relaxing dance of the flames upon the logs while feelings of peace, safety and tranquility fill their minds, separating them from the hectic lifestyle of the city.

Another way BWE can be experienced naturally is from driving a car down a long straight highway at sunrise or sunset with the roadside trees casting shadows across the road. The flickering sunlight may bring about an altered state of consciousness, making it difficult to focus on the task of driving. We can also experience BWE by cruising down a highway at 60 miles per hour at night. As the bright lines flicker past us at a theta frequency, we slowly drift into a dream state and before we know it, we spot a pink elephant or other apparition standing on the road in front of us. With a quick flash of panic, we grab the wheel and hit the brakes. In the blink of an eye, we are now wide awake and quite startled and the apparition has vanished. The highway induced BWE is gone.

BWE research has been difficult to collect because of the many terms used to describe photic stimulation because there was no standardized terminology within the medical community. Brainwave entrainment, which is the term most often used today, has been known in the past as *flicker stimulation, photic driving, cortical evoked response, visual evoked response, afferent sensory stimulation, variable frequency photo-stimulation, repetitive sensory response and brainwave synchronization*. As a result, collecting all of the research relating to BWE has been difficult and time consuming. It is important that I clarify the distinction between "cortical evoked response" (CER), and brainwave entrainment. The CER is the brain's response related to its processing a single stimulus. This "kick" of the brain occurs approximately 100 milliseconds (msec) following the stimulus, and the CER usually occurs only once, until the next stimulus. The evoked response is generally mixed with other brain activity. However, when the stimulus is repeated continuously above four Hz, the brain begins to "resonate" with the stream of stimuli and the resultant brainwave response is of the same frequency as the stimuli. The entraining brainwave occurs best at one's own natural alpha frequency (between 9 and 11 Hz). This leaves the brain little time to inject its own activity in between the continuous evoked responses, causing a decrease in all other brainwave frequencies. Depending on the waveform of the stimuli, a second or third harmonic may be seen on an EEG.

It is equally important that I clarify the distinctions between brainwave entrainment (BWE), audio-visual entrainment (AVE) and light and sound (L&S) stimulation. An L&S device flashes lights and makes sounds of some sort. The stimuli isn't designed to follow the rules of entrainment, so outside of a great light show, there may not be any neurological effects and benefits at all, just fun entertainment. AVE produces BWE by delivering pulses of light and sound in accordance with the rules of BWE. BWE as mentioned above can also be produced by nerve and kinesthetic (tactile) stimulation as well as visual and auditory stimulation, which is used in an AVE device.With the development of sophisticated electronic physiological measuring equipment, scientists now conduct and record research to show the effects that photic stimulation has on humans. There have been countless research articles printed in scientific and medical journals on the effects of BWE since the discovery of photic driving in 1934. In efforts to better understand the brain, most early research only observed of the physiological effects of BWE directly and not the clinical benefits of BWE. It has only been more recently that clinical research has been conducted. Listed below, is a brief summary of some of the most significant observations and discoveries that are available at the time of writing. However, continued research is being conducted on this amazing technology. For instance, since 1988, Comptronic Devices Limited has been involved in several clinical studies including dentistry, ADD, insomnia fibromyalgia and chronic pain. Few people had considered the effects of BWE on one's perceptions, feelings, health, performance, stress levels or consciousness until the 1960's when behavior research became regarded as a recognized approach to maintaining good health. This new paradigm was brought about in part by the psychedelic drug revolution and, more importantly, the application of biofeedback which proved beyond any doubt that we could control all aspects of our visceral functioning such as muscle and arterial tone, stomach acid excretion, brainwave activity and emotions.

Biofeedback soon expanded to basically anything that could be measured, and where those measurements could be "fed" back to the subject. This was a blow to the credibility of the dogmatic medical model which presumed that people could not control much bodily functioning and that pharmaceutical agents and surgical interventions were the only panacea for illnesses. Biofeedback was also of paramount importance in not only proving our control over our bodies, but it also proved that WE ARE OFTEN THE CAUSE of most of our illnesses. Hence biofeedback, psychological counselling, healthy eating, exercise, BWE and a plethora of non-drug approaches that focused on prevention rather than correction started making inroads into people's lifestyles. BWE, although not a new concept, has been recently receiving a lot of media attention and hype. However, even today, most people have not yet heard of
BWE, even though it has been around for nearly a century and it is only recently that BWE, through the use of AVE machines is making a comeback in a scientific way.

Over the years, there have been many different manufacturers of these brainwave entrainment devices available all over the world. These devices have evolved from large expensive "science fiction" looking devices to compact, easy-to-use, portable units. More and more we hear of "spas" and "Brain Gyms" and various holistic centres that are offering this technology to their clientele.

We have also documented other milestones in the development of BWE technology. We hope you will find traveling through the evolution of this amazing technology both fascinating and enlightening.

**RESEARCH**

The first known documented experimentation with photic stimulation was by Ptolemy, in approximately 200 AD. While spinning a spoked wheel into the sun, he noticed the apparent immobility of the wheel radius above a certain speed. He also noted that the flickering light caused patterns and colors to appear before his eyes. It wasn't until the seventeenth century before research involving flicker stimulation commenced once again. This research examined the frequency at which individual flickering light began to "fuse" into a steady light. This ***flicker fusion phenomenon*** was first established in 1834 - 1835 by the Englishman, Talbot and by the Belgian named Plateau, whose thesis at Leige is described as a
landmark in the field. They noted that healthy people could notice the flickering of light at a higher frequency than persons experiencing ill health. Twentieth century research has shown that meditators notice higher frequencies of flickering light than non-meditators.
Research into photic stimulation was of little consequence until 1895 when the illusion of colors produced by flickering light were demonstrated by Benham through his invention - the "artificial spectrum top."A few years later, the French psychologist, Pierre Janet, at the Salpetriere Hospital noted a reduction in hysteria and an increase in relaxation when he exposed patients to flickering light delivered by a rotating strobe-wheel illuminated by a lantern from behind. The patient would stare into the strobe-wheel to receive treatment. This was the first known clinical application using BWE as a treatment tool.

In 1929, with the invention of vacuum-tube amplifiers, Hans Berger, a German psychiatrist, working in Jena, began to publish strange little pictures consisting of nothing but wavy lines showing the electrical activity made by the human brain.

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The voltage of these signals ranged from 50 to 100 micro volts and at a frequency near 10 cycles per second (Hz). This was called the Berger rhythm (later termed the *alpha rhythm*). The signals appeared when the subject was at rest with the eyes closed and disappeared when the eyes were opened or during a task that involved attention. Berger's colleagues were not interested and no one took these wavy little lines seriously. And for a number of years no one even bothered repeating his experiments. Berger naturally felt hurt and disappointed. In 1934, the researchers, Adrian and Matthews confirmed many of Berger's observations but disagreed with the origin of the Berger rhythm. They were the
first to use a balanced amplifier, known today as a bipolar or differential amplifier (used widely in biofeedback). They also postulated, as did Tonnies in 1933, that this rhythm was associated with mental processes and involved a large number of neurons. (Today there is a much greater understanding of the visual cortex which is thought to consist of approximately 300 million neurons.) This was the first research showing that the Berger rhythm could be driven beyond its natural frequency by photic driving.By 1940, James Toman performed a number of simple studies into the effects of flicker stimulation on the flicker potentials of the brain. He noted several observations and his work provided the foundation to understanding the physiological properties of BWE. He studied and recorded the percentage of time that alpha was produced with the eyes closed and the range that BWE or photic driving could be achieved above and below one's natural alpha (where BWE occurs best). Toman confirmed the work of Loomis, Harvey and Hobart (1936)

which showed that people with strong alpha rhythms had a poor range of entrainment and those with little or no alpha rhythms could be entrained to a wider range of frequencies. Toman noted the BWE effects of the percentage of "on time" (duty cycle) of the stimulus and its effect on the visual evoked response. Toman also noted the importance of stimulating the eyes with a large, evenly illuminated visual field. Lastly, he observed that the cerebral frequency of stimulation seemed to maintain itself for a period of time following the end of flicker stimulation and he ypothesized that this was due to the mutual interaction of neurons. Toman also noted that stimulating in a wide, uniform visual field produced the best photic driving. Refer to Chapter 7 - *Rules of Brainwave Entrainment* for more details of Toman's work. During the 1940's, animal BWE research was conducted by the brain researchers,

Adrian and Bartley by implanting electrodes into the brains of animals. He concluded that the system of neurons which generate the alpha rhythm is different from those involved in the evoked response (BWE). Dempsey and Morison (1942) observed the "repetitive sensory response" in response to stimulation of the sciatic nerve (the nerve going to the legs). This proved that tactile stimulation also produced BWE. In 1946, Walter, Dovey and Shipton introduced the electronic stroboscope to provide highly accurate information about the latency of the evoked response. They also noted some perceived psychological effects. They exposed thousands of subjects to intense flickering white light, who all reported sensations of pattern, movement and color. The descriptions varied greatly from subject to subject. For some, the impressions were particularly intense only at certain frequencies. Several subjects who had full normal color vision with steady light showed "color blind" responses (such as the red-green response seen on a color card) usually at frequencies between five and ten Hz. In 1959, Dr. William Kroger and Sidney Schneider reported on the unusual effects of the rhythmic flashing of the dot on radar screens of ships and submarines. On several occasions the radar operators readily entered into a relaxed state of mind and others fell into deep hypnotic states while watching signals on the radar screen. They believed that these men were being visually stimulated at a frequency near the frequency the brain was producing. This prompted the construction of the "Brain Wave Synchronizer" by Sidney Schneider of the Schneider Instrument Company. Kroger stated that between 1957 and 1958, the Synchronizer had been tested on approximately 2,500 patients and subjects, some in groups and some individually. Of the 200 female subjects, they received prenatal training for childbirth under hypnosis by Dr. Kroger at the Edgewater Hospital in Chicago. Whenever the Brain Wave Synchronizer was used to induce hypnosis during the group training program, considerable time was saved. Kroger and Schneider's study also determined the percentage of subjects who entered a hypnotic state based on their level of expectation and experience with hypnosis.

In 1959, John Barrow, MD, from MIT, studied the effects of random photic stimulation on the EEG of his subjects. Barrow confirmed Bartley's earlier observations. He hypothesized that the "after-discharge," or sustained rhythm of the entrainment frequency is brought about by the brain's system which also generates the alpha rhythm and not the system responsible for the visual evoked response.

Also in 1959, Robert Ellingson, PhD, of the Nebraska Psychiatric Institute, examined the effects of photic stimulation on 700 babies. In his study, he placed a strobe light ten inches from the babies' faces. He noted that premature babies had response times (latencies) as long as 220 milliseconds (msec). Babies born at term had latencies of about 190 msec. These fell to nearly 100 msec by 15 weeks of age with very little change into adulthood. The amplitude of the evoked response in the babies was best when their eyes were closed and probably sleeping.

In 1959, Chatrian and his colleagues at the Rochester State Hospital, utilized depth-electrode recordings to observe the brain's response to clicks in either or both ears. They observed an auditory evoked response to clicks at three hertz (Hz) or less. At click rates of 15 Hz, they observed definite auditory driving. They also noted a 10% decrease in response when only the opposite ear was stimulated.

There was an 85% reduction in driving in the brain on the same side as the stimulus. This study definitely showed that most of the auditory driving was on the opposite side of the stimulus.

In 1963, M.S. Sadove, MD, Director of Anaesthesiology at the University of Illinois, reported that by using the Brain Wave Synchronizer, photic stimulation put over 90% of his patients into a trance, which reduced the amount of anaesthesia needed for surgery. Sadove believed that some day many of our drugs may be forgotten, but that there would always be a human need for hypnosis.

In 1963, C. Lewerenz, the editor of Hypnosis Quarterly describes his experience of a live demonstration of the Brain Wave Synchronizer by its developer, Sidney Schneider. He describes the setting of the Brain Wave Synchronizer facing the audience with a subject placed in front of it. Mr. Schneider conducted a six minute induction of the subject while the synchronizer was producing photic stimulation.

At the end of his induction, the subject and four others in the first row near the synchronizer became deeply hypnotized. Of those four, one person was considered to be completely non-hypnotizable, but under the influence of the synchronizer, he ended up in a deep stage-four state of hypnosis.

In 1964, Van der Tweel, a researcher at the University of Amsterdam, noted that rapid on/off transitions in the visual stimulus produced harmonics of the fundamental frequency of the stimulator as could be shown in spectral analysis.

His paper demonstrated the effects of sine-wave stimulation at various depths of modulation. He reported that, in some individuals, a modulation depth too low for one's subjective awareness also produced a cortical evoked response. He also verified some of Toman's work regarding the span of frequencies that could generate photic driving.

In 1966, Bernard Margolis, DDS, published an article using the Brain Wave Synchronizer to induce hypnosis during dental procedures. He noted several advantages of BWE over the conventional dental practices. Most important, the patients required less anaesthesia, had greater control of gagging, less bleeding, and their fear and anxiety was sharply reduced during the dental procedure.

In 1972, Richard Townsend developed a laboratory device which produced sine-wave modulation of the lamps in that the lamps were turned on and off slowly of light instead of the instantaneous flashes of light that conventional BWE devices were using. He presented the problems with instantaneous on/off flashing and supported Van der Tweel's findings that sine-wave modulation of the lamps eliminated the second harmonic of brainwave EEG activity. This may be the first record of a BWE system using "goggles" with light bulbs in them.Gerald Oster published an excellent article on the effects of binaural beats (BB) in Scientific American (1973). He showed the difference between monaural beats (MB) and binaural beats and they are perceived with respect to each other and when mixed with other tones. He demonstrated that binaural beats produced much smaller evoked potentials than that of monaural beats and concluded that binaural beats have almost no BWE value but could be beneficial in diagnosing certain neurological disorders such as Parkinson's Disease. Also in 1973, Jo Ann Kinney and her colleagues, at the Naval Submarine Research Laboratory in Connecticut, developed a mathematical model to determine the visual evoked response (VER) at frequencies of 4 Hz and higher. They concluded that the VER was the linear addition of a single VER and its tail, based on when the next flash would occur. They demonstrated their mathematical model with a fair degree of accuracy. In 1975, Williams and West, at the University Hospital in Wales, Great Britain, studied the effects of BWE on meditators and non-meditators. They noted that the meditators entered a BWE induced meditative state more quickly than the non-meditators, and following BWE, were less drowsy than the non-meditators. They hypothesized that these results may be due to the fact that alpha induction was related to the neurological changes resulting from the attention skills learned by the meditators.

In 1976, Takahashi and Tsukahara, at the Tohoku University School of Medicine in Japan, published their findings on the influence of color on the photo-convulsive response (PCR). They measured the effects of white, red, yellow, blue and green photic-stimulation on the PCR. They noted that the color red at a frequency of 15 Hz was most likely to cause a PCR. They also noted that a PCR elicited by red stimulation could be inhibited by introducing low levels of blue light at the same time. In the 1980's, Norman Shealy and his colleagues studied the effects of 30 minute sessions of 10 Hz photic stimulation. They measured blood levels of serotonin, endorphin, melatonin and norepinephrine. They noted a drop in the daytime level of melatonin and substantial increases in the levels of endorphin, serotonin and norepinephrine. Shealy's group suggested that an increase in beta endorphins is associated with a sense of well being and decreased pain. The increase in norepinephrine and serotonin and the decrease in melatonin suggested an increase in alertness. They also noted that people had better relaxation responses to AVE than from using self hypnosis, cranio-electro stimulation or "Hemi-Sync" tapes.

During the mid 1980's, Glen Solomon, MD, used a most unusual BWE approach for reducing tension headache using a Dzidra Glass. The Dzidra Glass is consisted of two liquid crystals which cast shadows on the eyes momentarily blocking light from an external light source. The maximum "flash" frequency was 3 Hz. Almost all of the muscle tension headache subjects reported complete relief of their symptoms. None of the sinusitis or migraine subjects reported any relief.Although research on the subjective effects of audio stimulation had continued, it received little attention. This was probably because the visual evoked response
could be reliably observed and recorded which was useful in providing a better understanding of the brain. This interest may also have been a result of the fascination with the visual hallucinations associated with BWE.

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In 1981, Arturo Manns, et. al. published a study showing the effectiveness of "isochronic" (evenly-spaced) tones. They examined several subjects experiencing facial pain and jaw tension (TMJ dysfunction). The subjects were given isochronic tones for 15 minutes, followed by 15 minutes of EMG biofeedback (sounds of muscle electrical discharge) on masseter muscle tension, then isochronic tones combined with the biofeedback. When the subjects used isochronic tone stimulation, they experienced deeper muscular relaxation than when they practised relaxation with biofeedback. The simultaneous use of both biofeedback and isochronic tones produced the deepest relaxation. There was an overall improvement in their mandibular movements. Facial pain, insomnia and emotional tension were reduced considerably.

During the 1980's, the flood of so many different BWE devices into the market prompted a case study in Neurology by Ruuskanen-Uoti and Salmi. They documented a case of a woman with no history of seizures, who experienced a photically-induced seizure while using an "Inner Quest" brainwave synchronizer that used red LEDs. After the seizure, the woman continued to have a normal EEG. She experienced no unusual side effects and continued her life as usual.

But AVE devices aren't the only products causing seizures. Children playing video games were found to be experiencing seizures, as well. A 1983 article in the Archives of Neurology by Glista and his colleagues discussed two cases of teenage boys developing seizures while playing video games. They both had normal EEGs with no history of seizures or continued problems after they quit playing video games.

In 1986, Joseph Glicksohn at the University of Tel Aviv studied the effects of photic driving on generating altered states of consciousness (ASC). Glicksohn concluded that (1) if a driving response is not observed, and ASC will not be experienced; (2) visual imagery is not necessary to produce and ASC; and (3) the increase in alpha activity from photic driving may bring about an ASC, visual imagery or both. In 1988, D. Siever and Dr. N. Thomas, of the University of Alberta, published research showing that persons with TMJ or chiropractic and muscle tension pain would actually unconsciously increase their muscle tension when asked to relax.

This effect is known as ***dysponetic activity*** or ***bracing habits***. When given BWE stimulation using the DAVID 1, developed by Comptronic Devices Limited, their muscles relaxed deeply and finger temperature increased, suggesting that subjects entered a meditative or alpha state. Refer to *Appendix A*.

In 1989, D. J. Anderson, of Queen Elizabeth Military Hospital, performed work on the treatment of migraine headaches. All seven subjects in the experiment experienced one or more migraine related symptoms such as: aura, photophobia or periodic vomiting. No subject had satisfactory results using drugs. The subjects were instructed to use BWE at the onset of a migraine. Of the 50 migraines recorded, 49 were rated by the subjects as being helped and 36 of the 49 were rated as being "stopped." Pre-treatment migraines lasted an average of six hours while post-treatment migraines lasted an average of 35 minutes.

In about 1990, the psychologists, Brucato and Abascal, at Mindworks International in Miami, conducted a study with the Metro-Dade Police department. They noted a reduction in the heart rate, and muscle tension. On the psychometric tests, the police showed an improvement in their coping ability and a reduction in their overall (state) and present (trait) anxiety.

In 1992, Fred Boersma, PhD, and Constance Gagnon, at the University of Alberta, published their study using DAVID Paradise devices to treat chronic pain involving three back injury subjects. They measured pain, medication used, suicide ideation, anxiety, self-esteem, hopefulness, coping ability and family stability. The results were very encouraging. Apparently, one person was taking up to 35 extra-strength Tylenol with codeine per day before treatment and experiencing a subjective pain level of "7" out of "9". After one year of BWE, he was down to two or less "Tylenol" daily and experienced a subjective pain level of "2." Refer to

*Appendix B*.

In 1992, Siever conducted a study to determine the effectiveness of BWE on jaw relaxation while the jaw was opened. Siever noticed that dentists were sometimes causing damage to patients' Temporo-Mandibular Joints (TMJ) as a result of having the patients' jaws opened wide for extended periods of time during routine dental treatments. This TMJ Dysfunction can cause chronic and sometimes debilitating pain. And for many, it remains undetected and incurable. During the study, Siever measured masseter muscle tension and found it to be high during wide openings. When the jaw was opened wide while using a DAVID *Paradise* at an alpha frequency, the muscle relaxed shortly after opening and remained relaxed for the duration of the wide opening. This showed that BWE would reduce the risk of developing a TMJ problem during dental procedures. A unique 1992 paper by Sappey-Mariner and his colleagues from the Department of Veterans Affairs Medical Centre in California on the effects of photic stimulation on cerebral blood flow and glucose metabolism as observed with magnetic resonance imaging. They used two hertz photic stimulation and observed increased cerebral blood flow. They also observed that the glucose uptake increased much more than the oxygen consumption, suggesting selective activation of anaerobic glycolysis (burning of glucose). They don't conclude if *anaerobic* (lactate) conversation of glucose is better or worse than *aerobic*conversation of glucose, only that it wasn't expected.

In 1993, Morse and Chow published the results of the effects of using a BWE device called the Shealy "Relaxmate" during endodontic (root-canal) procedures. Galvanic skin response, heart rate and anxiety levels were recorded during all aspects of the root-canal. Data was collected from three groups (1) a control group (no stimulation); (2) white light BWE only; and (3) white light BWE and music. The study concluded that using BWE during a root-canal procedure was an effective method of maintaining relaxation.

Refer to *Appendix C*.

In 1993, Russell and Carter conducted a blind study on a group of learning disabled boys between 8 and 12 years of age. The children were given 40 sessions of AVE stimulation at 10 Hz and 18 Hz. The children showed an average IQ increase of 8 points on the Raven IQ test. They also showed significant improvements (<.01) in memory, reading and spelling.

In 1994, Siever conducted an informal pilot study of elementary-school-aged children with ADD. All of the children were rated by their parents, using a modified Conners rating scale, for changes in behavior and study habits. In all instances, the parents reported improvments on all of the questions asked in the study.

In 1995, Rosenfeld, Reinhart, and Srivastava at Northwestern University collected their research on BWE using red LED photic stimulation. They stimulated in the alpha band at 10 Hz and in the beta band at 22 Hz. They found that some persons entrained to the stimulus and others didn't. Whether or not the participants entrained depended on their natural baseline alpha and beta activity.

In 1995 and 1996, at the annual conferences of the Association for Applied Psychophysiology and Biofeedback, David Noton, PhD, presented the findings of the pre-menstrual syndrome study of Duncan Anderson from the Postgraduate Medical School in London. They note that PMS is a "slow brainwave" disorder and belongs in the group of disorders including Attention Deficit Disorder, Chronic Fatigue Syndrome, and Minor Head Injury. "Of the seventeen women who completed the study, 76% experienced a greater than 50% reduction in their PMS symptoms." Noton concluded that these results reflect that BWE may be acting mostly by increasing cerebral blood flow and not so much by simply speeding up the brainwaves. In 1996, Leonard, Telch and Harrington, at the University of Texas observed that the DAVID 1 could easily and effectively generate disassociative states. The symptoms of a disassociative disorder are generally divided into five categories: *amnesia, depersonalization, derealization, absorption, or imaginative involvement* (*Carlson & Putnam, 1993*).

It has been suggested that one approach to treating people with disassociative disorders would be to induce a dissociative state in a clinical setting and teach the client to control it (Leonard et al). To determine if disassociative states could, in fact, be induced in a laboratory and to determine which method of disassociation induction would produce the most disassociative symptomatology, Leonard, Telch & Harrington (1990, not published) sampled 78 college students and assigned them to one of two groups (high disassociators and low disassociators) based on their scores on the Disassociative Experiences Scale (Bernstein & Putnam, 1986). All of the participants were given three induction conditions: in the first condition participants stared at a two-inch dot on the wall; in the second condition participants received audio and visual stimulation at 12 Hz on the DAVID 1; in the third condition participants wore the DAVID 1 equipment, but no light or sound was emitted. The dependent measure was the Acute Disassociation Index (ADI; developed specifically for this study). The ADI was administered immediately before and after each experimental condition.

These researchers found that it is indeed possible to induce disassociation, in a non-clinical population, in a laboratory. They also determined that the DAVID 1 produced the most disassociative symptomatology. In 1996, Russell reported on the effectiveness of using visual and auditory stimulation in helphing rehabilitate a four-year postaneurysm hemiplegic. Improvements were noted in central tone and truncal motor control and both sensory and motor improvements in the hands and feet including fine motor improvements for drawing and writing. In light of these improvements, Russell speculated that entrainment could be stimulating dendritic growth. Russell's study supports the results we have observed in people with brain injury. This promises to be an exciting area for AVE in the future and deserves a lot more research and study.

In 1997, Leonard, Telch and Harrington conducted another study - this time to observe the impact of the DAVID *Paradise* on anxiety produced with dissociation. They observed that after 12 minutes of Hemistep TM stimulation, all 101 participants had a reduction in their dissociation anxiety sensitivity and heart rate.

Contrary to their hypothesis, they found that anxiety sensitivity proved to be a better predictor of challenge and dissociation-induced anxiety than dissociation sensitivity. Also in 1997, Siever and Twittey completed a preliminary study in treating chronic pain using the DAVID *Paradise*. Of the twelve participants who completed the study, most had pain due to fibromyalgia, lupus, arthritis, TMJ Dysfunction and/or motor vehicle accidents. After eight weeks of treatment, the Visual Analogue Pain scale showed a reduction in pain to the $p<0.005$ level and the Beck Depression Index showed improvements to the $p<0.05$ level. This study shows the benefit of using BWE in the treatment of chronic pain. Refer to Appendix D. A subsequent study is currently in process.

For 10 weeks in 1998, Michael Joyce stimulated 30 Attention Deficit Disorder and eight reading challenged, primary school children with BWE. He used a specially designed BWE session that stimulated a beta frequency into the left hemisphere of the brain and stimulated 12 Hz into the right side of the brain, by using a patented field-independent eyeset from Comptronic Devices Limited. Joyce was able to treat 10 children at a time using a multiple stimulation system also from Comptronic. He observed substantial improvements in attention and reaction time and a reduction in impulsivity and variability. In the reading group he observed an 18 month improvement in instructional reading level and a 1/2 year advancement in grade level.

## *History of Harvard's Lower Level*

From the time of completion, for more than six decades, utilization of Memorial Hall's lower level was limited to kitchen, storage and mechanical space and restrooms. In 1940, the area beneath Sanders theatre was rebuilt to house a new Psycho Acoustic Laboratory which did secret research on noise reduction and communications in combat vehicles and aircraft. The lower level of Memorial Hall served as the locale for B.F. Skinner's early experiments with conditioned behavior, and early sonar experimentation. In 1946, the rest of the lower level was renovated to provide laboratories, an animal room, classrooms, a lecture hall, and a library for the newly reorganized psychology department, which remained there until 1964 when William James Hall was completed. Thereafter, until the opening of Loker Commons in 1996, approximately twenty student organizations and administrative units maintained offices under the hall while WHRB operated in the east end of the lower level.

## George A. Miller

George Armitage Miller was born February 3, 1920, in Charleston, West Virginia. In 1940 he received a Bachelor of Arts degree from the University of Alabama and in 1946 he received his Ph.D. in **Psychology** from Harvard University.

At Harvard, during and after World War II, he studied speech production and **perception**. In 1948 **C**. E. Shannon's mathematical theory of **communication** inspired a series of experiments measuring how far a listener's expectations influence his perceptions. Miller summarized that work in 1951 in "**Language** and **Communication**," a text that helped to establish psycholinguistics as an independent field of **research** in **psychology**. He subsequently tried to extend Shannon's measure of **information** to explain short-term **memory**, work that resulted in a widely quoted (and often misquoted) paper, "The Magical **Number** Seven, Plus or Minus Two."

Miller's attempts to estimate the amount of **information** per word in conversational speech led him to **Noam Chomsky**, who showed him how the sequential predictability of speech follows from adherence to grammatical, not probabilistic, rules. The next decade was spent testing psychological implications of Chomsky's theories. Some of those ideas found **expression** in 1960 in "Plans and the **Structure** of Behavior," a book written jointly with E. Galanter and K. Pribram. In 1960 Miller was co-founder, along with J. S. Bruner, of the Harvard Center for Cognitive Studies. On the basis of these activities, Miller is generally considered one of the fathers of modern cognitive **psychology**. In 1962 he was elected to the National Academy of **Science**.

Miller visited The Rockefeller University in New York in 1967, and in 1968 decided to stay there as Professor of Experimental **Psychology**. In 1969 he was elected President of the American Psychological Association. By then his **research** interests had shifted from **grammar** to lexicon, and in 1976 "**Language** and **Perception**," written with P. N. Johnson-Laird, presented a detailed **hypothesis** about the way lexical **information** is stored in a person's long-term **memory**. Miller attempted to test some aspects of the **hypothesis** with studies of the development of **language** in young children; that project was summarized in 1977 in "Spontaneous Apprentices: Children and **Language**." During this time, he served as a consultant to the Sloan Foundation in the **program** that helped to create the new field of cognitive **science**.

In 1979 Miller moved to Princeton University, where he is now James S. McDonnell Distinguished University Professor of **Psychology**, Emeritus. In 1986, in collaboration with Gilbert Harman, he established the Princeton Cognitive **Science** Laboratory. In 1990 he wrote "The **Science** of Words," which won the William James Book Award from Division 1 of the American Psychological Association. In 1991 he was awarded the National Medal of **Science** by President Bush.

From 1989 to 1994 Miller served as **Program** Director of the McDonnell-Pew **Program** in Cognitive **Neuroscience**. His own **research** has produced WordNet, a lexical **database** that is widely used by computational linguists as part of **natural language** processing systems; Miller's current interest is to use WordNet to identify the intended senses of polysemous words on the basis of their contexts of use.

# Ambiguous Words

by **George A. Miller**

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Understanding how humans process the subtlety of language is crucial to recreating the ability to understand natural language in computers. Dr. George Miller investigates the cognitive processes of resolving the vagueness in human language.

"If I accomplish nothing else in this story, I hope I will persuade you that human language is so vague and ambiguous that only a very clever brain could possibly understand it."

Most people are unaware how vague and ambiguous human languages really are, so they are disappointed when computers fail to understand linguistic communication. They are surprised when an information retrieval system gives responses that seem unrelated to their search word. They can't understand why question answering should be so hard for a machine. And they are really upset by the low quality of machine translations. As communication grows increasingly important, the computer's linguistic limitations become increasingly frustrating. As more and more documents are stored in computers, the machines' inability to understand the information they hold restricts their usefulness to both business and government. Computers are not to blame for this situation. Language itself is at the root of it.

I am the kind of psychologist who studies the basic cognitive processes of the human mind, the cognitive processes that support sensation and perception, learning and memory, problem solving and reasoning, and especially those characteristically human cognitive processes that support speech and language. As a psychologist, I say that I study the mind, but my private conceit is that I really study the brain, for surely it is the brain that performs all those processes that enable us to develop and maintain our knowledge of the world and of ourselves.

If I accomplish nothing else in this story, I hope I will persuade you that human language is so vague and ambiguous that only a very clever brain could possibly understand it.

**The Nature of the Problem**

The problem begins with words, which I shall take to be the smallest meaningful units of language. I am going to assume that we already understand how words are recognized as units in the flow of spoken sound. Speech recognition is still a challenging topic for research, but let's assume that this perceptual part of the process of understanding speech has been solved--that we already have an adequate theory of how individual words are recognized.

The first question is how we assign meaning to the spoken words. To take one example from thousands that are available, consider the noun "triangle." As philosophers pointed out long ago, the noun "triangle" is hopelessly vague. Without further explanation we don't know whether the triangle is acute or obtuse, oblique or right-angled, scalene or isosceles or equilateral, and we have no idea what color it is or where it is or how big it is or how it is oriented. So the word "triangle"' is referentially vague.

Moreover, the noun "triangle" is ambiguous, in the sense that it can be used to express more than one meaning. The word "triangle" can refer either to a three-sided polygon or to a musical percussion instrument or to a social situation involving three parties. If you were to hear someone say, "It's a good triangle," you could not be sure which meaning of "triangle" the speaker had in mind. So the noun "triangle" is semantically ambiguous.

Of course, "triangle" is seldom ambiguous when it occurs as part of an on-going conversation. It has several possible meanings, but the intended meaning is almost always clear from the context in which the word is used. The fact that it has several meanings makes it potentially ambiguous. But there is a difference between multiplicity of meaning and ambiguity. To keep this distinction clear, I am going to use a technical term. I am going to say that "triangle" is polysemantic: poly--meaning "many"--and semantic--meaning

"meaning." A polysemantic word can have many meanings, yet not be ambiguous when used in an appropriate context.

The point, however, is that words, the basic building blocks of meaningful language, are extremely slippery items and must be handled with great care. Indeed, some people think that words can be indefinitely polysemantic--that a word can express different meanings every time it is used. They point to the noun "container." If someone says he has a container of apples, you would probably understand "container" to mean "basket." But if he says he has a container of water, you would probably understand "container" to mean "glass" or "bottle." And if he says he has a container of groceries, you would probably understand "container" to mean "bag" or "box." According to this argument, every time "container" occurs in a different environment, it expresses a different meaning. Hence, unlimited polysemy.

Things are bad, but they are not that bad. If, like Humpty Dumpty, our words could mean whatever we wanted them to mean, we would not have much luck using words to communicate. The trouble with this argument for unlimited polysemy is that it confuses meaning and reference. The word "container," like the word "triangle," is referentially vague--it can be used to refer to any one of a great variety of containers. But its meaning is, roughly, "an object capable of holding material for storage or transport," and a great variety of objects, from spoons to boxcars, satisfy that definition.

Now, I can understand how people tolerate referential vagueness. It is a matter of common courtesy. A polite communicator gives the audience as much information as is needed, but not all that is available. Language evolved for social collaboration and once collaboration is achieved, language has done its job. Imagine telling someone to come here and then getting into an argument about precisely where "here" is--just there, or maybe an inch closer, or a tiny bit to the left? The adverb "here" is referentially vague, but that doesn't cause trouble; it would only cause trouble if it were *not* vague. So I understand vagueness.

What I don't understand is how we tolerate semantic ambiguity. Yet we seem to thrive on it. As a psychologist, I find it very interesting that most people are not even aware how ambiguous words can be. People are so skilled at resolving potential ambiguities that they don't realize that they are doing it. The realization hits you, however, when you try to develop a theory of how people do it. People use the context, of course, but precisely what context is and how people use it need to be explained.

## How Computers Resolve Ambiguity

There have been many attempts to enable computers to deal with ambiguity and I want to describe them briefly. If nothing else, it will help clarify what the problem is.

One of the benefits that modern computers provide for cognitive scientists is to give us a tool for sharpening and testing our theories. Many behavioral scientists believe that a computational theory is a first step toward a neuro-physiological theory. If we really understood how people cope with semantic ambiguity, we should be able to program a computer to do the same thing. But, so far, our attempts to devise such a theory and explain it to a computer have been only marginally successful.

The problem of ambiguity comes up almost everywhere that computers try to cope with human language. In information retrieval, the computer often retrieves information about alternative meanings of the search terms, meanings that we had no interest in. In machine translation, the different meanings of an English word may be expressed by very different words in the target language, so it is important to determine which meaning of the English word the author intended--and that is what a computer has trouble doing. Over and over, attempts to use computers to process human language have been frustrated by the computer's limited ability to deal with polysemy.

I will illustrate what a computer faces with a well- known excerpt from Robert Frost's poem, "Stopping by Woods on a Snowy Evening":

The woods are lovely, dark and deep, But I have promises to keep And miles to go before I sleep, And miles to go before I sleep."

To make my illustration as simple as possible, I will use only the couplet, `"But I have promises to keep, and miles to go before I sleep." Let's see what a computer might make of these thirteen words.

Imagine that a computer has been given all of the information about the meanings of English words that can be found in a good collegiate dictionary. So the computer will begin by looking up the word `But' and will discover that the dictionary provides 11 different meanings. Next, the computer looks up `I' and finds three meanings. On the assumption that the meaning of word combinations depends on the meanings of the individual words, the computer concludes that the two initial words, `But I,' must have 3 x 11 = 33 possible compound meanings.

Proceeding in this manner, the computer finds that the word `have' can be used to express 16 different meanings, so the number of possible compound meanings of `But I have' is 3 x 11 x 16 = 528. And 7 meanings of `promise' brings the number of possible meanings to 3,696.

| | | |
|---|---|---|
| But | 11 | 11 |
| I | 3 | 33 |
| have | 16 | 528 |
| promises | 7 | 3696 |
| to | 21 | 77616 |
| keep | 17 | 1319472 |
| And | 5 | 6597360 |
| miles | 5 | 32986800 |
| to | 21 | 692722800 |
| go | 29 | 20088961200 |
| before | 10 | 200889612000 |
| I | 3 | 602668836000 |
| sleep | 6 | 3616013016000 |

By the time the computer finishes looking up all 13 of the words in this couplet, the product is 3,616,013,016,000 (three trillion six hundred sixteen billion thirteen million and sixteen thousand) possible compound meanings. This works out to an average of 9.247 meanings per word.

Put it this way: Imagine the computer is running a maze and that at each choice point there are 9 alternative ways to continue. In order to run the maze, the computer must make the correct choice every time--it must find the one correct path out of three trillion possibilities. Computers find this maze very difficult, but you and I sail through it without even noticing that there are any alternatives.

Of course, this couplet is short and the words are as plain and familiar as only Robert Frost could make them. And that is part of the trouble--the words are so plain and familiar. It is a perverse feature of human languages that the words used most frequently tend to be the most polysemantic. If we took a passage filled with obscure but unambiguous technical terms, the branching would be far less. But it would still not be zero.

So far I have assumed that the computer has only a dictionary. Let's give the computer some capacity for syntactic analysis. Let's assume--which is not unrealistic--that the little words ("but," "I," "to," "and," "before"--the so-called "closed-class" words) are there primarily as markers of grammatical structure, so a good syntactic analyzer will take care of them. The only thing tricky about the grammar here is that "have to" is a kind of modal auxiliary verb, synonymous with "must"--"have to keep promises" and "have to go miles." The syntactic analyzer will also tell us that in this passage "promise" is a noun and "keep" is a transitive verb, and so on. Armed with this information, the computer can now make better use of its dictionary.

| | | | |
|---|---|---|---|
| But | conjunction | 1 | 1 |
| I | pronoun | 1 | 1 |
| have (t) | modal verb | 1 | 1 |
| promises | plural noun | 3 | 3 |
| keep | transitive verb | 14 | 42 |
| and | conjunction | 1 | 42 |
| miles | plural noun | 5 | 210 |
| go | intransitive verb | 23 | 4830 |
| before | conjunction | 1 | 4830 |
| I | pronoun | 1 | 4830 |
| sleep | intransitive verb | 2 | 9660 |

Geometric Mean = 2.026 senses/word

When the ambiguity calculation is repeated using only the meanings possible for the given syntactic structure, the product comes down to 9,660 possible meanings. Of course, this only looks like progress because three trillion was so absurd. But the computer still has to find the right meaning among a set of 9,660 possibilities.

The geometric mean per word is now 2.026 for this brief passage. If longer passages also average about two meanings per word, and if we were to guess at random which meaning was intended, we should be right about half the time. Not good enough.

The problem is even worse in other languages. The polysemy of words in spoken Chinese is far greater than it is in spoken English. Even French is more polysemantic than English.

The truth is that polysemy just doesn't bother people. While a computer is struggling with its 9,660 alternatives, you and I select the correct interpretation in the twinkle of an eye. And we don't even realize that we have done something remarkable.

But maybe language isn't as ambiguous as this example has made it seem. It is true that common words usually have several different meanings, but not all of those meanings are used equally often. Some meanings of polysemantic words are used much more frequently than others are. For example, the word "horse" can refer to an animal, or it can refer to a gymnastic apparatus, or it can refer to a sawhorse, or it can refer to heroin, but if you sample usage in books and newspapers and magazines, you will find that the noun "horse" refers to an animal 100 times as often as it refers to anything else.

So maybe the computer can use statistics to solve this problem. What would happen if the computer always chose the most frequent meaning at every choice point in the maze?

My colleagues and I at Princeton University actually explored this possibility a few years ago. It isn't easy, because good statistics about the relative frequencies of different meanings of polysemantic words do not exist. But we determined the context-appropriate meaning of every noun, verb, adjective, and adverb in some 104 passages (over 200,000 runningwords) of the Brown Corpus, which is a collection of 1,000,000 running words said to be representative of American prose writing. That gave us data on the relative frequencies of the different meanings of the most common polysemantic words.Then we went through this semantically disambiguated text and looked to see how often the context-appropriate meaning was the most frequent one. The results are shown in this graph (Figure 1).

Looking only at the polysemantic words, the most frequent meaning was correct just 56 percent of the time. Of course, many of the nouns, verbs, adjectives, and adverbs in the Brown Corpus are monosemantic (in which case the most frequent meaning is the only meaning). So if we look at all the words together, the most frequent meaning is the correct one just 67 percent of the time.

When we give a computer more information, it does a better job. But understanding the wrong meaning for a third of the words is still not good enough. So far we have given the computer information about the words' possible meanings, about the words' syntactic role, and about the words' most frequent usages. What more could we give it?

I have already said that people use context to determine the appropriate meanings of individual words, but so far we have not given the computer any information about context. Context can be linguistic--the other words that occur before and after a polysemantic word--or it can be situational--the situation in which the linguistic interaction is occurring. The linguistic context is the easiest to deal with, so let's start with that.

One way to explore linguistic context is to collect a large sample of excerpts that contain a particular target word and to classify those excerpts manually according to which meaning of the word was intended. This manually disambiguated collection of contexts can then serve as training material for a computer.

My colleagues Claudia Leacock and Martin Chodorow and I programmed a computer to look for certain features of the context, then exposed it to a large sample of manually disambiguated contexts, and finally tested how well the computer could distinguish among a new set of manually disambiguated contexts. One program looked to see what nouns, verbs, adjectives, and adverbs occurred within plus-or-minus 50 words of the target word; we called that topical context. Another program looked at the exact order of words plus-or-minus two words on either side of the target word; we called that local context. And finally, we combined the output of the two programs in the hope that what one program missed, the other might catch.

The results for three different target words are shown in the following slides, where the percent correct is plotted as a function of the number of training contexts provided. In all cases, the performance improved as the number of training contexts increased.

First (Figure 2), the program was trained to distinguish four different meanings of the verb "serve." As you can see, topical context was not very useful for this verb; the best results were obtained with local context. Combining them was only a little better than local context alone. Second (Figure 3), the program was trained to distinguish three different meanings of the adjective "hard." As in the case of the verb, local context was much more useful than topical context, and combining them was no help.

Finally, the program was trained to distinguish six different meanings of the noun "line." For this noun, the topical context was more useful than the local, and there was some advantage to combining them (Figure 4).

It is possible, of course--indeed, I think it likely--that we did not choose the correct properties of the context to train on, but in an international competition between programs that try to do this kind of thing [see Senseval-1 at http://www.itri.brighton.ac.uk/events/senseval/], ours was as good as any other. And we are only 85 percent correct at best, and we know how to do that well for only a few of the thousands of polysemantic English words. It's still not nearly good enough. If you misunderstood the meaning of every seventh important word, you would not find language very useful.

The reality is there does not exist today a large-scale, operational computer system for determining the intended meanings of words in discourse. But solving the polysemy problem is so important that we can be confident that efforts will continue and that future systems will continue to improve. If you were to ask me what more could be done, I would suggest that we still have a lot to learn about contexts in general and linguistic contexts in particular. If I were feeling reckless, I might even suggest that understanding contexts better is critical for the future of processing linguistic messages by computer.

An Internet-user knows that information technology can now provide large amounts of raw information at the touch of a button. Unfortunately, most of it is irrelevant and searching through it to find what we really wanted requires great patience and peace of mind. My reckless claim would be that in addition to information technology, we need context technology. The future belongs to those who discover how to help users better understand the information that is provided. And the only way I know to do that is provide contexts to make the information meaningful.

## How People Resolve Ambiguity

Enough about computers. Since people recognize intended meanings so easily, maybe computational linguists are missing something. So, what do we know about how people deal with ambiguous words?

Psychologists have learned a little about how people do it. We know, for example, that when a polysemantic word occurs, more than one meaning can be activated initially, but the context-appropriate meaning can be chosen very rapidly, within half a second. We assume that during that half second or so a meaning is chosen that can be integrated into a mental representation of the on-going discourse.

The nature of that representation of the on-going discourse is still uncertain, but it seems to involve more than just the linguistic context. It involves situational context and general knowledge. Some psychologists believe that the representation of discourse must be "propositional," with many propositions being filled in inferentially from general knowledge, and all of the propositions related by first order logic. A propositional representation of discourse would, of course, be easiest for a computer to simulate.

However, other psychologists maintain that the representation is "imaginal," a mental picture that provides many default values from general knowledge but in which many irrelevant details are missing. Probably both propositions and mental images are involved. In any case, we don't understand the mental representation of discourse well enough to replicate it with computers that are available today.

What we know is that the mental representations that people need in order to understand discourse must be both coherent and plausible.

First, a mental representation must be coherent. That is to say, if you scramble the order of sentences, or take sentences randomly from different sources, the result is not going to be organized around a unifying topic. It will not be coherent. The demand for coherence places many linguistic constraints on discourse. For example, new objects must be introduced with the indefinite article and thereafter referred to with the definite article; pronouns must have some antecedent to refer to; tense, locale and voice must agree, and so on.

And the mental representation must be plausible. If someone says, "Bill won the race from Sam because he had a good coach," it is not plausible to conclude that "he" and "Sam" are coreferential. If told not to play with those boys because they are too rough, only a child would go looking for a smooth one. And if you see a sign in a farmer's field saying "The bull may charge," it is not plausible to think that the bull might charge admission. The demand for plausibility implies that the discourse must conform to general knowledge. That is a strong demand, of course, for general knowledge is boundless. It has been said that there is no fact so small or obscure that it would not disambiguate some polysemantic word.

So we can argue with some confidence that when people encounter a polysemantic word, they quickly select a meaning that can be integrated into a coherent and plausible mental representation of the discourse in which the polysemantic word occurs. The word is truly ambiguous only if two or more meanings satisfy that criterion.

Unfortunately, there is no insurance that the mental representation of the speaker and the mental representation of the listener will coincide. When people misunderstand one another, it is usually because they are working with different mental representations of what is being said, not because they misinterpret polysemantic words. They disagree because they have different ideas about why the speaker uttered the words she did. They disagree about the speaker's pragmatic intentions. When it comes to estimating a speaker's pragmatic intentions, we really do approach something resembling unlimited polysemy, and there is no dictionary of sentence meanings to guide us. But the pragmatics of discourse is a much larger topic than we can pursue here. Suffice it to say that there are many issues that affect the speaker's pragmatic intentions, among them context, personal history, culture and the dynamic of the interaction. It's a vibrant area of research, right now.

The first step is a plausible theory of linguistic context. Knowing the possible meanings of words and the grammatical structure of sentences is necessary, of course, but until we understand how people use context to construct a coherent and plausible mental representation of discourse, we will have no theory of language understanding, neither a computational theory nor a psychological theory. One thing we can say with some assurance, however, is that people are extremely good at using context to resolve potential ambiguities. I believe that this skill in contextualizing is a general cognitive ability, not specific to language, but is involved in many higher cognitive processes. And I also believe that the best way to investigate our remarkable human ability to contextualize is to study ambiguous words.

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# Isochronous burst transmission
Wikipedia Encyclopedia

**Isochronous burst transmission** is a method of data transmission. In a data network where the information-bearer channel rate is higher than the input data signaling rate, transmission is performed by interrupting, at controlled intervals, the data stream being transmitted.

*Note 1:* Isochronous burst transmission enables communication between data terminal equipment (DTE) and data networks that operate at dissimilar data signaling rates, such as when the information-bearer channel rate is higher than the DTE output data signaling rate.

*Note 2:* The binary digits are transferred at the information-bearer channel rate. The transfer is interrupted at intervals in order to produce the required average data signaling rate.

*Note 3:* The interruption is always for an integral number of unit intervals.

*Note 4:* Isochronous burst transmission has particular application where envelopes are being transferred between data circuit terminating equipment (DCE) and only the bytes contained within the envelopes are being transferred between the DCE and the DTE. *Synonyms* **burst isochronous** *(deprecated)*, **interrupted isochronous transmission.**

Source: from Federal Standard 1037C and from MIL-STD-188

Retrieved from "http://en.wikipedia.org/wiki/Isochronous_burst_transmission"

Categories: Radio modulation modes

# Jan Evangelista Purkinje
Wikipedia Encyclopedia.

Jan Evangelista Purkyně (also written Johannes Evangelists Purkinje, 🔊 listen?) (1787 - 1869) was a Czech anatomist, patriot, and physiologist.

He was born in Libochovice, Bohemia on the 17th December 1787. In 1819 he graduated from the University of Prague with a degree in medicine, where he was appointed a Professor of Physiology after writing his doctoral dissertation. Working at the university, he discovered the Purkinje effect, whereby as light intensity decreases red objects seem to fade faster than blue objects of the same brightness. He published two volumes Observations and Experiments Investigating the Physiology of Senses and New Subjective Reports about Vision, which contributed to the emergence of the science of experimental psychology. He created the world's first Department of Physiology at the University of Breslau in Prussia in 1839 and the world's first official physiology laboratory in 1842.

He is best known for his 1837 discovery of Purkinje cells, large neurons with many branching fibres found in the cerebellum. He is also known for his discovery, in 1839 of Purkinje fibres, the fibrous tissue that conducts electrical impulses from the atrioventricular node to all parts of the ventricles of the heart. He also introduced the scientific terms plasma (for the component of blood left when the suspended cells have been removed) and protoplasm (the substance found inside cells). Yet another discovery of his is the Purkinje effect.

Purkinje was the first to use a microtome to make wafer thin slices of tissue for microscopic examination and was among the first to use an improved version of the compound microscope. He described the effects of camphor, opium, belladonna and turpentine on humans in 1829, discovered sweat glands in 1833 and recognised fingerprints as a method of indentification in 1823.
He died at the age of 82 on the 28th July, 1869.
The Masaryk University in Brno, Czech Republic, bore his name from 1960 to 1990, as did the standalone military medical academy in Hradec Kralové (1994 - 2004). Today a university in Ústí nad Labem bears his name: Jan Evangelista Purkyně University in Ustí nad Labem (Univerzita Jana Evangelisty Purkyně v Ústí nad Labem).

# Jean Baptiste Joseph Fourier

Wikipedia Encyclopedia

**Jean Baptiste Joseph Fourier** (March 21, 1768 - May 16, 1830) was a French mathematician and physicist who is best known for initiating the investigation of Fourier series and their application to problems of heat flow. The Fourier transform is also named in his honor.

He was born at Auxerre in the Yonne département of France, the son of a tailor, and was educated by the Benedictines. The commissions in the scientific corps of the army were reserved for those of good birth, and being thus ineligible he accepted a military lectureship on mathematics. He took a prominent part in his own district in promoting the revolution, and was rewarded by an appointment in 1795 in the *École Normale Supérieure*, and subsequently by a chair at the *École Polytechnique*.

Fourier went with Napoleon on his Eastern expedition in 1798, and was made governor of Lower Egypt. Cut off from France by the English fleet, he organized the workshops on which the French army had to rely for their munitions of war. He also contributed several mathematical papers to the Egyptian Institute which Napoleon founded at Cairo, with a view of weakening English influence in the East. After the British victories and the capitulation of the French under General Menou in 1801, Fourier returned to France, and was made prefect of Isère, and it was while there that he made his experiments on the propagation of heat. He moved to Paris in 1816. In 1822 he published his *Théorie analytique de la chaleur*, in which he bases his reasoning on Newton's law of cooling, namely, that the flow of heat between two adjacent molecules is proportional to the extremely small difference of their temperatures. In this work he claims that any functions of a variable, whether continuous or discontinuous, can be expanded in a series of sines of multiples of the variable - this result isn't correct at all. But the fact that some discontinuous functions are the sum of infinite series was a breakthrough. The question of determining when a function is the sum of its Fourier series has been fundamental for centuries. Lagrange had given particular cases of this (false) theorem, and had implied that the method was general, but he had not pursued the subject. Dirichlet was the first to give a satisfactory demonstration of it, with some restrictive conditions.

Fourier left an unfinished work on determinate equations which was edited by Claude Navier, and published in 1831; this contains much original matter, in particular there is a demonstration of Fourier's theorem on the position of the roots of an algebraic equation. Lagrange had shown how the roots of an algebraic equation might be separated by means of another equation whose roots were the squares of the differences of the roots of the original equation. François Budan, in 1807 and 1811, had enunciated the theorem generally known by the name of Fourier, but the demonstration was not altogether satisfactory. Fourier's proof is the same as that usually given in textbooks on the theory of equations. The final solution of the problem was given in 1829 by Jacques Charles François Sturm (1803--1855).

Fourier is also credited with the discovery in his essay in 1824 that gases in the atmosphere might increase the surface temperature of the Earth. This was the effect that would later be called the greenhouse effect. He established the concept of planetary energy balance. That planets obtain energy from number of sources that causes temperature increase. Planets also lose energy by infrared radiation (that Fourier called "chaleur obscure" or "dark heat") with the rate increasing with temperature. Therefore some temperature balance is reached. And atmosphere shifts the balance toward the higher temperatures due to consumption of radiation. Fourier recognized that Earth primarily gets energy from Sun radiation for which atmosphere is transparent and that internal Earth heat doesn't contribute much to the energy balance. However he incorrectly believed that there is a significant contribution of radiation from interplanetary space. Fourier reported on an experiment by M. de Saussure with a black box exposed to the Sun, and in which if thin glass is put on top of the box the temperature inside of the box increases [1]. Infrared radiation was only discovered by Frederick Herschel 25 years later. Fourier understood that rate of infrared radiation increases with temperature but exact form of this dependency Stefan-Boltzmann law (fourth-power law) was only discovered 50 years later.

He died in Paris.

# Purkinje effect

Wikipedia Encyclopedia

The Purkinje effect (sometimes called dark adaptation) is the tendency for the peak sensitivity of the human eye to shift toward the blue end of the spectrum at low illumination levels.

This effect introduces a difference in colour contrast under different levels of illumination. For instance, notice the bright red of geranium flowers against the dull green of their leaves in bright sunlight, and then view the same scene at dusk. The contrast will be reversed, with the petals appearing a dull red against paler green leaves.

The physiological reason for this effect is that the colour-sensitive cones in the retina are most sensitive to yellow light, whereas the rods, which are more light-sensitive but do not distinguish colours (and thus are more important at dusk), respond best to green-blue light. For this reason, we become virtually colour-blind under low levels of illumination, for instance moonlight.

In visual astronomy, it can affect visual estimates of variable stars when using comparison stars of different colours, especially if one of the stars is red.

The effect was discovered by Johannes Evangelista Purkinje (born December 17, 1787 in Libochowitz (Libochovice), Bohemia – died July 28, 1869). Purkinje was a real polymath who would often meditate at dawn, in long walks in the blossomed Bohemian fields. Purkinje saw his favourite flowers (that were red) on a sunny afternoon. But at dawn they certainly looked bluish-red only. He figured that our eyes have not one but two systems adapted to see colours, one for bright overall light intensity, and the other for dusk and dawn.

# Sturm-Liouville theory

Wikipedia Encyclopedia

In mathematics and its applications, a **Sturm-Liouville problem**, named after Charles Francois Sturm (1803-1855) and Joseph Liouville (1809-1882), is a second-order linear differential equation of the form

$$\frac{d}{dx}\left(p(x)\frac{dy}{dx}\right)+q(x)y=\lambda w(x)y, \quad (1)$$

often together with specified boundary values of $y$ and $dy/dx$. The value of $\lambda$ is not specified by the problem; finding the values of $\lambda$ for which there exist solutions satisfying the boundary conditions is part of the problem. The function $w(x)$ is the "weight" or "density" function.

The solutions are eigenfunctions of a Hermitian differential operator in some function space defined by boundary conditions.

**Sturm-Liouville theory** is important in applied mathematics, where S-L problems occur very commonly, particularly when dealing with linear partial differential equations which are separable.

## *Sturm-Liouville theorem*

The **Sturm-Liouville theorem** states:

- The eigenvalues $\lambda_n$ of a regular *(* p(x) *is differentiable,* q(x) *and* w(x) *are continuous,* p(x) > *0 and* q(x) > *0 over the interval )* Sturm-Liouville problem are real and well ordered such that

  $$\lambda_1 < \lambda_2 < \lambda_3 < \ldots < \lambda_n < \ldots \to \infty.$$

- Corresponding to each eigenvalue $\lambda_n$ is a unique eigenfunction $y_n(x)$.
- The eigenfunctions are mutually orthogonal and satisfy the orthogonality relation

  $$\int_a^b y_n(x) y_m(x) w(x) dx = 0, m \neq n$$

  , where $w(x)$ is the weighting function.
- If the set of eigenfunctions satisfy the orthogonality relation

  $$\int_a^b y_n(x) y_m(x) w(x) dx = \delta_{mn}$$

  , then it's said to form an orthonormal set.
- eigenvalues of the Sturm-Liouville problem are given by the Rayleigh quotient:

  $$\lambda_n = \frac{-p y_n(x) y_n'(x)|_a^b + \int_a^b (p y_n'(x)^2 - q y_n(x)^2) dx}{\int_a^b (y_n(x)^2 w(x)) dx}$$

## *Sturm-Liouville form*

The differential equation

$$\frac{d}{dx}\left(p(x)\frac{d}{dx}y(x)\right) + q(x)y(x) = \lambda w(x) y(x)$$

is said to be in Sturm-Liouville form. The function $w$ is known as the weight function. All second-order linear ordinary differential equations can be recast in the form to the left of "=" above by multiplying both sides of the equation by an appropriate "exponential multiplier" (although the same is not true of second-order partial differential equations, or if $y$ is a vector.)

### Examples

The Legendre equation,

$$(1 - x^2)y'' - 2xy' + \nu(\nu + 1)y = 0$$

can easily be put into Sturm-Liouville form, since $D(1-x^2)=-2x$, so, the Legendre equation is equivalent to

$$((1 - x^2)y')' + \nu(\nu + 1)y = 0$$

Less simple is such a differential equation:

$$x^3y'' - xy' + 2y = 0$$

Divide throughout by $x^3$:

$$y'' - \frac{x}{x^3}y' + \frac{2}{x^3}y = 0$$

Multiplying throughout by an integrating factor of

$$e^{\int x/x^3\, dx} = e^{\int 1/x^2\, dx} = e^{-1/x}$$

giving

$$e^{-1/x}y'' + \frac{e^{-1/x}}{x^2}y' + \frac{2e^{-1/x}}{x^3}y = 0$$

which can be easily put into Sturm-Liouville form since

$$De^{-1/x} = \frac{e^{-1/x}}{x^2}$$

so the differential equation is equivalent to

$$(e^{-1/x}y')' + \frac{2e^{-1/x}}{x^3}y = 0$$

In general, given a differential equation

$$P(x)y'' + Q(x)y' + R(x)y = 0$$

dividing by $P(x)$ and then multiply through by the integrating factor of

$$e^{\int Q(x)/P(x)}\, dx$$

and then collect to give the Sturm-Liouville form.

## *Sturm-Liouville differential operators*

The map

$$Lu = \frac{d}{dx}\left(p(x)\frac{du}{dx}\right) + q(x)u$$

can be viewed as a linear operator mapping a function $u$ to another function $Lu$. We may study this linear operator in the context of functional analysis. If we put $w=1$ in equation (1), it can be written as

$$Lu = \lambda u$$

This is precisely the eigenvalue problem; that is, we are trying to find the eigenvalues $\lambda$ and eigenvectors $u$ of the $L$ operator. However, to be honest we must also include the boundary conditions. Let's say that we want to look at the problem over the interval [0,1] and that we pose the boundary conditions $u(0) = u(1) = 0$.

The importance of eigenvalue problems stems from the fact that they may help us to solve the associated inhomogeneous problem

$Lu = f$ in the interval (0,1)
$u = 0$ at 0 and 1.

Here, *f* is some function in $L^2$. If a solution *u* exists and is unique, we may write it as

$$u = Af$$

because the mapping from *f* to *u* must be linear. Now observe that finding eigenvectors and eigenvalues of *A* is essentially the same as finding eigenvectors and eigenvalues of *L*. Indeed, if *u* is an eigenvector of *L* with eigenvalue *λ* it must be that *u* is also an eigenvector of *A* with eigenvalue *1/λ*.

[edit]

## Some highly technical details

Under some assumptions on *L*, the map *A* will be continuous from $L^2$ to the Sobolev space $H^2$ of "twice differentiable" $L^2$ functions (differentiability must be understood in terms of Sobolev spaces.) This is for instance the case if *p* is in $H^1$, *q* is in $L^2$, $p \leq c$ for some negative constant *c*, and $q \geq 0$. However, this is not a necessary condition: there are other *L* which make *A* continuous.

Here we use three very important theorems:

1. *$H^2$ is a subset of $L^2$; if B is the open unit ball in $H^2$ then the closure of B in $L^2$ is compact.*
2. *Hence the map A regarded as a linear map from $L^2$ to $L^2$ is a compact linear map.* (See the spectral theorem.)
3. *All hermitian compact linear maps have an orthonormal basis of eigenvectors; the eigenvalues form a sequence which must tend to zero.*

The key words are not all that important, the only important conclusion is that *A* has an orthonormal basis of eigenvectors.

## Useful consequences of the preceding technicalities

If we can find the eigenvectors of *L*, that is, find the solutions $u_k$ of

$Lu_k = \lambda_k u_k$ in (0, 1)
$u = 0$ at 0 and 1,

along with the eigenvalues $\lambda_k$, we can attempt to solve the problem

$Lu = f$ in (0,1)
$u = 0$ at 0 and 1.

Indeed, from the technical property that the eigenvectors form an orthonormal basis and from Fourier series, we see that any solution *u* and data *f* can be written as

$$u = \sum_k a_k u_k$$

$$f = \sum_k b_k u_k$$

If we take the liberty of exchanging the summation sign and the operator *L* (which can be justified in Sobolev spaces) we obtain:

$$\sum_k \lambda_k a_k u_k = \sum_k b_k u_k$$

We must use another theorem of Fourier series, which tells us that there is only one way of representing a function as a Fourier series. Hence, we obtain that

$$a_k = \frac{1}{\lambda_k} b_k \quad (2)$$

That is, given *f* (or equivalently its Fourier coefficients $b_k$) we may compute the Fourier coefficients $a_k$ of *u*, which is almost as good as computing *u* directly. Also, as noted above, the coefficients $1/\lambda_k$ converge to zero hence (again by Fourier series) the vector $u=\sum a_k u_k$ is well defined as long as $f=\sum b_k u_k$ is well defined.

When implemented on a computer, this is the spectral method.

## Example

We wish to find a function $u(x)$ which solves the following Sturm-Liouville problem:

$$Lu = \frac{d^2u}{dx^2} = \lambda u$$

where the unknowns are $\lambda$ and $u(x)$. As above, we must add boundary conditions, we take for example

$$u(0) = u(\pi) = 0$$

Observe that if *k* is any integer, then the function

$$u(x) = \sin kx$$

is a solution with eigenvalue $\lambda = -k^2$. We know that the solutions of a S-L problem form an orthogonal basis, and we know from Fourier series that this set of sinusoidal functions is an orthogonal basis. Since orthogonal bases are always maximal (by definition) we conclude that the S-L problem in this case has no other eigenvectors.

Given the preceding, let us now solve the inhomogeneous problem

$$Lu = x, x \in (0, \pi)$$

with the same boundary conditions. In this case, we must write $f(x)=x$ in a Fourier series. The reader may check, either by integrating $\int \exp(ikx)x\,dx$ or by consulting a table of Fourier transforms, that we thus obtain

$$Lu = \sum_{k=1}^{\infty} -2\frac{(-1)^k}{k} \sin kx.$$

This particular Fourier series is troublesome because of its poor convergence properties. It is not clear apriori whether the series converges pointwise. Because of Fourier analysis, since the Fourier coefficients are "square-summable", the Fourier series converges in $L^2$ which is all we need for this particular theory to function. We mention for the interested reader that in this case we may rely on a result that says that Fourier's series converges at every point of differentiability, and at jump points (the function $x$, considered as a periodic function, has a jump at $\pi$) converges to the average of the left and right limits (see convergence of Fourier series).

Therefore, by using formula (2), we obtain that the solution is

$$u = \sum_{k=1}^{\infty} 2\frac{(-1)^k}{k^3} \sin kx.$$

In this case, we could have found the answer using antidifferentiation. This technique yields $u=(x^3-\pi^2 x)/6$, whose Fourier series agrees with the solution we found. The antidifferentiation technique is no longer useful in most cases when the differential equation is in many variables.

## Application to normal modes

Suppose we are interested in the modes of vibration of a thin membrane, held in a rectangular frame, $0 < x < L_1$, $0 < y < L_2$. We know the equation of motion for the vertical membrane's displacement, $W(x, y, t)$ is given by the wave equation:

$$\frac{\partial^2 W}{\partial x^2} + \frac{\partial^2 W}{\partial y^2} = \frac{1}{c^2}\frac{\partial^2 W}{\partial t^2}.$$

The equation is separable (substituting $W = X(x) \times Y(y) \times T(t)$), and the normal mode solutions that have harmonic time dependence and satisfy the boundary conditions $W = 0$ at $x = 0, L_1$ and $y = 0, L_2$ are given by

$$W_{mn}(x, y, t) = A_{mn} \sin\left(\frac{m\pi x}{L_1}\right) \sin\left(\frac{n\pi y}{L_2}\right) \cos\left(\omega_{mn} t\right)$$

where $m$ and $n$ are non-zero integers, $A_{mn}$ is an arbitrary constant and

$$\omega_{mn}^2 = c^2\left(\frac{m^2\pi^2}{L_1^2} + \frac{n^2\pi^2}{L_2^2}\right).$$

Since the eigenfunctions $W_{mn}$ form a basis, an arbitrary initial displacement can be decomposed into a sum of these modes, which each vibrate at their individual frequencies $\omega_{mn}$. Infinite sums are also valid, as long they converge.

See also: normal mode.

# Johnniac

| | |
|---|---|
| Manufacturer | Rand Corporation, Santa Monica, California |
| Identification,ID | Johnniac |
| Date of first manufacture | 1953? |
| Number produced | 1, many clones at universities |

### Architecture

The **JOHNIAC** had an interesting heritage. John von Neumann et.al. wrote a report after studying the ENIAC, (see Preliminary Discussion of the Logical Design of an Electronic Computing Instrument" by Burks, Goldstien, & von Neumann) describing a desirable computing machine.

This was implemented as the IAS computer (Institute for Advanced Study). (It was first operational in 1952.)

The builders of the IAS computer (Institute for Advanced Study) in Princeton, N.J, (not Princeton University) under the direction of John von Neumann, were contractually obliged to share their designs with other research institutions.

This resulted in a number of clones, including:

- the MANIAC at Los Alamos Scientific Laboratory,
- the ILLIAC at the University of Illinois,
- the **Johnniac** at Rand Corp. (Santa Monica, CA),
- the SILLIAC in Australia, and others.

### Historical Notes

"At the same time, a commercial industry was beginning to emerge. In late 1953, RAND installed an IBM 701 (serial number 11). It came with rudimentary programming support tools, such as an assembler and a library. However, since the concept of an operating system had not yet evolved, the programmer would have hands-on possession of the machine for a specified period of time. At the end of the assigned time slot, a printout (memory dump) and perhaps a card deck would be the basis for examination of the program's behavior. If the run crashed, a special camera arrangement could take a Polaroid picture of the display lights on the console."

"$300,000 ... - was the only computer at the time to use Selectron memory. Each of the 80 glistening Selectron vacuum tubes held 256 bits of data and cost RCA $500 to manufacture. (Hence, Selectron memory was quickly replaced by core memory, a matrix of tiny iron-oxide rings representing 1s or 0s, depending on the direction of magnetization.)

### Other information

The JOHNNIAC was one of an illustrious group of computers built in the early 1950's, all inspired by the IAS computer designed by John von Neumann at the Institute for Advanced Study in Princeton. Some of these other machines were the MANIAC (Los Alamos) and the ILLIAC (Univ. of Illinois), as well as WEIZAC, AVIDAC, and ORDVAC. JOHNNIAC was built at the RAND Corporation in Santa Monica, and named after John von Neumann himself.

JOHNNIAC ran for the first time in March, 1954. It pioneered the development of time shared operating systems with JOSS (the JOHNNIAC Open Shop System). JOSS could support several dozen users with drum swapping. JOHNNIAC was also one of the first users of magnetic core memory, which dominated computer memories for the next 25 years. Among other tasks, JOHNNIAC was also used to develop digitizing tablets for computer input.

This talk will be given in front of The JOHNNIAC itself since this remarkable machine is now part of the permanent collection of The Computer Museum History Center--home to the world's largest collection of historical computer hardware.

Our speakers were all working on JOHNNIAC over 40 years ago. Willis Ware led the development of JOHNNIAC and received the IEEE Pioneer Award in 1994 for this work. Bill Gunning was the computer engineer who built JOHNNIAC; Paul Armer managed the Numerical Analysis Dept. at Rand where JOHNNIAC was built, and later directed the Computation Center at Stanford University. Paul hired Mort Bernstein to work on software for JOHNNIAC at RAND, and Mort is now working on a JOHNNIAC simulator, due to be completed before the year 2000.

Mort Bernstein <mib@lafn.org> kindly provided this timeline for the JOHNNIAC, taken from his notes for a presentation given at a local ACM meeting in 1996.

## *JOHNNIAC*

JOHNNIAC went operational for the first time in the first half of 1953 (no one seems to know the exact date of this event) with 256 40-bit words of RCA Selectron Tube storage, a 40-column numeric printer, a converted IBM Collator for a card reader and a converted IBM Summary Punch. It had two 19-bit instructions per word with two sets from an introduction at the Computer History Museum

of "transfer" instructions (what are now called jumps or branches), one set to the left half word and one set to the right half word. It had an initial repertoire of 83 instructions (four of which all cleared the accumulator to zero).

Later that year, RAND contracted with Telemeter Magnetics for the first commercially built core storage for the JOHNNIAC. The Selectron Tubes were removed in 1954 in anticipation of the installation of the core storage.

In March 1955 the machine was back on line with 4096 40-bit words of magnetic core storage. A bit later that year a 12K drum was installed.

In 1956 the analog adder circuitry was replaced with digital transistor logic. Additional transistor circuitry eventually replaced the shift registers and the multiplication and division control logic.

In 1957, the 40-column printer was replaced with a 600 line-per-minute ANelex 120-column drum printer with a 56 character repertoire.

In 1958 a 30" X 30" flat bed plotter was added.

In 1961 a 5-inch scope and the prototype of the RAND digitizing Tablet was added.

In 1962 one level indirect addressing was added to the machine using the two heretofore unused bits in the instruction format. Shortly after the machine came back on the air, it was discovered that a number of library programs ran incorrectly because the programmers had used one or both of the "unused" bits in instruction words as semaphores. A switch was added to the operator's console to disable or enable indirect addressing. That same year, the Multiple Typewriter Communication System (MTCS) consisting of 8 IBM Model B typewriter consoles and drum buffer was added. Additional instructions were added to control the flow of data between the drum buffers and core storage.

In 1964 a real time clock was added to support the time sharing functions of JOSS (the JOHNNIAC Open Shop System).

The JOHNNIAC was decommissioned on February 11, 1966. It had been in service for 13 years and logged over 50,000 operational hours. It was one of the longest lived computers of its era. It spanned the time from the first generation of computers to the advent of the IBM 360.

Mort Bernstein

# Reverberation

For many years reverberation time was the only real objective measure of the acoustic performance of an auditorium. For many architects, even today, it still is. However, there are many more aspects to sound behaviour in rooms. This topic covers the following additional objective measures:

- Early Decay Time
- Clarity and Definition
- Spatial Impression
- Speech Intelligibility

Early work in the area of reverberation (especially by Haas) has shown that people are most influenced by the initial portion of arriving sound energy. It is well known that the perceived direction of a sound is solely determined by the first arriving impulse (which is pretty reasonable as this is nearly always the direct sound). Secondary impulses (reflected sound) therefore contribute more to a perception of how large the source is and what sort of space it is in.

Another, more physiological effect is that of the integration period. If a reflected sound arrives within a certain time period after the direct sound, it is integrated by the ear together with the direct sound. In this way, very early reflections actually increase the perceived level of the direct sound, thus enhancing the signal-to-noise ratio.

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### Early Decay Time

The reverberation time, as discussed earlier, refers to the time taken for the reverberant component of an enclosure to fall by 60 dB after the source is abruptly switched off. In an ideal enclosure this decay is exponential, resulting in a straight line when graphed against Sound Level. Studies of actual auditoria, however, show that this is not always the case.

Research (Kuttruff 1973) has shown that it is the initial portion of the sound decay curve process which is responsible for our subjective impression of reverberation as the later portion is usually masked by new sounds. To account for this, the Early Decay Time (EDT) is used. This is measured in the same way as the normal reverberation time but over only the first 10 - 15 dB of decay, depending on the work being referenced.

### Clarity and Definition

Clarity and Definition refer to the ease with which individual sounds can be distinguished from within a general audible stream. This stream of sound may take many forms; a conversation, a passage of music, a shouted warning, the whirring of machinery, whatever.

The degree of clarity is, of course, greatly dependant on the particular sounds involved, however, from an architectural point of view, it refers to the ratio between the amount of early to late arriving sound energy. Because the definition of what is early is not absolute, a number of these ratios exist. In whatever form, however, such measures allow an objective evaluation of the amount of 'blend' offered to music by the enclosure.

As discussed in the introduction, when two very similar sounds arrive at the ear within close temporal proximity (50 - 80 msec), the ear integrates them together as part of the one sound. This means that any reflected sound energy arriving within the integration period acts to effectively increase the perceived intensity of the direct sound. This is an extremely useful piece of information as it means that, by providing close reflections, the acoustician has a tool to combat a lot of the problems associated with low sound levels

***Deutlickeit (D):***

Hitherto referred to as 'definition', was proposed by Theile for use in speech criteria and is the linear ratio between the sound energy within the first 50 msec and the total of all arriving sound energy.

***Klarheitsmass (C80):***

Hitherto referred to as 'clarity', was first proposed by Reichardt as more suitable for music and is a logarithmic ratio measuring the sound energy within the first 80 msec against that arriving later.

When considering the optimum values of these measures, the particular type of sound or style of music expected to be involved becomes very important. For example, a solo guitarist should be quite clearly distinguishable by all members of the audience whilst the sound of a string section greatly benefits from a little.

r In terms of musical experience, there would appear to be two very clear extremes; the intimacy of chamber music compared to the rousing strains of a full Wagnerian symphony. Each of these optimally requires rather different acoustic environments in order to properly enhance the audiences appreciation.

A feeling of intimacy almost always implies close proximity between the audience and musician. One of the major features of proximity is that the direct sound field appears to dominate over the reverberant field. Thus, an environment that promotes this feeling of intimacy would be one that minimises long term reverberation whilst maximising the number of first or second order reflections arriving within the integration period. These reflections act to reinforce the direct sound without necessarily being perceived as reverberation. The result of this approach is to maximise very early sound energy, optimally within the first 35 to 50 msec, whilst minimising late sound energy. The inspirational or awe inspiring extreme, on the other hand, may require a greater feeling of distance. In this way the listener can perhaps feel that they are really witnessing some consequential event, given the perceived power of the source. In this case, the early reflections should be maximised in order to emphasise the source loudness, as well as some emphasis on adequate reverberation.

A further maximisation of this effect may be to minimise early reflections arriving at those members of the audience already quite close to the source, as the inverse square law may mean that the direct sound still dominates, even with increased reverberation. Thus the structure may be 'fine tuned', with the amount of early arriving sound at the audience varying with distance from the source. The aim in this case, is not to minimise either ratio, as too little early energy creates a very muddy and unclear sound for even the most epic of operas.

e **Spatial Impression**

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Measures of spatial impression are therefore calculated based on the angle of each reflection relative to the direct sound. The first of these physical measures, the Lateral Energy Fraction ($L_f$), was proposed by Barron & Marshall as a linear ratio of lateral energy to total energy within the first 80 msec. Thus:

***????***

Where:

***Q*** = the angle between the reflection path and the axis between the two ears.

The value of(cosQ) may be replaced by (|sinA|cosB), where:

***A*** = the relative azimuth, and

***B*** = the relative altitudemay

From this relationship, it can be seen that, assuming the listener directly faces the source, the contribution of any particular reflection to the degree of spatial impression is at its maximum when A approaches 90o and B approaches 0.0. This means that the sound arrives directly adjacent to one ear, resulting in the maximum interaural delay and head shadowing effect. The absolute value in the substitution simply suggests that the reflections arriving from both sides of the head contribute equally to this measure.

By interpreting the calculated impulse model, the lateral energy fraction may easily be determined. Given that, like the measures of clarity and definition, Lf represents a ratio, then the units of intensity used to define the impulses are arbitrary. Thus, assuming the addition of incoherent energies, the squared impulse response is used. From this value, the degree of spatial impression may be estimated from the following suggested formula:

***SI = 14.5 (Lf - 0.05)*** e useful

As can be seen directly from the first equation, the delay of each reflection appears to be relatively unimportant for values between 5 and 80 msec when considering the respective contribution to the spatial impression. At delays of less than 5 msec, Barron & Marshall conclude that masking effects significantly reduce any contribution to the spatial impression, thus such reflections are included only in the total sound energy

Another of these values, the correlation degree (K), was proposed by Gottlob. This is a measure not of lateral energy, but of non lateral energy. As defined, non-lateral energy is considered to be the result of those reflections arriving within a +/- 6o angle from the medial plane. This value may be expressed as:

***????***

Using the impulse model, this is calculated in much the same way as Lf, with each impulse being subjected to two boolean tests; whether delay < 0.1 and whether -60< a < +60.

### Speech Intelligibility

In terms of individual communication, speech is probably the most important and efficient means, even in today's multimedia society. Experimental tests by Chapanis show that, as would be expected, the performance time of co-operative tasks performed in groups was up to ten times faster when speech was allowed compared to when it was not. Thus, with many rooms being used solely for speech between individuals and groups, it is important that acoustic designs accommodate and enhance such use.

## Measuring Intelligibility

The intelligibility of speech refers to the accuracy with which a normal listener can understand a spoken word or phrase. Given the fact that some of the information communicated through speech is contained within contextual, visual and gestural cues, it is still possible to understand meaning even if only a fraction of the discrete speech units are heard correctly. However, in large auditoria and places where reproduced speech is used, the listener has limited access to these cues and must rely more heavily upon the sound actually produced by the mouth.

Research into this area began with the development of telephone and telecommunication systems in the early part of this century. A product of this research was a quantitative measure for intelligibility based on articulation testing. This procedure (as described by Lochner and Burger) normally consists of an announcer reading out lists of syllables, words or sentences to one or more listeners within the test enclosure. The percentage of these correctly recorded by the listeners is called the articulation score

The science of articulation testing was substantially refined at Bell Telephone Laboratories and later at the Psycho-Acoustic Laboratory at Harvard University. From this later work, a set of phonetically balanced, monosyllabic test lists were prepared, called the Harvard P.B.50 word score. In order to negate any influence of non-phonetic cues on the measured intelligibility, these word lists comprise only of meaningless or jumbled syllables. Thus, in order to be correctly recorded by the listener, each consonant and vowel sound must be clearly audible. As a further measure, many tests are conducted with the syllables embedded in a carrier phrase in an attempt to simulate fluent speech. There are now many derivations of this methodology (such as the Fairbanks rhythm method used by Bradley and Latham), however, the resulting value is a percentage score of correctly recorded syllables. Thus the degree of intelligibility is considered to correlate with the average of these scores. This percentage becomes the measured speech intelligibility rating for that particular enclosure.

As stated before, normal connected speech can be understood even if some of the syllables are unintelligible. This is due to the fact that the listener can deduce the meaning from the context of the sentence. However, even under perfect conditions, the maximum word score normally attainable is about 95% due to unavoidable errors. A word score of 80% enables the audience to understand every sentence without due effort. In a room where the word score is closer to 70%, the listener has to concentrate to understand what is said whilst below 60% the intelligibility is quite poor.

## Predicting Intelligibility

d There are several available methods of predicting Speech Intelligibility within an enclosure. These include the articulation index (AI), the speech interference level (SIL), the A-weighted signal-to-noise ratio (Lsa), useful/detrimental sound ratio's (U80 and U95) and the speech transmission index (STI). Each of these methods is based on the same fundamental principle, determining a ratio between the received speech signal and the level of interfering noise. It is this basic signal-to-noise relationship upon which speech intelligibility is deemed to depend - the higher the ratio, the greater the intelligibility. is then ta For the purpose of these lectures, speech is considered only as that recognisable vocal information necessary for the correct interpretation of specific speech units. All other sound energy reaching the listener is considered to be interfering noise. Thus a number of signal-to-noise ratios may be measured from the same signal but at different frequency bands. There are basically three measurable factors which influence these signal-to-noise ratios:

- The level and manner of the speech output,
- The level and spectrum of background noise and
- The nature and duration of the room response

## Speech Level

n In a disturbance-free environment, normal speech levels fall between 55 and 65 dB (measured at a distance of 1m from the speaker). In specific situations, levels may reach as high as 96 dB when shouting a warning, or as low as 30 dB when whispering softly. It should be noted that speech levels vary significantly between individuals, even in similar acoustic conditions. Thus, when making predictions of speech intelligibility, it is often wise to base them on worst-case values rather than the average. This can be done by tempering the average value by an amount representing one standard deviation of inter-individual speech levels. Even this does not fully account for the variation at extremes of effort. As can easily be shown (Pearsons et al), up to 15% of women cannot raise their voice above 75 dB whilst 15% of shouting men can easily exceed 96 dB, sometimes reaching as high as 104 dB. The following table presents 'worst-case' values for vocal effort. 'in-situ' measure of the speech intelligibility of that enclosure.

| Vocal Effort | dB(A) |
|---|---|
| Whispering | 32 |
| Soft | 37 |
| Relaxed | 42 |
| Normal (private) | 47 |
| Normal (public) | 52 |

| Vocal Effort | dB(A) |
|---|---|
| Raised | 57 |
| Loud | 62 |
| Very Loud | 67 |
| Shouting | 72 |
| Max. Shout | 77 |

**Table 1 - Table of average vocal effort and sound level.**

When calculating intelligibility, it has been shown that loud or shouted speech is more difficult to understand, regardless of the level at the listeners ear. This is due mainly to changes in phonetics and intonation, becoming noticeable above 75 dB. Additionally, if, for more normal speech, the level arriving at the ear is very high (greater than 80 dB), there is research to indicate an overloading of the ear. This may occur as a result of a very short speaker-listener distance and results in a further decrease.

For the purposes of simplified calculation, these phenomenon may be summarised in the following manner. Firstly for loud speech, for every 10 dB rise in output level above 75 dB (as measured 1m from the speaker), the signal-to-noise ratio between received speech and interfering noise should be reduced by 4 dB. Secondly for normal speech, it is assumed that output levels between 45 and 75 dB and received levels below 80 dB have no such noticeable effect. The effects of extreme proximity calculate out to an approximate 3-5% reduction in intelligibility for every 10 dB above 80, less than a 1dB reduction in the signal-to-noise ratio (assuming moderately low levels of interfering noise).

## Background Noise

Within every acoustic environment, there is always a certain level of ambient background noise present. The level of this is mostly dependant on the activities taking place within the space and its more immediate surrounds. The most obvious effect of background noise is that it masks the speech signal, thus reducing the signal-to-noise ratio as the receiver must specifically concentrate on the speech. There is, however, another effect of background noise.

As is obvious, short duration speech may entail significant vocal effort whereas conversations of a longer duration require a much lower level in order that it be comfortably sustained by the speaker. This, however, explains only one aspect of a speaker choice of speech level.

One of the most important determinants of speech level is what is termed the Lombard effect. This effect (originally noted by Lombard and studied further by Lane and Tranel) is most clearly illustrated when required to speak whilst listening to headphones. In general, a speaker checks his vocal effort using feedback from his own hearing and the exertion of muscles participating in the speech process. With headphones obscuring the ears and the music masking much of the feedback, the voice is almost automatically raised to compensate. Lane and Tranel showed that background and other interfering noise have much the same effect, as do both temporary and permanent hearing loss.

Quantifying this effect is difficult as the individual response is often complex. For example, in normal conversation, rather than raising their voice, participants are more likely to move closer together. However a rule-of-thumb relationship (as suggested by Lazarus) is that every 1 dB increase in interfering noise above 45 dB will result in an average rise in output speech level of 0.5 - 0.6 dB. This automatic rise does not normally occur at softer speech levels as these are more likely to mean individual or face-to-face conversations. In these situations, the clear preference is almost always to move closer together meaning that this effect is only applied to speech levels of 55 dB or higher.

## Room Response

The nature of the room response can significantly effect speech intelligibility. This influence, whether beneficial or detrimental, is a function of the impulse response. In general, the enclosure will enhance the perception of speech when the amount of energy reaching the listener within the speech integration period (35-50 msec) is relatively high. Given that ambient background noise is constantly being reflected about the enclosure, any additional early speech reflections will effectively increase the apparent signal-to-noise ratio. However, late arriving reflections and excessive reverberation actually contribute to the apparent background noise level by interfering with the direct speech signal. Thus, too much late sound energy will tend to reduce the apparent signal-to-noise ratio.

### Measures of Speech Intelligibility

## The A-weighted Signal/Noise Ratio (SNA)

This is probably the simplest and easiest to apply of all the methods proposed. Simply determined, this measurement relates to the difference between the A-weighted long-term average speech level and the A-weighted long-term average level of background noise, measured over any particular time.

$$SNA = LSA - LNA$$

## The Articulation Index (AI)

This value is basically a linear measure ranging from 0.0 to 1.0 based on calculations of the signal to noise ratios in five octave bands (with centre frequencies of 0.25, 0.5, 1, 2 and 4 kHz). It is possible to obtain a more accurate calculation based upon 1/3rd octave band sound pressure levels (based on work by Kryter), however, this requires more detailed knowledge of both the speech and noise spectrums. Since the speech level usually refers to the long term value for normal speakers, octave spectra are normally sufficient for simple calculations.

Calculation of the AI. consists of three basic steps:

- The measurement of the effective signal-to-noise ratio for each octave band.
- Applying a weighting factor to each ratio and clipping to ensure that maximum contributions occur at +18dB and minimum at -12dB.
- Calculating the average value.

Thus the articulation index can be calculated from:

$$AI = \frac{G_{[i]}}{30dB} \sum_{i=1}^{5} (Lsa - Lna + 12) dB$$

Where:

**G[i]** = the weighting factor for each octave band.

## Speech Transmission Index (STI)

First introduced as a measure of speech intelligibility by Houtgast and Steeneken, the derivation of the speech transmission index is basically a much more detailed version of the articulation index. One of the more important improvements is that an attempt is made to include distortions in the time domain.

As discussed earlier, these distortions result from reverberation and delayed reflections. Their principle effect is a tendency to smooth out fast fluctuations in the intensity of a speech signal with a secondary effect of increasing the effective interference level of background noise. Thus, a criteria for the transmission of speech was established where speech was regarded as a flow of sound energy with temporal variations in intensity and spectrum. The degree to which these fluctuations were preserved by the transmission system was therefore considered a measure of its faithfulness.

Steeneken and Houtgast argued that the preservation of the temporal envelope of a speech signal implied the preservation of it's individual sinusoidal components. This reasoning, they suggested, leads to the determination of a rooms acoustic merits by the extent to which sinusoidal intensity modulations, produced by the speaker, are still present at the receiver.

Thus, the long term average speech level is replaced by a theoretical test signal with a spectrum similar to normal speech. The intensity of this signal is then modulated by a function with a modulation index of 1. In this way, any degradation of the signal will appear as a reduction in the modulation index derived from the received signal.

Given that, for any average enclosure, the rate of reverberant decay is relatively stable, it's effect on slower modulations of the signal will be different from faster modulations. A study of normal speech showed that modulation frequencies between 1 and 8 Hz are strongly represented, peaking at 3 Hz. Steeneken and Houtgast therefore suggest a faithful transmission should represent 0.4 to 20 Hz in order to ensure excellent intelligibility of both very slow and very fast speech.

If F represents the modulation frequency (ranging from 0.4 to 20 Hz in 18 x 1/3rd octave steps), and t is the time in seconds, then the intensity of the test signal is modulated by the following function: 1+cos(2pFt).

Relating this to the impulse model, the following relationship is given for the modulation index:

$$m(F) = \frac{\left| \sum_n \frac{a_n \exp(-j\pi F \frac{r_n}{c})}{r_n^2} \right|}{\sum_n \frac{a_n}{r_n^2}}$$

Where:

**c** = the speed of sound and refers to the respective attenuation factor, and

**rn** = the relative path length of the nth impulse.

The impulse response is then applied to this formula 18 times, once for each value of F. This set of 8 modulation indexes can then be referred to as representing the Modulation Transfer Function (MTF) of an enclosure. The current calculation, however, does not consider the effects of background noise. This can be included by modifying the calculated modulation index by a ratio of the intensity of the background noise (In) to the average intensity of the received signal, measured at the listener:

$$m'(F) = m(F) \frac{I_s \sum_n \frac{a_n}{r_n^2}}{I_s \sum_n \frac{a_n}{r_n^2} + I_n}$$

Within this one function, the effects of reverberation and the direct field are all represented, whilst allowing an easy translation into an apparent signal-to-noise ratio:

$$SNR = 10 \log\left(\frac{m(F)}{1 - m(F)}\right)$$

After clipping each individual ratio to a value between +15 and -15 dB, an average apparent overall signal to noise ratio is obtained from the 18 equally weighted values. The STI thus represents a linearised ratio in the following form:

$$STI = \left(\frac{SNR + 15}{30dB}\right)$$

## Useful / Detrimental Ratio's

These measures are essentially an early to late sound ratio, similar to those discussed earlier, with the effects of background sound energy added to the late arriving sound. Lochner and Burger first introduced the concept of such a ratio as a predictor of speech intelligibility scores based on useful energy calculated from a weighted sum of the sound energy arriving in the first 95 msec. The detrimental energy was therefore that sound energy arriving later, with the ambient background noise added in. In order to derive the useful/detrimental energy, an early to late ratio must first be established. The Lochner and Burger form, referred to as C95 is given by the following equation:

$$C_{[95]} = 10\log\left[\int_{0.0}^{0.095} mp^2(t)dt \Big/ \int_{0.095}^{\infty} p^2(t)dt\right]$$

Where:

**m** = the fraction of energy of each individual reflection integrated into the useful energy sum.

The calculation of ***m*** is quite tricky as it is based on subjective threshold observations. The basic assumption is that for any specific impulse earlier than 95 msec, a portion of its energy will be integrated with the direct sound. This portion, varies as a function of both relative delay and relative level. An approximation of the value of ***m*** is given by Bradley as:

$$m = (2.3 - 0.6a^{0.7}) + (0.0248t - 0.00177a^{1.35}t)$$

Where:

**a** = the relative amplitude of the reflection, and

**t** = its relative delay.

From this early/late ratio, the useful/detrimental ratio (U95) may be determined in the following manner:

$$U_{95} = \left[\frac{C_{[95]}}{1+(C_{[95]}+1)(E_{BL}/E_{SL})}\right]$$

Where:

**EBL** and **ESL** = the total background and speech energies given by:

EBL=10(BL/10) and ESL=10(SL/10) respectively

(**SL** and **BL** being the long-term, steady-state rms background and speech levels in dB, meaning that EBL and ESL are energy values in Watts).

Using the above equation, Bradley suggests that other early to late ratios can be applied similarly, for example U80 derived from C80. The benefit of these values is that they are simpler to calculate as they do not require the complex weighting procedure as described by Lochner and Burger. From a plot of measured speech intelligibility against measured U95 and U80 values, Bradley derived the following relationships from the best-fit third order polynomial for each data group:

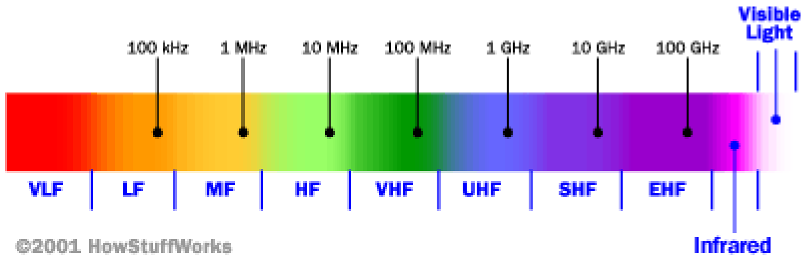
$$SI = 0.7348U95 - 0.09943.U95^2 + 0.0005457.U95^3 + 197.39$$

$$SI = 1.219U80 - 0.02466.U80^2 + 0.00295.U80^3 + 95.65$$

From an investigation of the relative merits of these and other measures, Bradley suggests that U80 seemed a safer and generally more reliable predictor of intelligibility.

# United States Frequency Allocations-Radio Spectrum

A radio wave is an **electromagnetic wave** propagated by an **antenna**. Radio waves have different **frequencies**, and by tuning a radio receiver to a specific frequency you can pick up a specific signal.




In the United States, the FCC (Federal Communications Commission) decides who is able to use which frequencies for which purposes, and it issues licenses to stations for specific frequencies. See How Radio Works for more details on radio waves.

When you listen to a radio station and the announcer says, "You are listening to 91.5 FM WRKX The Rock!," what the announcer means is that you are listening to a radio station broadcasting an FM radio signal at a frequency of 91.5 megahertz, with FCC-assigned call letters of WRKX. **Megahertz** means "millions of cycles per second," so "91.5 megahertz" means that the transmitter at the radio station is oscillating at a frequency of 91,500,000 cycles per second. Your FM (frequency modulated) radio can tune in to that specific frequency and give you clear reception of that station. All FM radio stations transmit in a **band** of frequencies between 88 megahertz and 108 megahertz. This band of the radio spectrum is used for no other purpose but FM radio broadcasts.

In the same way, AM radio is confined to a band from 535 kilohertz to 1,700 kilohertz (kilo meaning "thousands," so 535,000 to 1,700,000 cycles per second). So an AM (amplitude modulated) radio station that says, "This is AM 680 WPTF" means that the radio station is broadcasting an AM radio signal at 680 kilohertz and its FCC-assigned call letters are WPTF.

Common frequency bands include the following:

- **AM radio -** 535 kilohertz to 1.7 megahertz
- **Short wave radio -** bands from 5.9 megahertz to 26.1 megahertz
- **Citizens band (CB) radio -** 26.96 megahertz to 27.41 megahertz
- **Television stations -** 54 to 88 megahertz for channels 2 through 6
- **FM radio -** 88 megahertz to 108 megahertz
- **Television stations -** 174 to 220 megahertz for channels 7 through 13

What is funny is that every wireless technology you can imagine has its own little band. There are hundreds of them! For example:

- Garage door openers, alarm systems, etc. - Around 40 megahertz
- Standard cordless phones: Bands from 40 to 50 megahertz
- Baby monitors: 49 megahertz
- Radio controlled airplanes: Around 72 megahertz, which is different from...

- Radio controlled cars: Around 75 megahertz
- Wildlife tracking collars: 215 to 220 megahertz
- MIR space station: 145 megahertz and 437 megahertz
- Cell phones: 824 to 849 megahertz
- New 900-MHz cordless phones: Obviously around 900 megahertz!
- Air traffic control radar: 960 to 1,215 megahertz
- Global Positioning System: 1,227 and 1,575 megahertz
- Deep space radio communications: 2290 megahertz to 2300 megahertz

Why is AM radio in a band at 550 kilohertz to 1,700 kilohertz, while FM radio is in a band at 88 to 108 megahertz? It is all completely arbitrary, and a lot of it has to do with history.

AM radio has been around a lot longer than FM radio. The first radio broadcasts occurred in 1906 or so, and frequency allocation for AM radio occurred during the 1920s (The predecessor to the FCC was established by Congress in 1927.). In the 1920s, radio and electronic capabilities were fairly limited, hence the relatively low frequencies for AM radio.

Television stations were pretty much non-existent until 1946 or so, which is when the FCC allocated commercial broadcast bands for TV. By 1949, a million people owned TV sets, and by 1951 there were 10 million TVs in America.

FM radio was invented by a man named Edwin Armstrong in order to make high-fidelity (and static-free) music broadcasting possible. He built the first station in 1939, but FM did not become really popular until the 1960s. Hence the higher frequencies for FM radio.

# RAND Contributions to the Development of Computing

*by Willis H. Ware*

**Project RAND has a historic record of achievement** in the development of computing: RAND staff designed and built one of the earliest computers, developed an early on-line interactive terminal-based computer system, and invented the telecommunications technique that has become the basis for modern computer networks.

Project RAND was also the first to exploit new mathematical and computational techniques to solve Air Force problems and was a force behind the introduction of computing to the Air Force at all levels. RAND staff members served as advisors throughout the 1950s and 1960s, as the Air Force absorbed computer technology into its structure. They helped establish the career path for computer specialists, participated in the Scientific Advisory Board, designed the curriculum and taught courses for the DoD Computer Institute, and participated in formal study groups and committees sponsored by the Air Staff. In all these interactions, Project RAND helped the Air Force make the transition to computer maturity and supplied it with computer-based analytic methodology and software.

### In the Beginning

From its inception, RAND research was heavily quantitative, and calculating aids were in great demand. Project RAND acquired a Reeves Electronic Analog Computer in 1948 for missile and orbital simulations and promptly made a number of engineering improvements that were adopted by the industry of the time. Calculations for early studies were done on punched-card "electric accounting machines." Early models did only simple arithmetic, generally only a few operations per card; later models could be "programmed" by making electrical connections among the parts through wiring on removable plugboards. RAND pressured IBM for many years to produce improved equipment, which eventually could do many tens of operations per card. Innovative RAND programmers created large and complex plugboards in a continuing effort to create more elaborate computational environments.

Demand for random numbers in support of modeling studies prompted construction of a special electronic mechanism to generate them. This work became the well-known *A Million Random Digits with 100,000 Normal Deviates*, published in 1955, whose tables have become a standard reference in engineering and econometrics textbooks even to this day.

Efficient calculation of mathematical functions was a trying problem. Cecil Hastings' *Numerical Approximations for Digital Computers* was a major contribution in this area. It has been estimated that this research saved enough machine time and memory (measured in dollar value) to have financed Project RAND for 15 years.

## The Move to Electronic Digital Machines

The demand for solutions to complex analytic studies outstripped the computing power of the time. In 1949, a RAND team (John Williams, Bill Gunning, and George Brown) visited major potential vendors of electronic computers to assess future possibilities for electronic computers. One of them described the state of the art as "dismal"; another wrote in the trip report that "they were all doing tweaky things."

So RAND decided to build its own computer. It was one of five organizations in the country that decided to piggy-back on the work of John von Neumann, whose project at the Institute for Advanced Study, Princeton, N.J., was building the first parallel scientific computer. With Air Force funding, a team of RAND engineers (led by Gunning) started building the machine in the basement of the building at 4th and Broadway in Santa Monica. The new computer, named JOHNNIAC after von Neumann, first became operational in early 1953 and stimulated a necessary surge of system software development to make the machine efficient and convenient for users.

## Computer Science R&D

With the JOHNNIAC, every detail of data flow, every step in program logic, managing memory allocation, and handling input-output actions had to be conceived and programmed for each problem. Memory was always in short supply; machines were never fast enough; magnetic drums were always too small. Such problems led to innovative software development and tricks, as well as ingenious mathematical algorithms.

At the same time, a commercial industry was beginning to emerge. In late 1953, RAND installed an IBM 701 (serial number 11). It came with rudimentary programming support tools, such as an assembler and a library. However, since the concept of an operating system had not yet evolved, the programmer would have hands-on possession of the machine for a specified period of time. At the end of the assigned time slot, a printout (memory dump) and perhaps a card deck would be the basis for examination of the program's behavior. If the run crashed, a special camera arrangement could take a Polaroid picture of the display lights on the console.

The evolving demands of analytic studies and the potential of new computer technology led to a variety of innovative applications in software and mathematical algorithms. Among the most important RAND contributions were linear programming for optimization problems (George Dantzig) and the associated Simplex method of computation, dynamic programming (Dick Bellman) and its software; later, the so-called Information Processing Languages (developed by Al Newell, Cliff Shaw, and Herb Simon), which became the basis for subsequent artificial intelligence and expert-system software; and SIMSCRIPT, a language for simulation and modeling developed by Harry Markowitz, who left RAND to form his own software company. Two of RAND's analysts in this area--Herb Simon and Harry Markowitz--went on to become Nobel Laureates.

Commercial machines were evolving so rapidly that it was economically unrealistic to upgrade the JOHNNIAC. However, that machine continued to be the basis of engineering advances, such as the first commercially produced magnetic-core memory; the first 140-column-wide, high-speed impact printer; and a swapping drum to support multiple users. The JOHNNIAC also supported the development phase of the Tablet, the first operational digitizing surface by which freehand movements of a pen could be digitally entered into a computer.

### Milestones for the Information Revolution

Of particular importance was the JOHNNIAC Open Shop System (JOSS). Developed by Cliff Shaw, JOSS-1 was a very early on-line, time-shared computer system for individual users. It led the state of the art by allowing tens of users to work at the same time on one machine. By the mid-1960s, several Air Force installations had terminals linked via telephone connections to the JOSS-2 in Santa Monica.

The single Project RAND study with the most lasting and widest technological impact was Paul Baran's work on the concept of "distributed communications"--now known as packet switching. Developed in the mid-1960s in response to an Air Force requirement for communications able to survive a nuclear attack, this work defined the concept underlying modern data networks--from international to local-area networks. In particular, packet switching is the communication protocol for the Internet and the Ethernet.

By the time JOHNNIAC was finally retired in 1966, a large commercial industry had evolved with extensive software for every machine, and RAND shifted entirely to commercial sources. UNIX systems became the choice for computer science research, and the concept of electronic messaging evolved. RAND computer scientists perceived the requirement for a comprehensive mail system and, over a weekend in 1979, demonstrated the principles of what became the RAND-MH message-handling system. This system became the model for other commercial mail systems and is a part of current UNIX software distributions.

### Integration and Security Issues

Also in the 1970s, PAF conducted a major computer-resource management study to advise the Air Force on charting its long-term course for the acquisition, management, and operation of its computers, software, information systems, and related personnel. Staff members advised on then-innovative digital avionics and supported Air Force managers on acquisition of modern computer-intensive aircraft. In the 1980s, PAF continued its computer-science work with the development of programming languages tailored especially to battlefield and other military simulations, and incorporating both rule-based and object-oriented constructs--such languages as SWIRL, TWIRL, and ROSS.

By the 1990s, computer science under PAF sponsorship had given way to direct involvement with Air Force-specific issues, such as the security of information systems, the vulnerability of such systems to deliberate electronic attack, and the possibility of applying "expert systems" as decision support in Air Force support and administrative functions.

Records of Harvard University, World War II contract research and training, general administrative and contract records, 1940-1948.

by Harvard University.

| | |
|---|---|
| Description: | 27.5 cubic ft. |
| Owning Repository: | Harvard University Archives. Pusey Library. Cambridge, MA 02138. |
| Country of Repository: | USA |
| Scope of Material: | These records were maintained by the University central offices administering contracts (especially the University Treasurer) and by individual laboratories or investigators; they were gathered at the end of hostilities by the University's War Archives Office. In addition to records relating to Army and Navy training (which included electronics and similar programs), there are procedural and policy documents on contracts especially with the Office of Scientific Research and Development (OSRD), espionage and patent agreement forms, and subcontracts for the Radio Research and Underwater Sound Laboratories. Also available are contracts, correspondence, notebooks, and especially technical reports for the Electro- and Psycho-Acoustics laboratories and for a number of smaller projects in medicine, chemistry, physics, engineering, and other fields. |
| Added Author: | AIP-ICOS |
| Genre Term(s): | Laboratory notebooks.<br>Technical reports. |

# A D V E N T U R E S in C Y B E R S O U N D

**A Chronology of Vision Research** 1600-1960

### Introduction

There are many well known accounts of the history of visual science (some references are given below) but it seems hard to find a simple chronological listing of major events. Sometimes such a list can be helpful in gaining a quick historical perspective. This note presents a chronology listing 133 significant events between 1600 and 1960.

All of this material is based on standard secondary sources : the author (Jack Yellott) is not a specialist in the history of science, and the object here is not to contribute anything new to the history of vision research but rather simply to collate material already scattered throughout the literature, though of course the choice of "significant" events is idiosyncratic.

**1604**

Kepler's **Ad Vitellionem Paralipomena** : First explanation of the optics of the eye.

**1610**

Galileo publishes the **Siderial Messenger.**

First look at the sky through a telescope.

**1611**

Kepler's **Dioptrice** : First analysis of the optics of myopia.

Projection theory of stereoscopic vision.

**1619**

Scheiner's **Oculus** : First demonstration that accommodation is an active process.

First use of fixatives to preserve the eye for anatomical study.

First accurate diagrams of the human eye. Discovery of the pupillary "near reflex."

**1621**

Snell's law. (Kepler's optical analysis was based on Ptolemy's small angle approximation to Snell's law.)

**1625**

Scheiner : First direct observation of the retinal image.

**1637**

Descartes' **La Dioptrique**. Corpuscular theory of light.

First suggestion of point to point projection of retina onto brain (in his view, onto the walls of the ventricles).

**1664**

Willis traces the optic tract to the thalamus.

**1665**

Grimaldi describes diffraction (posthumously).

**1666**

Newton's prism experiments.

**1675**

Roemer measures the speed of light.

**1678**

Briggs describes fibers in the retina.

**1681**

Mariotte discovers the blind spot; articulates trichromacy of human colour vision.

**1682**

Newton proposes partial decussation at the optic chiasm.

**1684**

First microscopic observation of the retina : Leewenhock notices receptors.

**1684**

Briggs describes night blindness.

**1690**

Huygens : Longitudinal wave model of light; discovery of polarisation .

**1700**

Ruysch describes ocular circulatory system.

**1704**

Newton's **Optics.**

**1705**

Hooke reports 1' limit of visual acuity.

**1719**

Morgani describes homonymous hemianopia.

**1751**

Whytt explains neurology of pupillary light reflex.

**1755**

LeRoy demonstrates electrical phosphenes in blind observers : First hint of a relationship between electricity and vision.

**1757**

Lomonosov suggests three - "particle" basis of colour vision.

**1760**

Bouguer measures luminance contrast thresholds, prediscovers Weber's Law.

**1776**

Gennari describes striate area of occipital cortex.

**1789**

Maskelyne describes night myopia.

**1793**

Young discovers astigmation and that accommodation of the eye is due to a change in the curvature of the lens.

**1798**

Dalton describes colour blindness (his own deuteranopia).

**1800**

Herschel discovers infrared light.

**1801**

Ritter discovers ultraviolet light.

Young proposes three receptor theory of colour vision and introduces mapping of visual fields.

**1802**

Young discovers interference.

**1804**

Troxler describes loss of colour in the periphery of the visual field.

**1807**

Gall proposes concept of localisation of mental functions in the cortex.

**1808**

French Academy refuses to admit Gall on grounds that the cortex has nothing to do with thinking.

**1817**

Young proposes transverse wave model of light.

Josef Fraunhofer discovers the "Fraunhofer lines" in the spectrum of sunlight.

**1818**

Vieth-Muller horopter.

**1824**

Wollaston explains homonymous hemianopia in terms of partial decussation at the chiasm.

Flourens demonstrates loss of vision following cortical lesions (first proof that the cortex is involved in vision).

**1825**

Purkinje describes optokinetic nystagmus, entopic visualization of retina blood vessels, "Purkinje shift" in spectral luminosity during dark adaptation, blue arcs of the retina, "Purkinje images" (reflections from surfaces of cornea, lens), and motion aftereffects.

**1826**

Niepce makes the first photograph.

J. Muller proposes doctrine of specific energy of nerves, explains optics of compound eyes.

**1829**

Plateau initiates study of flicker, discovers stroboscopic movement, invents motion pictures (the "phenakistoscope")

**1832**

Chevreul describes simultaneous colour contrast.

Weber measures increment thresholds; Weber's law.

**1833**

Wheatstone invents the stereoscope.

**1834**

Plateau-Talbot law.

Robert Addams rediscovers the motion aftereffect after looking at the Waterfall of Foyers in Scotland : an illusory motion that notwithstanding the fact that there were at least three earlier reports on this effect, still became known as the Waterfall Illusion. The effect was probably first described by Aristotle in his treatise on dreams. The direction of this illusory motion was first described by Lucretius, a couple of centuries later.

In 1825 Johann Evangeliste Purkyne also described the phenomenon after having looked at a cavalry parade.

**1838**

Fechner discovers subjective colour.

**1841**

Dove shows that stereopsis does not depend on eye movements.

**1844**

Haidinger's brushes.

**1845**

Masson shows that Weber's law fails at low luminances.

**1847**

Donder's law of ocular movements.

**1849**

Du Bois Reymond discovers the resting potential of the eye.

**1851**

H. Muller notices visual purple in rods.

Helmholtz invents the opthalmoscope.

**1853**

Grassman formulates laws of trichromacy.

**1854**

H. Mueller proves that photoreception occurs in rods and cones.

Gratiolet traces visual radiation from thalamus to occipital cortex. Listing's law of ocular movements.

**1856**

Maxwell tests validity of Grassman's laws; discovers "Maxwell's spot."

Helmholtz proves that accommodation is effected by a reshaping of the lens. Von Graefe introduces clinical perimentry.

Helmholtz' **Handbuch der Physiologischen Optik**.

**1857**

Aubert and Forster demonstrate extrafoveal falloff in acuity.

**1858**

Panum measures areas of stereoscopic fusion.

**1860**

Fechner's **Element der Psychophysik**.

**1862**

Maxwell's theory of electromagnetic radiation.

**1864**

Donders explains principles of clinical refraction and prescription.

**1865**

Aubert : First quantitative studies of absolute threshold and dark adaptation.

Mach describes "Mach bands," suggests lateral inhibition in the retina.

First measurements of stereoscopic acuity (Hering, Helmholtz).

**1866**

Holmgren discovers the electroretinogram.

Schultz distinguishes rods and cones; proposes duplicity theory of the retina.

**1867**

Helmholtz discovers the Bezold-Brucke effect.

**1870**

Meynert shows that optic radiation terminates in striate area.

**1875**

Golgi stain. von Gudden establishes partial decussation at the chiasm.

Hering proposes opponent process theory of color vision.

**1876**

Boll discovers that "visual purple" is bleached by light.

**1877**

Ricco's law.

**1878**

Kuehne isolates rhodopsin.

**1879**

Munk formulates concept of topographic projection of retina onto occipital cortex.

**1880**

Kuehne and Steiner measure gross electrical response of isolated retina.

**1881**

Rayleigh's anomaloscope.

**1885**

Bloch's law.

**1886**

Konig "Fundamentals."

**1890**

Willbrand proposes point to point projection of retina onto striate area.

**1892**

Ferry-Porter law.

**1892**

Wulfing measures vernier acuity.

**1893**

Cajal's **La retine des vertebres :** first complete description of retinal neuroanatomy as revealed by Golgi stain.

Abbe initiates Fourier optics (first informed manipulations of image spectrum).

**1894**

Konig demonstrates agreement between absorption spectrum of rhodopsin and scotopic spectal sensitivity.

**1896**

Flechsig describes course of visual radiation from lateral geniculate nucleus to striate area (based on myelogenesis).

Stratton experiments with inverted retinal images.

**1900**

Planck introduces quantum concept.

**1903**

Piper's law.

**1905**

Einstein's photon theory.

**1910**

Minkowski demonstrates point to point projection onto striate area in dogs via behavioral methods.

**1911**

Gullstrand invents the slit lamp.

**1913**

Abney's law. Minkowski demonstrates separate laminar terminations of left and right optic nerve fibers in lateral geniculate nucleus.

**1918**

Holmes presents first map of striate cortical projection of the visual field in man.

**1920**

First anatomical demonstration of point to point projection of retina onto lateral geniculate nucleus (Minkowski, Brouwer and Zeeman).

**1922**

First application of Fourier analysis to flicker sensitivity (Ives).

**1924**

First C. I. E. photopic luminosity function.

**1925**

Holm demonstrates that vitamin A deficiency causes night blindness.

**1927**

First recording of electrical activity in optic nerve (Adrian and Matthews)

**1929**

Berger discovers alpha component of the EEG.

**1929**

First electrical stimulation of human visual cortex (Foerster and Penfield).

**1931**

C. I. E. standardises calorimetry (Guild-Wright primaries).

First measurement of rhodopsin regeneration in vivo (Tansley)

**1932**

First recording of electrical activity in single optic nerve fibres (in **Limulus**; Hartline and Graham).

**1933**

Stiles and Crawford demonstrate directional sensitivity of cones.

Wald finds vitamin A in rhodopsin.

First electronically amplified human ERG (Cooper, Creed, and Granit)

**1935**

Osterberg : First cell count of rods and cones in human retina.

LeGrand measures visual acuity bypassing the optics of the eye.

**1939**

Stiles introduces Pi mechanism analysis of increment thresholds.

**1941**

First mapping of the cortical projection of the retina based on electrical responses (Talbot and Marshall).

**1942**

Hecht, Schlarr, and Pirenne show that rods respond to single quanta.

**1943**

DeVries-Rose law.

**1947**

Granit distinguishes sustained and transient ganglion cells.

**1948**

Gabor describes principles of holography.

Rose introduces the concept of detective quantum efficiency

**1949**

Transient VEP first reported by C. C. Evans

**1951**

C. I. E. standardises scotopic luminosity function.

**1952**

First electrical recording from individual mammalian retinal ganglion cells : Discovery of antagonistic center-surround organization of receptive fields (Kuffler).

First demonstration of subjective disappearance of stabilized retinal images (Ditchburn and Ginsborg; Riggs, Ratcliff, Cornsweet and Cornsweet).

**1953**

First recording from horizontal cells (Svaetichin's S potential).

**1954**

First psychophysical demonstration of rod saturation (Aguilar and Stiles).

Peterson, Birdsall and Fox present the theory of signal detectability.

Tanner and Swets apply the theory of signal detectability to human sensation.

**1955**

Photoreversal (Hagins, Hubbard, and Kropf).

Jameson and Hurvich use hue cancellation to infer opponent color codes.

First study of rhodopsin regeneration in living human retina by ophthalmic densitometry by Rushton, Campbell, Hagins, and Brindley.

Rushton demonstrates light induced changes in human cone pigments; identifies chlorolabe and erythrolabe.

Flament makes the first measurement of the line-spread function of the human eye.

**1956**

First measurement of human spatial modulation transfer function by Schade.

Barlow demonstrates the existence of dark light at absolute threshold.

**1957**

Reichardt presents an autocorrelation model for motion detection.

**1959**

Land's color demonstrations.

First electrical recording from individual visual cortical neurons; discovery of simple, complex, hypercomplex receptive fields by Hubel and Weisel.

Lettvin, Maturana, McCullogh and Pitt examine feature detectors in the frog visual system.

**1960**

Publication of first random dot stereogram by Julesz.

Average transient VEP reported W. A. Cobb & G. D. Dawson

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## References


Addams, R. (1834). An account of a peculiar optical phenomenon seen after having looked at a moving body, etc. London & Edinburgh Philosophical Magazine and Journal of Science, 5, 373-374.
Barlow, H. (1956). Retinal noise and absolute threshold, Journal of the Optical Society of America 46, 634-639.
Baumgardt, E. (1972) Threshold quantal problems. In Handbook of Sensory Physiology, Vol. VII/4 : Visual Psychophysics. (Edited by Jameson, D., and Hurvich, L.M.) Springer-Verlag, New York.
Blackwell, H. R. (1972) Luminance difference thresholds. In Handbook of Sensory Physiology, Vol. VII/4 : Visual Psychophysics. (Edited by Jameson, D., and Hurvich, L.M.) Springer-Verlag, New York.
Boring, E. G. (1942) Sensation and perception in the History of Experimental Psychology. Appleton-Century, New York.
Brindley, G. S. (1970) Physiology of the Retina and Visual Pathway. Williams & Wilkins Co., Baltimore.
Cornsweet, T. N. and Yellott, J. I. (in press) - Visual Perception. In Handbook of Physiology, Vol. II. (Edited by Darian-Smith, I.) American Physiological Society.
Davson, H. (1976) The Eye, Vol. 2A : Visual Function in _ . Academic Press, New York.
Duke-Elder, S. (1958) System of Ophthalmology, Vol. I : The Eye in Evolution. C. V. Mosby Co., St. Louis.
Duke-Elder, S. and Wybar, K. C. (1961) System of Ophthalmology, Vol. II : The Anatomy of the Visual System. C. V. Mosby Co., St. Louis.
Duke-Elder, S., Gloster, J., and Weale, R. (1968) System of Ophthal-mology, Vol. IV : Physiology of the Eye and of Vision. C. V. Mosby Co., St. Louis.
Duke-Elder, S. and Scott, G. I. (1971) System of Ophthalmology, Vol. XII : Neuroopthalmology. C. V. Mosby Co., St. Louis.
Fraunhofer, J. (1817). Bestimmung des Brechungs- und Farbenzerstreuungs-Vermoegens verschiedener Glasarten, in Bezug auf die Vervollkommnung achromatischer Fernroehre. Denkschriften der koeniglichen Akademie der Wissenschaften zu Muenchen, 5, 193-226 (also in : Gilberts Annalen der Physik, 56, 264-313).
Julesz, B. (1960) Binocular depth perception of computer-generated patterns, Bell System Technical Journal 39, 1125-62.
Kelly, D. H. (1972) Flicker. In Handbook of Sensory Physiology, Vol. VII/4 : Visual Psychophysics. (Edited by Jameson, D., and Hurvich, L.M.) Springer-Verlag, New York.
Lucretius (1975) De Rerum Natura. Translated into English by W.H.D. Rouse. Cambridge, Mass : Harvard University Press.
Pledge, H. T. (1952) Science Since 1500. Harper & Bros., New York.
Polyak, S. L. (1957) The Vertebrate Visual System. Univ. of Chicago Press, Chicago.
Purkinje, J.E. (1825). Beobachtungen und Versuche zur Physiologie der Sinne. Bd II. Neurere Beitrage zur Kenntnis des Sehens in subjectiver Hinsicht. Berlin : Reimer.
Reichardt, W. (1957) Autokorrelationsauswertung als Funktionsprinzip des Zentralnervensystems, Z. Naturforsch 1957, 12b, 447-457.
Rose, A. (1948). The sensitivity performance of the human eye on an absolute scale. Journal of the Optical Society of America 38, 196-208.
Wertheimer, G. (1972) Visual acuity and spatial modulation thresholds. In Handbook of Sensory Physiology, Vol. VII/4 : Visual Psychophysics. (Edited by Jameson, D., and Hurvich, L.M.) Springer-Verlag, New York.


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# *Synchronous Period-Doubling in Flicker Vision of Salamander and Man*

The Journal of Neurophysiology Vol. 79 No. 4 April 1998, pp. 1869-1878

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# ABSTRACT

**Crevier, Daniel W. and Markus Meister.** Synchronous period-doubling in flicker vision of salamander and man. *J. Neurophysiol.* 79: 1869-1878, 1998. Periodic flashes of light have long served to probe the temporal properties of the visual system. Here we show that during rapid flicker of high contrast and intensity the eye reports to the brain only every other flash of light. In this regime, retinal ganglion cells of the salamander fire spikes on alternating flashes. Neurons across the entire retina are locked to the same flashes. The effect depends sharply on contrast and flash frequency. It results from a period-doubling bifurcation in retinal processing, and a simple model of nonlinear feedback reproduces the phenomenon. Pharmacological studies indicate that the critical feedback interactions require only cone photoreceptors and bipolar cells. Analogous period-doubling is observed in the human visual system. Under bright full-field flicker, the electroretinogram (ERG) shows a regime of period-doubling between 30 and 70 Hz. In visual evoked potentials from the occiput, the subharmonic component is even stronger. By analyzing the accompanying perceptual effects, we find that retinal period-doubling begins in the periphery of the visual field, and that it is the cause of a long mysterious illusory flicker pattern.

# INTRODUCTION

A rapidly flashing light evokes the sensation of flicker, which eventually disappears as the flash frequency increases (Kelly 1972♣), a phenomenon known as flicker fusion. Our ability to perceive such flicker is limited in large part by temporal processing in the retina, and satisfying parallels have been established between human perception and the responses of retinal ganglion cells near the threshold of detection (Lee et al. 1989♣; Spekreijse et al. 1971♣; van de Grind et al. 1973♣). However, much of human vision involves stimuli far above the detection threshold, and strong flickering lights produce perceptual phenomena that are only poorly understood. For example, a large uniform flickering field evokes an impressive illusion of spatial patterns (Smythies 1959♣; Welpe 1970♣). Such flicker patterns have been known for centuries (Purkinje 1819♣), but have largely defied physiological explanation.

It is commonly held that the response of visual neurons repeats periodically at the frequency of the flash stimulus (Kelly 1972♣; van de Grind et al. 1973♣). Here we show that a bright large-field stimulus evokes dramatically different responses. Above a critical flash frequency, retinal ganglion cells systematically fire only on every other flash of light, ignoring the intervening flashes. The effect is found in both salamanders and humans and points to previously unknown aspects of retinal processing.

# METHODS

## Salamander eyecup recordings

The eyeball of a larval tiger salamander was hemisected, drained of vitreous, filled with Ringer medium (Meister et al. 1994), and placed in a well containing a reference electrode behind the sclera. Moist 95% $O_2$-5% $CO_2$ was blown over the preparation. Fiber signals from a sharp tungsten electrode inserted in the optic disk were filtered at 100-1,000 Hz, the ERG signal from a Ag/AgCl electrode in the eyecup was filtered at 1-1,000 Hz. A red light-emitting diode above the eyecup produced periodic square-wave flashes at frequency *f*. The mean intensity was constant in all reported experiments and equivalent to a flux of $7.7 \cdot 10^7$ photons/µm$^2$/s at 621 nm for the red cone receptors. Period-doubling occurred also at lower intensities, down to $4.9 \cdot 10^5$ photons/µm$^2$/s. Stimulus contrast, *C*, was measured as the intensity ratio (ON-OFF)/(ON + OFF). Animals were handled according to institutional guidelines.

## Nonlinear feedback model

We analyzed a simple model of nonlinear feedback to account for period-doubling in the ERG response to periodic flashes (see Fig. 5*A*). Let *x* denote the amplitude of the response to a flash. Assume that $x = C \cdot g(y)$, where *C* is the stimulus contrast, and $g(y)$ is the response gain, which depends on the feedback variable *y*. Assume further that *y* increases by an amount $B \cdot x$ on a flash of amplitude *x*, and that *y* decreases continuously by exponential decay with time constant $\tau$. In a sequence of flashes with frequency *f*, the response to the *i*th flash is therefore $x_i = C \cdot g(y_i)$ with

$$y_i = e^{-1/f\tau} B x_{i-1} + e^{-2/f\tau} B x_{i-2} + \cdots = e^{-1/f\tau}(B x_{i-1} + y_{i-1})$$

$$= e^{-1/f\tau}[\, BC \cdot g(y_{i-1}) + y_{i-1}]$$

Depending on the functional form of $g(y)$, this recurrence relation can become unstable leading to period-doubling and chaos. For the plots in Fig. 5, *B* and *C,* we chose $g(y) = 1/(1 + y^4)$. At each value of *C* and *f*, the recursion for $y_i$ was iterated 200 times, and the subsequent 100 values of $x_i$ were plotted along the ordinate. Note that the model has only two free parameters, *B* and $\tau$, which set the scaling along the contrast and frequency axes.

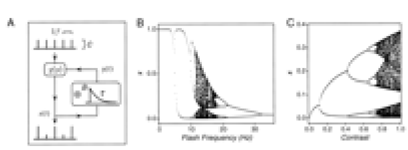

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**FIG. 5.** Period-doubling in a model of nonlinear feedback. *A*: diagram of the model: input pulses are multiplied by a variable gain that depends on the amplitude of preceding output pulses. See text for details. *B* and *C*: bifurcation plots of the output pulse amplitude, *x*, as a function of flash frequency (*B*) and contrast (*C*). $B = 35$, $\tau = 58$ ms.

### Pharmacology

Drugs were added to Ringer medium, and the eyecup's contents were replaced several times to achieve the nominal concentrations at the retina. The pharmacological effects of all these agents have previously been analyzed in the retina of the salamander or closely related species, often using the eyecup preparation (Werblin 1991): 2-amino-4-phosphonobutyric acid (APB), 2-amino-7phosphonoheptanoic acid (AP-7), D-aminovaleric acid (AVA),6-cyano-7-nitroquinoxaline-2,3-dione (CNQX), D-O-phosphoserine (DOS), $\gamma$-aminobutyric acid (GABA), and *N*-methyl-D-aspartic acid (NMDA).

### Human ERG

Subjects looked into a hemisected ping-pong ball, illuminated from behind by white light from a DC-operated tungsten source, which was modulated in square-wave fashion by a liquid crystal shutter (Stereographics). The average luminance was 5,000 cd/$m^2$, the ON/OFF intensity ratio was 100, and the rise and fall times of the intensity (measured between 0.1 and 0.9 of maximum) were <4 ms. No pupil dilation was used. The ERG was recorded with a bipolar Burian-Allen contact lens electrode and filtered at 1-1,000 Hz. For stimulation of central retina, the subject was moved back from the light source; for peripheral stimulation, black circles were glued to the hemisphere.

### Human scalp potentials

The visual evoked potential (VEP) was recorded with the active electrode on the midline 5 cm above the inion, the reference electrode 8 cm anterior, and a ground electrode on the forehead. In some experiments, the reference electrode was 3 cm lateral of the active electrode, producing essentially identical results. Signals were filtered at 1-500 Hz. Stimulation was as described for ERG measurements, with one eye covered by a patch. All human subjects gave their informed consent.

# RESULTS

### Salamander retina

We first describe observations in the eyecup preparation of the tiger salamander. The retina was stimulated with bright periodic square-wave flashes. The collective response of ganglion cells was monitored with an extracellular tungsten electrode inserted into the optic disk, where the axons converge to form the optic nerve. The ERG was measured with an electrode in the vitreal medium.

### Synchronous period-doubling

When the light flashed slowly, a volley of ganglion cell spikes was observed at the onset and two volleys at the offset of each flash (Fig. 1*A*). When the flash frequency increased above ~4 Hz, the ON volleys disappeared and a single OFF volley followed each flash (Fig. 1*B*). At flash frequencies >9 Hz, the ganglion cell response changed abruptly (Fig. 1*C*): now every other flash produced a volley of spikes, whereas the intervening flashes produced no response. We will call these the "odd" and "even" flashes, respectively. A parallel change occurred in the ERG: its response to the odd flashes was systematically larger than to the even flashes. Thus the response of retinal neurons was still periodic, but with a period twice that of the visual stimulus. When the flash rate was increased further, another change occurred above 12 Hz (Fig. 1*D*): the ganglion cells still responded to every other flash, but both the fiber volley and the ERG signal were larger for every fourth flash, so that the retinal response repeated only every 4 stimulus periods. Above 15 Hz, the response changed dramatically to a seemingly chaotic pattern, with no recognizable periodicity in the ERG signal or the fiber volleys (Fig. 1*E*).

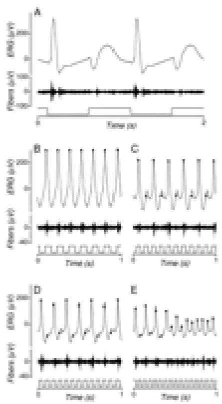

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**FIG. 1.** Response of the salamander retina to uniform flicker. Recordings of the electroretinogram (ERG; *top trace*) and optic nerve fibers (*middle*) to the uniform flash stimulus (*bottom*), at a flash frequency of $f$ = 1 Hz (*A*), 7 Hz (*B*), 11 Hz (*C*), 13 Hz (*D*), 16 Hz (*E*). Filled circles on the ERG trace indicate the value at a given delay during each flash interval, illustrating that the response repeats on every stimulus cycle in *B,* every 2 cycles in *C,* every 4 cycles in *D,* and lacks recognizable periodicity in *E.* For each flash rate, the delay was chosen to include the maximum of the waveform.

At sufficiently high flash rates, the ganglion cells appear to systematically "ignore" every other flash (Fig. 1*C*). This suggests some form of refractoriness within the network, by which the activation threshold is transiently elevated after a strong flash response. More strikingly, an entire population of nearby retinal ganglion cells acts in synchrony, responding to the same set of flashes, rather than choosing the odd or even flashes independently of each other. To assess the spatial extent of this synchrony, we recorded with two extracellular electrodes from opposite margins of the optic disk, thus sampling two bundles of axons from separate regions of the retina. Figure 2 shows the time course of fiber volleys in the two regions following the sudden onset of the flashing stimulus. For a short time, every flash produced a burst of spikes, but within a few tenths of a second the volleys became restricted to alternating flashes. In this final state, bursts on the two electrodes were in phase, a result observed in all such two-electrode experiments. Thus the response synchrony extends across the entire retina.

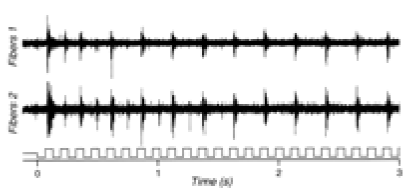

**FIG. 2.** Synchrony in alternating responses to uniform flicker. Fiber signals (*top 2 traces*) were recorded from 2 electrodes at opposite edges of the optic disk in the salamander eye cup. At *time 0,* the stimulus (*bottom trace*) changed from constant illumination to 8-Hz square-wave flicker of the same mean

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intensity.

The multiunit recordings from the optic disk cannot resolve the behavior of single neurons. To test whether individual ganglion cells respond systematically to every other flash, we isolated single-unit spikes recorded from cell bodies. Figure 3 shows the response of an OFF ganglion cell during a continuous frequency ramp. At low flash frequencies, the neuron fired after every flash. At a flash rate of ~11 Hz, it suddenly switched to firing on alternating flashes. This occurred just after an alternating response appeared in the waveform of the ERG. Taken together with the above multiunit results, it appears that OFF cells across the entire retina systematically fire on the same set of alternating flashes.

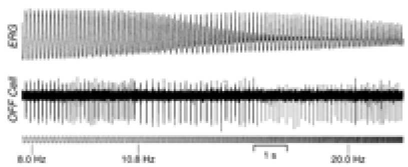


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**FIG. 3.** Period-doubling during a continuous frequency ramp. Recordings of the salamander ERG (*top trace*) and extracellular spikes from a single OFF cell (*middle trace*) in response to square-wave flicker (*bottom trace*) that increased smoothly in frequency.

How do different ganglion cells become synchronized? One might postulate that each individual neuron begins the alternating response rhythm in the same flash period, triggered by some change in the visual stimulus. The observations in Fig. 3 speak against this: where the alternating response begins, the flicker frequency changes very slowly, by <1% during each cycle. Thus the response properties of all ganglion cells in the retina would need to be identically calibrated to within 1% for the synchrony to arise independently. This is very unlikely. For example, different regions of the retina were illuminated with somewhat different intensity, due to the curvature of the eyecup, and intensity was found to significantly affect the threshold frequency for alternating responses (data not shown). Furthermore, on subsequent repeats of the same ramp stimulus, the alternating response initiated a few cycles earlier or later. In summary, the synchronization of many ganglion cells does not simply follow from their individual responses to the visual stimulus, but arises spontaneously within the retinal network, presumably mediated by lateral interactions. We will refer to this phenomenon as "synchronous period-doubling."

As a result of the retina-wide synchrony, period-doubling is easily observed in the ERG (Fig. 1*C* and Fig. 3). Figure 4*A* summarizes how the ERG response period depends on flash frequency with a "bifurcation plot." As frequency increases, the abrupt branches in this plot indicate transitions from a period of 1 to 2, then 4 flash intervals. The subsequent smear along the ordinate reflects the chaotic response around 16 Hz. At higher flash frequencies the branches merge again, indicating successive halving of the response period, until, above 30 Hz, the ERG signal was again periodic with the stimulus. These changes in the response period occurred very suddenly, within a fraction of 1 Hz. In other experiments we varied the contrast of the flashes, while keeping the flash frequency constant (Fig. 4*B*). At low contrast, the ERG followed the stimulus, but its period abruptly switched to 2 and then 4 flash intervals as the contrast increased. At the highest contrasts, the response again became chaotic. Note that the peak amplitude of the ERG grew linearly with contrast over most of this range, suggesting that the signaling processes involved were not saturated by the visual stimulus.

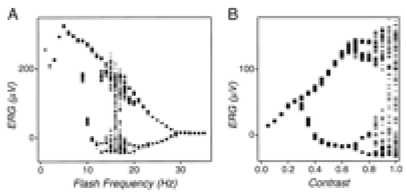


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**FIG. 4.** Bifurcation plot of the salamander ERG. *A*: ERG amplitude as a function of flash frequency at contrast $C = 1.0$. For each frequency value on the abscissa, the ERG was recorded for 12 s. The maximum of this waveform was located, and the values at the corresponding phase in all other flash intervals were plotted on the ordinate. These correspond to the markers on the ERG trace in Fig. 1, *B-E*. *B*: ERG amplitude as a function of contrast at flash frequency $f = 16$ Hz, displayed as in *A*.

## Nonlinear dynamics

This sequence of successive period-doublings has close parallels in the nonlinear dynamics of other physical and mathematical systems (Feigenbaum 1983; Rasband 1990). Often, an accelerating sequence of period-doublings leads to a chaotic regime (Canavier et al. 1990; Guevara et al. 1981). Many nonlinear systems that exhibit period-doubling bifurcations contain some form of negative feedback by which a strong response during one cycle of the input reduces the response to the subsequent cycle. Indeed, a simple model of nonlinear feedback (Fig. 5*A* and METHODS) reproduces the phenomenology observed on the salamander ERG. Here, the peak amplitude of the ERG, $x$, is taken to be proportional to the amplitude of the light flash, $C$, and a gain factor, $g(y)$. This gain, in turn, depends on the amplitude of recent flash responses through the feedback variable $y$. Figure 5, *B* and *C,* shows the behavior of this mechanism as a function of flash frequency and contrast. The model predicts a sequence of period-doublings as the frequency is increased, followed by a reverse sequence of period-halvings until a period of one is reached again at the highest flash rates. Similarly, increasing the contrast leads to a series of period-doublings ending in chaos. With just two parameters, the model can match the approximate locations of the branch points in the experimentally observed sequence (Fig. 4, *A* and *B*). Moreover, it also matches the decrease in ERG amplitude with increasing flash rate (Fig. 4*A*). Thus it is plausible that period-doubling in retinal responses results from a nonlinear gain control.

## Circuit mechanisms

To identify the mechanisms that might produce such effects, we restricted the active circuitry pharmacologically, with a particular aim at negative feedback elements. The phototransduction cascade in rod and cone receptors includes various feedback loops that serve to terminate the light response and adjust its gain to the mean intensity (Baylor 1996). To isolate the photoreceptors from the rest of the retina, we blocked their glutamatergic transmission to second-order cells, by adding to the medium 100 µM APB (Nawy and Jahr 1990) (see METHODS for full names of all compounds) and 50 µM CNQX (Hensley et al. 1993). The ERG derived from photoreceptors alone was strictly periodic with the stimulus at all flash frequencies (Fig. 6*B*) and showed no indication of the period-doublings observed under control conditions (Fig. 6*A*). The same result was obtained when photoreceptors were isolated using 100 mM aspartate (Shimazaki et al. 1984), or 100 µM APB with 5 mM kynurenic acid (Xu et al. 1991). Clearly the nonlinearities of phototransduction are not responsible for perioddoubling.

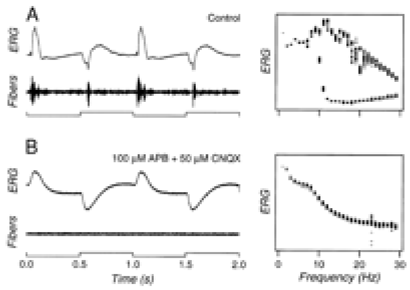


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**FIG. 6.** Phototransduction currents do not undergo period-doubling. *A*: control recordings from the salamander eye cup in Ringer medium. *Left*: ERG (*top trace*) and optic nerve fiber signals (*middle trace*) responding to a 1-Hz flash (*bottom trace*). *Right*: bifurcation plot of ERG amplitude vs. flash frequency, displayed as in Fig. 4*A*. *B*: repeat measurements after the photoreceptor ERG was isolated by adding to the medium 100 µM2-amino-4-phosphonobutyric acid (APB) and 50 µM 6-cyano-7-nitroquinoxaline-2,3-dione (CNQX).

To test the role of refractoriness in ganglion cells, we silenced their action potentials (5 µM tetrodotoxin): the ERG signal still showed frequency-dependent period-doubling. In 1 mM NMDA, which strongly polarizes and thus inactivates ganglion cells and most amacrine cells (Slaughter and Miller 1983), period-doubling still persisted. Thus the effect likely does not require circuitry in the inner retina. To test for destructive interference between responses to the onset and offset of the light flashes, we blocked the ON pathway at the photoreceptor synapse (100 µM APB). As expected, ON-ganglion cell responses disappeared, but the remaining optic disk signals and the ERG still showed strong period-doubling. On the other hand, no period-doubling occurred when ionotropic glutamate receptors were blocked, reducing the functional circuit to cones and ON bipolars[5 mM kynurenic acid; or 50 µM CNQX with 100 µMAP-7 (Diamond and Copenhagen 1995)]. Blocking the light response of horizontal cells [5 mM DOS (Slaughter and Miller 1985)], which eliminates their negative feedback onto cone terminals, had no effect on period-doubling. Finally, we interfered with other negative feedback pathways in the retina using a cocktail of blockers for the inhibitory transmitters GABA and glycine [250 µM picrotoxin (Maguire et al. 1989), 100 µM strychnine (Belgum et al. 1984), 2 mM AVA (Hare and Owen 1996), and 1 mM phaclofen]. As expected, this produced a large increase in ganglion cell firing activity (Fig. 7). It also eliminated the oscillatory potentials in the ON-response of the ERG, thought to derive from inhibitory amacrine circuits (Hamasaki et al. 1990; Wachtmeister and Dowling 1978). However, the ERG still underwent period-doubling during frequency ramps.

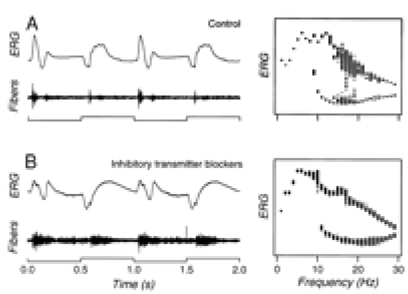


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**FIG. 7.** Inhibitory synaptic transmission is not required for period-doubling. *A*: control recordings from the salamander eye cup in Ringer medium. *Left*: ERG (*top trace*) and optic nerve fiber signals (*middle trace*) responding to a 1-Hz flash (*bottom trace*). *Right*: bifurcation plot of ERG amplitude vs. flash frequency, displayed as in Fig. 4*A*. *B*: repeat measurements after adding to the medium blockers of inhibitory transmission: 250 µM picrotoxin, 100 µM strychnine, 2 mM D-aminovaleric acid (AVA),1 mM phaclofen.

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Thus synchronous period-doubling originates after the photoreceptors but before ganglion cells. It occurs in the isolated OFF pathway, consistent with the fact that ON responses are lost at lower flash frequencies. Period-doubling does not seem to rely on intercellular inhibitory feedback. The minimal circuit required to produce period-doubling under all the above conditions consists of only cones and OFF-bipolar cells.

### Human vision

ERG. To explore whether period-doubling occurs in human vision, we measured the ERG of three subjects under bright full-field periodic flashes. Figure 8*A* illustrates the ERG waveform at two flash frequencies. At 26 Hz the ERG response repeated identically with every flash, but at 46 Hz alternating flashes produced large or small peaks. This alternating rhythm was maintained without breaks throughout a 200-s recording. Note the close analogy to ERG waveforms from the salamander eyecup (Fig. 1, *B* and *C*).

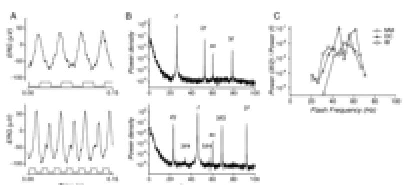

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**FIG. 8.** Response of the human ERG to uniform flicker. *A*: raw waveform recorded at flash frequencies of $f$ = 26 Hz (*top*) and 46 Hz (*bottom*). *B*: power spectrum of the ERG at $f$ = 26 Hz (*top*) and 46 Hz (*bottom*), computed over a 200-s window, and normalized to the power density at $f$. Peaks at harmonics and subharmonics of the flash frequency are labeled; ac, 60-Hz line interference. *C*: relative strength of period-doubling in the ERG of 3 subjects, measured as a function of flash frequency, by the ratio of (power at $3f/2$) to (power at $f$). The subharmonic modulation was evaluated at $3f/2$ rather than $f/2$ because of the severe increase in the background power at low frequencies (see *B*), which is mostly due to eye movement transients.

The strength of period-doubling in these signals is revealed by their power spectrum (Fig. 8*B*). Under 26-Hz stimulation the spectrum contains peaks only at the stimulus frequency ($f$) and its higher harmonics ($2f$, $3f$, ···). However, under 46-Hz stimulation, one also finds peaks at the even subharmonics of the stimulus frequency ($f/2$, $f/4$) or their multiples ($3f/2$, $3f/4$, $5f/4$). This occurs because certain components of the response repeat only over even multiples of the stimulus period. One obtains a simple measure of this period-doubling by comparing the power at $f$ with that at the subharmonics (Fig. 8*C*): period-doubling was strictly limited to the range between 30 and 70 Hz. At both ends of the range, the effect disappeared very suddenly: the relative power of the subharmonics changed by a factor of 100 over 10 Hz, similar to the sharp frequency dependence seen in salamander (Figs. 3 and 4*A*). The absolute frequencies at which alternating responses were observed are about threefold higher in humans than in the salamander. This correlates well with the relative speeds of other retinal processes; for example, the flash response of primate cones (Schnapf et al. 1990) is two- to threefold faster than that of salamander cones (Matthews et al. 1990).

VISUAL EVOKED POTENTIALS. Whereas the flash ERG is dominated by contributions from the outer retina, the time structure of visual signals that reach the brain is revealed in scalp potentials from the occipital part of the head. This VEP to a periodic stimulus is generally thought to vary at the stimulus frequency and its higher harmonics (Regan 1989). Under the above stimulus conditions we observed very different behavior (Fig. 9): At $f$ = 51 Hz, the VEP had a period of two flash intervals, and the dominant component of the power spectrum was at $f/2$. At 16 Hz, there was no indication of period-doubling in the VEP waveform or its power spectrum. Generally, the degree of period-doubling, as measured by the power in subharmonics of the flash frequency, was much greater in the VEP response than in the ERG (compare Figs. 9*C* and 8*C*). This can be understood because the ERG includes signals from the outer retina that still follow every flash (see Figs. 1*C* and 6*B*). Near $f$ = 50 Hz, the VEP power at the $f/2$ subharmonic even exceeded the power at the stimulus frequency, $f$. In this regime, it appears that the majority of retinal ganglion cells respond exclusively to every other flash, and do so in synchrony across the visual field. This affects visual processing in all subsequent visual circuits.

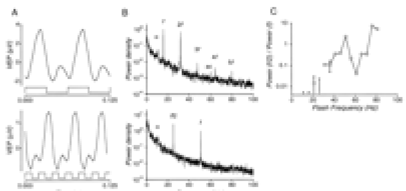

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**FIG. 9.** Response of the human visual evoked potential (VEP) to uniform flicker. *A*: average VEP waveform of *subject MM,* triggered on the odd flashes over a 100-s recording, at $f$ = 16 Hz (*top*) and 51 Hz (*bottom*). *B*: power spectrum of the VEP at $f$ = 16 Hz (*top*) and 51 Hz (*bottom*). Peaks at harmonics and subharmonics of the flash frequency are labeled; ac, 60-Hz line interference; α, alpha waves. *C*: relative strength of period-doubling in the VEP, measured as a function of flash frequency, by the ratio of (power at $f/2$) to (power at $f$). Error bars indicate uncertainty due to the background electroencephalogram (EEG) power. For flicker at $f \leq 26$ Hz, the power spectrum had no significant peak at $f/2$.

PERCEPTION. All human subjects reported strong perceptual effects during these experiments. At flash frequencies near 50 Hz, there was little or no perceptible flicker, but the field showed a strong spatial pattern: a distinct yellow region in the center of gaze, 35-50° diam, surrounded by an intensely bright, blue-white region in the periphery. Note that this illusion is a striking violation of the Talbot-Plateau law, which states that for flicker frequencies above perceptual fusion the field should have the same appearance as a steady light of the same mean intensity (van de Grind et al. 1973).

This yellow spot was first described by Welpe (Welpe 1970). It is of retinal origin, because binocular stimulation produced two yellow spots of slightly different shape, alternating in binocular rivalry. We found that the spot's diameter increased at both lower and higher flash rates. Because the strength of the $f/2$ signal in the ERG decreases on either side of 50 Hz (Fig. 7*C*), one suspects that period-doubling originates in the peripheral region outside the yellow spot, possibly because peripheral retina is more sensitive at high flicker rates (Seiple and Holopigian 1996). This was confirmed by varying the visual display: limiting the flash stimulus to the central 65° abolished the $f/2$ components in the ERG, whereas occluding the central 35° of the flashing field had no such effect.

These observations suggest that near $f$ = 50 Hz the ganglion cells in the periphery respond synchronously at $f/2$, whereas those in the center respond at $f$ or have lost any phase-locking to the flashes. The resulting difference in spike patterns received from central and peripheral neurons may evoke the marked increase of perceived brightness in the periphery.

# DISCUSSION

Our view of temporal processing in the visual system is revised in several aspects. From previous work, it had been assumed that the response of retinal neurons degrades gracefully at high temporal frequencies, with a gradual loss of phase-locking to the stimulus (Enroth 1952+; van de Grind et al. 1973+). Instead, under certain stimulus conditions, the retinal output undergoes a series of successive period-doublings before flicker fusion is reached. In this regime, retinal responses are synchronized across the retina, over distances of several centimeters in the human eye. Underlying this, there appears to be a mechanism of strong nonlinear feedback, possibly in retinal bipolar cells, along with lateral coupling circuits that promote the global synchrony. The resulting temporal and spatial structure of the optic nerve signals affects all subsequent visual processing and leads to illusory percepts under high-frequency flicker.

**History**

There have been isolated reports of subharmonic responses to a periodic flicker stimulus. Remarkably, they were seen in some of the earliest recordings from retina (Adrian and Matthews 1928+). In optic nerve signals from the eel eye, period-doubling occurred at ~14 Hz, similar to the first bifurcation frequency we measured in salamander (Fig. 4*A*). Later on, Best and Bohnen (1957)+ reported "alternating potentials" in the human ERG under bright square-wave flicker. This subharmonic response was evident at frequencies between 40 and 60 Hz, similar to the range reported here (Fig. 7*C*). In visual evoked potentials, subharmonic components were thought to be rare (Regan 1972+), but exceptions have been reported, notably in dog (Lopes da Silva et al. 1970+) and fish (Karamursel and Bullock 1994+). None of these observations were pursued to trace their cellular origins or implications for visual function.

By contrast, this subject has received considerable attention in the auditory system. For sound frequencies above ~100 Hz, auditory nerve neurons no longer fire in every cycle of the pressure wave. Yet their patterns of firing somehow encode both frequency and intensity of the sound. An early "volley theory" proclaimed that individual nerve fibers fire systematically on every *n*th cycle of the sound wave, and that nerve fibers from neighboring hair cells are locked to different cycles (Wever 1949+). In this way the collection of auditory afferents would faithfully produce one spike volley for every cycle. This idea has been thoroughly disproved. Individual auditory nerve fibers fire stochastically in each cycle. As a result, the histogram of interspike intervals in such a spike train shows all multiples of the stimulus period, with probabilities declining roughly exponentially with interval length (Kiang 1965+). Power spectra of the spike trains in this regime show no indication of a subharmonic component at 1/*n*th of the stimulus frequency (Javel et al. 1988+). Finally, nearby auditory fibers are statistically independent in whether they fire during the same cycle or not (Kiang 1990). On all counts, this behavior at high stimulus frequencies is very different from the period-doubling we describe. Thus period-doubling is not a necessary consequence of high-frequency stimulation, but arises from a specific type of processing within the retinal network.

**Mechanisms**

Our pharmacological analysis showed that the photoreceptors themselves do not produce period-doubling in the ERG. Perturbations of neurons in the inner retina did not abolish the effect. Also, inhibitory feedback among neurons was not required. It appears that period-doubling arises at the synapse between photoreceptors and bipolar cells. Several candidate mechanisms exist, although we have no evidence yet to distinguish them.

For example, the nonlinear feedback might involve a delayed voltage-activated conductance in the bipolar cell membrane (Klumpp et al. 1995; Tessier-Lavigne et al. 1988) that reduces the gain of the light response for a short period after a strong flash (Lasansky 1992; Mao et al. 1998). In this context, the model of Fig. 5*A* might have the following components: synaptic input current during the first flash cycle depolarizes the bipolar cell membrane potential ($x$), which leads to a delayed activation (with time constant $\tau$) of an outward conductance ($y$). This reduces the membrane impedance ($g$), which, in turn, limits the cell's response to synaptic current from the subsequent flash. The synchronization of nearby bipolar cells could be achieved if they are electrically coupled (Cohen and Sterling 1990; Hare and Owen 1990; Raviola and Gilula 1975; Saito and Kujiraoka 1988). For two bipolar cells that respond to alternating flashes in the same phase, electrical coupling will have no effect, because they produce the same membrane potential at all times. However, if they respond out of phase, electrical coupling reduces the swing of the membrane potential in each cell, thus reducing the amount of negative feedback. Therefore the threshold for period-doubling of the synchronous mode is lower than for the asynchronous mode, and synchrony will be favored as period-doubling develops.

A similar mechanism might operate presynaptically: the membrane of the photoreceptor inner segment contains an inward-rectifying conductance, $I_h$, activated by hyperpolarization below −50 mV, and with a reversal potential above the cell's resting potential (Bader and Bertrand 1984). In response to a strong flash of light, the outer segment current shuts off, the inner segment rapidly hyperpolarizes, but after a short delay $I_h$ is activated and repolarizes the cell to a plateau (Baylor et al. 1984). While this conductance is active, the subsequent flash will produce a smaller voltage response. In lizard cones, the time constant for activation of $I_h$ has been measured near 52 ms (Maricq and Korenbrot 1990), comparable with the value of $\tau$ = 58 ms derived from Fig. 5, *B* and *C*. This feedback loop could lead to period-doubling in the membrane voltage at the cone terminal, and thus in the response of second-order neurons. On the other hand, the conductance changes at the inner segment produce no noticeable change in the circulating current through the outer segment membrane (Baylor et al. 1984), which makes the photoreceptor's contribution to the ERG. This could explain why the isolated photoreceptor ERG never showed an alternating response (Fig. 6*B*). In this scheme, photoreceptors could become synchronized if they are electrically coupled near their terminals (Attwell et al. 1984♦; Schneeweis and Schnapf 1995♦; Tsukamoto et al. 1992♦), for the same reasons invoked above for bipolar cells.

Clearly, the above proposals are speculative, and intracellular recordings would help pinpoint the site of period-doubling. We attempted to interfere with lateral coupling by treating the salamander retina with putative gap-junction blockers, such as heptanol or intracellular acidification by acetate (DeVries and Schwartz 1989♦; Spray and Burt 1990♦ ). Unfortunately, these treatments have rather nonspecific effects throughout the retina, and light responses often changed substantially or ceased before period-doubling was affected. More specific blockers will be needed before the role of gap-junctions can be tested directly.

**Visual processing**

The mechanisms discussed above act to reduce the gain of the photoreceptor or the bipolar cell in the face of strong swings of the light intensity. This would help stabilize the neuron's response and keep the membrane potential in a range where the synaptic output is still modulated. Such a feedback pathway may well underlie the rapid contrast gain control documented in cat retina (Victor 1987♦).

More generally, one expects that such a gain control would serve any neuron in dealing with strong fluctuations of its input signals. In fact, we have some indications that period-doubling also occurs beyond the retina. For example, the alternating response in the human ERG was abolished when the stimulus covered only the center 65°, whereas the VEP still showed a strong subharmonic component under these conditions. Similarly, reducing the light intensity by a factor of 4 abolished period-doubling in the ERG, but not in the VEP (data not shown). This suggests that period-doubling can arise at a second site, possibly in cortical circuits.

At flash frequencies of ~10-30 Hz, we observed no subharmonics in the ERG or the VEP, but human subjects reported dramatic visual illusions: the field broke up into varying geometric patterns that appeared to flicker violently, with neighboring regions flashing in counterphase. The phenomenology of these flicker patterns has been described extensively (Purkinje 1819♦; Smythies 1959♦). They could be explained if neurons in a retinotopic map, for example in visual cortex, respond at $f/2$, but their activity is not globally synchronized. If two adjacent regions respond to the odd and even flashes, respectively, the percept of spatial structure with counterphase flicker could arise. The shape of the regions corresponding to the two phases would reflect the circuits of lateral inhibition and excitation within the map. Because adjacent out-of-phase regions make opposite contributions to large-scale field potentials, one would not observe such local period-doubling in the VEP, but it could well be studied with single-unit electrodes.

# REFERENCES


- ADRIAN, E. D., MATTHEWS, R. The action of light on the eye. Part III. The interaction of retinal neurones. J. Physiol. (Lond.) 65: 273-298, 1928.
- ATTWELL, D., WILSON, M., WU, S. M. A quantitative analysis of interactions between photoreceptors in the salamander (Ambystoma) retina. J. Physiol. (Lond.) 352: 703-737, 1984.[Abstract]
- BADER, C. R., BERTRAND, D. Effect of changes in intra- and extracellular sodium on the inward (anomalous) rectification in salamander photoreceptors. J. Physiol. (Lond.) 347: 611-631, 1984.[Abstract]
- BAYLOR, D. How photons start vision. Proc. Natl. Acad. Sci. USA 93: 560-565, 1996.[Abstract/Free Full Text]
- BAYLOR, D. A., MATTHEWS, G., NUNN, B. J. Location and function of voltage-sensitive conductances in retinal rods of the salamander, Ambystoma tigrinum. J. Physiol. (Lond.) 354: 203-223, 1984.[Abstract]
- BELGUM, J. H., DVORAK, D. R., MCREYNOLDS, J. S. Strychnine blocks transient but not sustained inhibition in mudpuppy retinal ganglion cells. J. Physiol. (Lond.) 354: 273-286, 1984.[Abstract]
- BEST, W., BOHNEN, K. Alternierende Potentiale im Elektroretinogramm des Menschen bei Flimmerbelichtung. Acta Ophthalmol. 35: 273-278, 1957.
- CANAVIER, C. C., CLARK, J. W., BYRNE, J. H. Routes to chaos in a model of a bursting neuron. Biophys. J. 57: 1245-1251, 1990.[Abstract]
- COHEN, E., STERLING, P. Demonstration of cell types among cone bipolar neurons of cat retina. Philos. Trans. R. Soc. Lond. B Biol. Sci. 330: 305-321, 1990.[Medline]
- DEVRIES, S. H., SCHWARTZ, E. A. Modulation of an electrical synapse between solitary pairs of catfish horizontal cells by dopamine and second messengers. J. Physiol. (Lond.) 414: 351-375, 1989.[Abstract]
- DIAMOND, J. S., COPENHAGEN, D. R. The relationship between light-evoked synaptic excitation and spiking behaviour of salamander retinal ganglion cells. J. Physiol. (Lond.) 487: 711-725, 1995.[Abstract]
- ENROTH, C. The mechanism of flicker and fusion studied in single retinal elements in the dark-adapted eye of the cat. Acta Physiol. Scand. 27, Suppl. 100: 1-67, 1952.
- FEIGENBAUM, M. Universal behavior in nonlinear systems. Physica 7D: 16-39, 1983.
- GUEVARA, M. R., GLASS, L., SHRIER, A. Phase locking, period-doubling bifurcations, and irregular dynamics in periodically stimulated cardiac cells. Science 214: 1350-1353, 1981.[Medline]
- HAMASAKI, D. I., TUCKER, G. S., MAGUIRE, G. W. Alterations of the cat's electroretinogram induced by the lesioning of the indoleamine-accumulating amacrine cells. Ophthalmic Res. 22: 19-30, 1990.[Medline]
- HARE, W. A., OWEN, W. G. Spatial organization of the bipolar cell's receptive field in the retina of the tiger salamander. J. Physiol. (Lond.) 421: 223-245, 1990.[Abstract]
- HARE, W. A., OWEN, W. G. Receptive field of the retinal bipolar cell—a pharmacological study in the tiger salamander. J. Neurophysiol. 76: 2005-2019, 1996.[Abstract/Free Full Text]
- HENSLEY, S. H., YANG, X. L., WU, S. M. Identification of glutamate receptor subtypes mediating inputs to bipolar cells and ganglion cells in the tiger salamander retina. J. Neurophysiol. 69: 2099-2107, 1993.[Abstract/Free Full Text]
- JAVEL, E., MCGEE, J. A., HORST, J. W., FARLEY, G. R. Temporal mechanisms in auditory stimulus coding. In: Auditory Function: Neurobiological Bases of Hearing, edited by G. M. Edelman, W. E. Gall, and W. M. Cowan New York: Wiley, 1988, p. 515-558.
- KARAMURSEL, S., BULLOCK, T. H. Dynamics of event-related potentials to trains of light and dark flashes: responses to missing and extra stimuli in elasmobranch fish. Electroencephalogr. Clin. Neurophysiol. 90: 461-471, 1994.[Medline]
- KELLY, D. H. Flicker. In: Handbook of Sensory Physiology, edited by D. Jameson, and L. M. Hurvich New York: Springer, 1972, p. 273-302.
- KIANG, N.Y.S. In: Discharge Patterns of Single Fibers in the Cat's Auditory Nerve. Cambridge, MA: MIT Press, 1965.
- KIANG, N.Y.S. Curious oddments of auditory-nerve studies. Hear. Res. 49: 1-16, 1990.[Medline]
- KLUMPP, D. J., SONG, E. J., ITO, S., SHENG, M. H., JAN, L. Y., PINTO, L. H. The Shaker-like potassium channels of the mouse rod bipolar cell and their contributions to the membrane current. J. Neurosci. 15: 5004-5013, 1995.[Abstract]
- LASANSKY, A. Properties of depolarizing bipolar cell responses to central illumination in salamander retinal slices. Brain Res. 576: 181-196, 1992.[Medline]
- LEE, B. B., MARTIN, P. R., VALBERG, A. Sensitivity of macaque retinal ganglion cells to chromatic and luminance flicker. J. Physiol. (Lond.) 414: 223-243, 1989.[Abstract]
- LOPES DA SILVA, F. H., ROTTERDAM, A. V., STORM VAN LEEUWEN, W., TIELEN, A. M. Dynamic characteristics of visual evoked potentials in the dog. I. Cortical and subcortical potentials evoked by sine wave modulated light. Electroencephalogr. Clin. Neurophysiol. 29: 246-259, 1970.[Medline]

- MAGUIRE, G., LUKASIEWICZ, P., WERBLIN, F. Amacrine cell interactions underlying the response to change in the tiger salamander retina. J. Neurosci. 9: 726-735, 1989.[Abstract]
- MAO, B. Q., MACLEISH, P. R., AND VICTOR, J. D. The intrinsic dynamics of retinal bipolar cells isolated from tiger salamander. Vis. Neurosci. In press.
- MARICQ, A. V., KORENBROT, J. I. Inward rectification in the inner segment of single retinal cone photoreceptors. J. Neurophysiol. 64: 1917-1928, 1990.[Abstract/Free Full Text]
- MATTHEWS, H. R., FAIN, G. L., MURPHY, R. L., LAMB, T. D. Light adaptation in cone photoreceptors of the salamander: a role for cytoplasmic calcium. J. Physiol. (Lond.) 420: 447-469, 1990.[Abstract]
- MEISTER, M., PINE, J., BAYLOR, D. A. Multi-neuronal signals from the retina: acquisition and analysis. J. Neurosci. Methods 51: 95-106, 1994.[Medline]
- NAWY, S., JAHR, C. E. Suppression by glutamate of cGMP-activated conductance in retinal bipolar cells. Nature 346: 269-271, 1990.[Medline]
- PURKINJE, J. E. Beiträge zur Kenntniss des Sehens in subjectiver Hinsicht. Prague: J. G. Calve, 1819.
- RASBAND, S. N. In: Chaotic Dynamics of Nonlinear Systems. New York: Wiley, 1990.
- RAVIOLA, E., GILULA, N. B. Intramembrane organization of specialized contacts in the outer plexiform layer of the retina. A freeze-fracture study in monkeys and rabbits. J. Cell Biol. 65: 192-222, 1975.[Abstract]
- REGAN, D. In: Evoked Potentials in Psychology, Sensory Physiology and Clinical Medicine. London: Chapman & Hall, 1972.
- REGAN, D. In: Human Brain Electrophysiology: Evoked Potentials and Evoked Magnetic Fields in Science and Medicine. New York: Elsevier, 1989.
- SAITO, T., KUJIRAOKA, T. Characteristics of bipolar-bipolar coupling in the carp retina. J. Gen. Physiol. 91: 275-287, 1988.[Abstract]
- SCHNAPF, J. L., NUNN, B. J., MEISTER, M., BAYLOR, D. A. Visual transduction in cones of the monkey Macaca fascicularis. J. Physiol. (Lond.) 427: 681-713, 1990.[Abstract]
- SCHNEEWEIS, D. M., SCHNAPF, J. L. Photovoltage of rods and cones in the macaque retina. Science 268: 1053-1056, 1995.[Medline]
- SEIPLE, W., HOLOPIGIAN, K. Outer-retina locus of increased flicker sensitivity of the peripheral retina. J. Opt. Soc. Am. A 13: 658-666, 1996.[Medline]
- SHIMAZAKI, H., KARWOSKI, C. J., PROENZA, L. M. Aspartate-induced dissociation of proximal from distal retinal activity in the mudpuppy. Vision Res. 24: 587-595, 1984.[Medline]
- SLAUGHTER, M. M., MILLER, R. F. The role of excitatory amino acid transmitters in the mudpuppy retina: an analysis with kainic acid and N-methyl aspartate. J. Neurosci. 3: 1701-1711, 1983.[Abstract]
- SLAUGHTER, M. M., MILLER, R. F. Identification of a distinct synaptic glutamate receptor on horizontal cells in mudpuppy retina. Nature 314: 96-97, 1985.[Medline]
- SMYTHIES, J. R. The stroboscopic patterns. II. The phenomenology of the bright phase and after-images. Br. J. Psychol. 50: 305-324, 1959.[Medline]
- SPEKREIJSE, H., VAN NORREN, D., VAN DEN BERG, T. J. Flicker responses in monkey lateral geniculate nucleus and human perception of flicker. Proc. Natl. Acad. Sci. USA 68: 2802-2805, 1971.[Abstract]
- SPRAY, D. C., BURT, J. M. Structure-activity relations of the cardiac gap junction channel. Am. J. Physiol. 258: C195-C205, 1990.[Abstract/Free Full Text]
- TESSIER-LAVIGNE, M., ATTWELL, D., MOBBS, P., WILSON, M. Membrane currents in retinal bipolar cells of the axolotl. J. Gen. Physiol. 91: 49-72, 1988.[Abstract]
- TSUKAMOTO, Y., MASARACHIA, P., SCHEIN, S. J., STERLING, P. Gap junctions between the pedicles of macaque foveal cones. Vision Res. 32: 1809-1815, 1992.[Medline]
- VAN DE GRIND, W. A., GRÜSSER, O.-J., LUNKENHEIMER, H.-U. Temporal transfer properties of the afferent visual system. In: Handbook of Sensory Physiology, edited by and R. Jung New York: Springer-Verlag, 1973, p. 431-573.
- VICTOR, J. D. The dynamics of the cat retinal X cell centre. J. Physiol. (Lond.) 386: 219-246, 1987.[Abstract]
- WACHTMEISTER, L., DOWLING, J. E. The oscillatory potentials ofthe mudpuppy retina. Invest. Ophthalmol. Vis. Sci. 17: 1176-1188, 1978.[Abstract]
- WELPE, E. Über die Strukturierung des Gesichtsfeldes bei intermittierender Belichtung des Auges im Frequenzbereich zwischen 33 Hz und der Flimmerverschmelzungsfrequenz. Vision Res. 10: 1457-1469, 1970.[Medline]
- WERBLIN, F. Synaptic connections, receptive fields, and patterns of activity in the tiger salamander retina. Invest. Ophthalmol. Vis. Sci. 32: 459-483, 1991.[Medline]
- WEVER, E. G. In: Theory of Hearing. New York: Wiley, 1949.
- XU, X. J., XU, J., HUANG, B., LIVSEY, C. T., KARWOSKI, C. J. Comparison of pharmacological agents (aspartate vs. aminophosphonobutyric plus kynurenic acids) to block synaptic transmission from retinal photoreceptors in frog. Exp. Eye Res. 52: 691-698, 1991.[Medline]

# *The Nature of Sound*

A vibrating object will produce a sequence of compressions and rarefactions in the air surrounding it. These small fluctuations in air pressure travel away from the source at relatively high speed, gradually dying off as their energy is spread over a wider and wider area and is absorbed by the medium. What we call sound is simply the sensation produced by the ear when stimulated by these vibrations.

Consider the air close to the surface of some vibrating object. As the surface moves forwards, the air molecules next to the surface are pushed closer together to form an area of increased pressure. The air cannot move back into its original position as the space is now occupied by the advancing surface. The increased pressure forces some of this air to move outwards, which then pushes the air further out closer together and so on, creating a pressure wave moving away from the surface. As the vibrating surface recedes, it creates an area of reduced pressure, drawing the nearby air back towards it, as shown in Figure 1 below. For us to be able to perceive this as sound, these cycles have to occur many hundreds or even thousands of times a second.

**Properties of Sound**

If you were to graph the pressure maxima and minima at any given instant, what you get is something that looks like a sinusoidal wave. It should be noted that air cannot sustain any form of shear stress so sound can only be transmitted as a longitudinal wave.

## Amplitude

Refers to the difference between maximum and minimum pressure. In a sound wave, pressure fluctuations are symmetrical about the current atmospheric pressure (as measured by a barometer). For simplicity, and because this value can take hours to change, a reference value of zero is normally used. Thus maximum pressure is given as a positive value and minimum as a negative.

## Frequency

Refers to the number of pressure peaks that pass a particular point in space over a period of one second. Thus a 1kHz (1000Hz) sound would have 1000 waves pass a point each second.

## Wavelength

Refers to the physical distance between successive pressure maxima and is thus dependant on the speed of sound in the medium divided by the frequency of the wave. This relationship is given by:

$$V = \lambda * f$$

Where:

$V$ = velocity (m/s),

$\lambda$ = wavelength (m) and

$f$ = frequency (Hz).

## Velocity

Refers to the speed of travel of the sound wave, basically how far a specific pressure maxima moves in one second. This varies between mediums and is also dependant on temperature. Assuming air acts as an ideal gas, its velocity relates to temperature as follows:

$$V = 331.5 + (0.6\ T)$$

Where:

$V$ = velocity (m/s) and

$T$ = air temperature (°C).

In other materials, the speed of sound can vary quite substantially. The following table shows the speed of sound in a number of different materials.

| Material | Speed of Sound (m/s) |
|---|---|
| Steel | 6100 |
| Aluminium | 4877 |
| Brick | 4176 |
| Hardwood | 3962 |
| Glass | 3962 |
| Copper | 3901 |
| Brass | 3475 |
| Concrete | 3231 |
| Water | 1433 |
| Lead | 1158 |
| Cork | 366 |
| Air | 343 |
| Rubber | 150 |

**Table 1 – Speed of sound in a selection of materials.**

(from the IAC Noise Control Reference Handbook, 1989 Edition)

| United States Patent | *4,632,126* |
|---|---|
| Aguilar | December 30, 1986 |

# Biofeedback method and apparatus

**Abstract**

The new biofeedback technique permits simultaneous, preferably redundant visual and auditory presentation of any intrinsically motivating stimuli together with continous information pertaining to the physiological parameter to be controlled. Essentially, it varies the signal to noise ratio (S/N) of an audio or video signal as a function of any physiological parameter or combination of several parameters. That is, intrinsically motivating stimuli, visual and auditory, are presented through a color TV set; image and sound are initially masked by white noise, set to a level just above perception (minimum signal and maximum noise). As the experimental subject changes a certain physiological parameter, image and sound become clearer if the change occurs in the desired direction. The video signal remains synchronized at any noise level. The final S/N ratio has been utilized as an index of motivation in an experiment to evaluate the efficiency of the new technique.

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| | |
|---|---|
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| **Intern'l Class:** | A61B 005/04; A63B 071/04 |
| **Field of Search:** | 128/630,731,732,733,905,668 |

**References Cited [Referenced By]**

**U.S. Patent Documents**

| | | | |
|---|---|---|---|
| 3841316 | Oct., 1974 | Meyer | 273/1. |
| 3890957 | Jun., 1975 | Freeman | 128/732. |
| 3893450 | Jul., 1975 | Ertl | 273/DIG. |
| 4149716 | Apr., 1979 | Scudder | 273/DIG. |
| 4170225 | Oct., 1979 | Criglar et al. | 128/733. |
| 4335710 | Jun., 1982 | Williamson | 128/1. |
| 4358118 | Nov., 1982 | Plapp | 273/1. |
| 4461301 | Jul., 1984 | Ochs | 128/732. |

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*Attorney, Agent or Firm:* Bloom; Leonard

## *Claims*

What is claimed is:

1. An apparatus for making unconscious and involuntary bodily responses perceptible to at least one sense of a subject in order for the subject to manipulate said responses by conscious mental control, comprising:

first means for providing a physiological stimulus perceptible to at least one sense of the subject;

second means for measuring the unconscious and involuntary bodily responses of the subject to the physiological stimulus;

third means for generating a noise signal in response to the measurement of the unconscious and involuntary bodily responses of the subject; and

fourth means for distorting the stimulus with the noise signal generated, thereby making said unconscious and involuntary bodily responses perceptible to at least one sense of the subject, so that said responses may be manipulated.

2. The device of claim 1, wherein said first means is any auditory stimuli susceptible of presentation through an audio amplifier and speaker.

3. The device of claim 1, wherein said first means is any visual stimuli susceptible of presentation through a video monitor or television screen.

4. The device of claim 1, wherein said third means comprises a white noise generator coupled to said first means and adapted to decrease as a function of the subject's ability to manipulate the unconscious and involuntary bodily response desired in a chosen direction, whereby said first means becomes clearer to the subject.

5. The device of claim 2, wherein said third means comprises a white noise generator coupled to said first means and adapted to decrease as a function of the subject's ability to manipulate the unconscious and involuntary bodily response desired in a chosen direction, whereby said first means becomes clearer to the subject.

6. The device of claim 3, wherein said third means comprises a white noise generator coupled to said first means and adapted to decrease as a function of the subject's ability to manipulate the unconscious and involuntary bodily response desired in a chosen direction, whereby said first means becomes clearer to the subject.

7. The device of claim 6, wherein said first means further comprises an audio input, and wherein said second means is in the form of a physiological signal input, the numeric value for which is modified by taking the square root thereof, a quantity thus derived multiplied by said audio input, said same quantity is similarly modified by a video input, an inverse of the square root of said quantity is multiplied by a signal from the white noise generator, the output of which is added respectively to the modified auditory input and the modified visual input, whereby auditory and visual stimuli are conditioned by said white noise generator and the subject's ability to alter said second means, and means for denoting the ratio of said auditory signal applied and said visual signal applied as a function of said white noise generator signal conditioned by said inverse of said physiological signal input.

8. An improvement in a biofeedback system comprising, in combination:

a parameter measuring means adapted to monitor change in at least one unconscious and involuntary physiological characteristic of a subject,

means providing a stimuli to the subject, and a stimuli enhancing means coupled operatively to said measuring means and to said stimuli providing means and including means for generating a noise signal to vary discernability of said stimuli,

whereby incentive is provided to increase discernability of said stimuli for biofeedback conditioning.

9. The device of claim 8, wherein said stimuli providing means is any auditory stimuli.

10. The device of claim 8, wherein said stimuli providing means is any visual stimuli.

11. The device of claim 8, wherein said means for generating a noise signal is a white noise generator signal coupled to said stimuli providing means and adapted to decrease as a function of the subject's ability to manipulate the characteristic desired in a chosen direction, whereby said stimuli providing means becomes clearer to the subject.

12. A method for enhancing biofeedback conditioning including the steps of:

measuring at least one unconscious and involuntary physiological parameter of the subject to be conditioned,

deriving a voltage signal corresponding to the measurement, with a source of stimuli to be imparted to one of the senses of the subject,

distorting the source of stimuli with a noise signal and

lowering the distortion in response to control of the parameter by the subject.

13. The method of motivating a subject to control an unconscious and involuntary physiological parameter of the subject's body, comprising the steps of providing a stimulus to be sensed by the subject, measuring the physiological parameter, generating a noise signal in response to the measurement of the parameter, and using the noise signal to distort the stimulus, such that the stimulus becomes clearer as the physiological parameter is controlled by the subject.

14. The method of claim 13, wherein the stimulus comprises a visual signal presented on a television set viewed by the subject.

15. The method of claim 13, wherein the stimulus comprises an audio signal heard by the subject.

16. The method of motivating a human subject to control an unconscious and involuntary physiological parameter of the subject's body, comprising the steps of allowing the subject to both view a video signal on a television screen and simultaneously listen to an audio signal, detecting and measuring the physiological parameter, generating a noise signal in response to the measurement of the parameter, and using the noise signal to distort the video and audio signals; such that as the parameter is controlled by the subject, the noise signals are reduced to reduce the distortion, and the visual and audio signals become clearer to the subject.

17. A biofeedback system to assist a subject to control at least one unconscious and involuntary physiological parameter of the subject's body, comprising, in combination, means for providing at least one stimulus to be imparted to one of the subject's senses, means for measuring the physiological parameter of the subject and obtaining a signal in response thereto, a noise generator for obtaining a noise in response to the signal from the parameter being measured, and means for distorting the stimulus in accordance with the noise; such that as the subject controls the physiological parameter being measured, the noise is reduced and the stimulus imparted to the subject becomes less distorted.

18. In a biofeedback system, wherein at least one unconscious and involuntary physiological parameter of a subject is being monitored and is intended to be controlled by the subject using biofeedback, the

improvement which comprises means for providing a signal to be sensed by the subject, means for generating noise in response to the physiological parameter being monitored, means for mixing the noise with the signal, thereby providing a signal-to-noise ratio and distorting the signal, and means for varying the signal-to-noise ratio in accordance with the parameter being monitored, such that the signal-to-noise ratio will be increased and the distortion decreased as the subject controls the physiological parameter using biofeedback.

19. In a biofeedback method, wherein at least one unconscious and involuntary physiological parameter of a subject is being monitored and is intended to be controlled by the subject using biofeedback, the improvement which comprises, in combination, providing a signal to the subject, mixing the signal with noise, thereby providing a signal-to-noise ratio, setting the signal-to-noise ratio just above minimum perception of the signal by the subject, and varying the signal-to-noise ratio in accordance with the physiological parameter being monitored, whereby as the subject controls the physiological parameter, the signal-to-noise ratio will be increased and the signal will become clearer, thereby motivating the subject to control the physiological parameter using biofeedback.

20. A method of making unconscious and involuntary bodily responses perceptible to at least one sense of a subject in order for the subject to manipulate said responses by conscious mental control, comprising:

first, providing a physiological stimulus perceptible to at least one sense of the subject;

second, measuring the unconscious and involuntary bodily responses of the subject to the physiological stimulus;

third, generating a noise signal in response to the measurement of the unconscious and involuntary bodily responses of the subject; and

fourth, distorting the stimulus with the noise signal generated, thereby making said unconscious and involuntary bodily responses perceptible to at least one sense of the subject, so that said responses may be manipulated.

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## ***Description***

BACKGROUND OF THE INVENTION

This invention relates generally to a method and apparatus for biofeedback conditioning. More particularly, this invention relates to a device having audio and visual stimuli adapted to react to at least one parameter of the subject being evaluated, an iterative process being defined thereby with the audio and visual stimuli changing as a function of patient parameter variation.

Biofeedback represents an attempt to utilize the engineering principle of feedback control on human organisms. The importance of this control, from a psychological point of view, is that the functions to be controlled are those associated with the structures that determine the emotional status of the organism. However, whereas machines have a hard wired algorithm ("drive") to reduce the error signal, humans require a "voluntary" motivational drive to develop the algorithm that achieves the goal of physiological control. Hitherto used error signal means for presenting information have not been intrinsically motivating (i.e. nobody likes or dislikes a meter needle). Since development of those algorithms in human learning requires error-signal detection through feedback (stimulus discrimination) as well as optimum drive level through feedforward (motivation), it would be more efficient to manipulate both variables through the same feedback device.

The biofeedback process can be expressed in cybernetic terms as a system (the organism) provided with an external feedback loop and a transfer function which permits the efficient perception of the functions to be controlled. A man-machine symbiosis is established in this case, because the feedback loop transfer function is performed by electronic devices. It is this utilization of technology that has made possible the development of biofeedback, because the electronic devices can perform the detection, transformation and presentation of relevant information in a faster and easier to discriminate form than that which could be obtained by the organism's own means.

The field called visceral learning is studied using a mixture of theoretical frames of references derived from operant and "classical" conditioning. It could be argued that in the same way as the neuroendochrinal control system "learns" about the organism's external environment, it can also "learn" to control the internal environment.

In cybernetic terms, learning implies control. For a response to be stable, it must be first sensed or perceived and then compared with an internal performance reference. If it is not known what the organismm is sensing, one cannot determine what is being controlled to maintain a certain response. It is this inextricable relationship between perception and control that has been misinterpreted as a direct stimulus-response relationship, but it is needed to explain the relationship between external events and behavior.

Different types of devices have been used to present visual feedback information. All of them act by changing some perceptible visual characteristic as a function of the changes of the physiological parameter to be controlled. For instance, luminous indicators that change their intensities (analogic) or different indicators that turn on and off (binary) have been used. Nevertheless, the most utilized devices have been numeric indicators, like needle meters or digital displays.

The following citations reflect the state of the art of which applicant is aware insofar as these citations appear germane to the process at hand.

U.S. Pat. No. 3,967,616, Ross

U.S. Pat. No. 3,991,304, Hillsman

U.S. Pat. No. 4,014,323, Gilmer et al

U.S. Pat. No. 4,184,485, Agoston

U.S. Pat. No. 4,246,906, Winberg et al

Brener, S., Sensory and perceptual determinants of voluntary visceral control. In G. E. Schwartz and J. Beatty (Eds.), Biofeedback Theory and Research. New York: Academic Press, 1977.

Buckley, E. P. The man-machine system. In C. T. Morgan, A. Cahpanis, and M. W. Lund (Eds.), Human Engineering Guide to Equipment Design. New York: McGraw Hill, 1963.

Cornsweet, T. N. Visual Perception. New York: Academic Press, 1970.

Gearder, E. Control of states of consciousness. In E. Peper, S. Ancoli and M. Quinn (Eds.), Mind/Body Interaction. New York: Plenum Press, 1979.

Hoon, E. E. Biofeedback-assisted sexual arousal in females, a comparison of visual and auditory modalities. Biofeedback and Self Regulation, 1980. 5-2, 175-191.

Izard, C. E. The emergence of emotions and the development of consciousness in infancy. In J. M. Davidson and R. J. Davidson, (Eds.), The Psychology and Consciousness. New York: Plenum Press, 1980.

John, E. R. Multipotenciality: A statistical theory of brain function-evidence and implications. In J. M. Davidson and R. J. Davidson (Eds.), The Psychology of Consciousness. New York: Plenum Press, 1980.

Kimmel, H. D. The relevance or experimental studies to clinical applications of biofeedback. Biofeedback and Self-Regulation. Hillside, NJ: Erlbaum, 1979.

Powers, W. T. Systems approach to consciousness. In J. M. Davidson and J. R. Davidson (Eds.), The Psychobiology of Consciousness. New York: Plenum Press, 1980.

Stevens, S. S. Psychophysical law. In J. Cummings (Ed.), Encyclopedia of Psychology. New York: Herder and Herder, 1972.

Winberg et al is concerned with an apparatus for self-monitoring of physiological variables, in particular the temperature of a subject's hand. Provisions are made for the subject to hear and see respectively an audio and visual output which changes with respect to the monitored physiological variable. The termperature of the subject's fingertip is the preferred variable. The audible and visual indications are provided by a speaker 64 and a light-emitting diode 66 as shown in FIG. 1.

The patent to Agoston is concerned with a measuring arrangement for decreasing the emotional influence on instrumental diagnostical measurements which utilize a biofeedback arrangement which includes instrumentalities so that the tested person learns about the reduction in his pulse, for example, by noticing the increase in tone pitch in the audio output of the arrangement and by seeing the momentary pulse number on the dial of an indicator of the memory unit 8.

The patent to Ross proposes a multichannel system for controlling the nervous system of an organism by utilizing biofeedback. Here again, as can be seen from column 9 lines 44-48, one or more visual displays and/or auditory means such as one or more buzzers is used to indicate when the apparatus is in an inhibit mode. Thus, one set of transducing means 24 and another set of transducing means 124 are provided as portions of respective feedbacks.

Gilmer et al provides a system utilizing a low power level of pulsed alternating current for assisting a patient in producing an improved physiological or psychological condition within his body, and provides an electrotherapy treating unit with a biofeedback detecting and displaying unit for the patient's observation. Again, the stimuli defining an output from the biofeedback unit is a single pulsed frequency.

The patent to Hillsman includes preferred waveforms for breathing, monitoring of the breathing pattern, and the generation of a rectilinear raster display is employed for converting digital values in real time superimposed patterns.

None of these devices teach or render obvious either singly or in any conceivable combination that which is defined as the invention according to the instant application. The instant invention is distinguished thereover in that all of the citations are not intrinsically motivating nor more informative. In any case the only comparisons made have been between the informative properties of needle meters and digital numerical indicators, or between their binary and analogical characteristics.

In addition, auditory presentation devices have also been employed which in these cases, physiological information is presented by means of changes in intensity or frequency of pure tones (sine waves), or change in the repetition to audible "beeps". Moreover, the visual characteristics of the known prior art include observation of a needle meter or digital equivalent. There are equal lack of studies pertaining to optimum characteristics of discriminability as in the case of visual and audio stimuli. Usually the decision about which types of stimulus to utilize is arbitrary.

Biofeedback stimuli presently employed, therefore, are emotionally neuter, being neither intrinsically pleasant or aversive. Apparently, the process of control is simplified by presenting to the subject a purely informative stimulus that permits him to discriminate any change in the physiological parameters that are being controlled. Nevertheless, controlling the function implies learning and for it to occur, in addition to a discriminable stimulus, it is required that the subject be properly motivated.

The use of money as motivator has been a convenient way of standarizing the motivational level of subjects in research, be it paying them the same amount of money for their participation or giving them such amount contigent to their performance. Another motivator used in the same way as money has been the bonification of academic credits to subjects (participation is required as part of a course). For obvious reasons, the motivators mentioned cannot be used so effectively in the daily practice of biofeedback techniques (psychotherapy). In the clinical situation, the motivational problems are contemplated by the interaction between the client and the therapist.

## OBJECTS AND SUMMARY OF THE INVENTION

Thus, it is a primary object of this invention to provide a feedback stimuli simultaneously discriminable and intrinsically motivating. More particularly, the use of a feedback procedure is contemplated which functions as an intrinsic reinforcer so as to provide significant advances in the application of the biofeedback technique.

While in the prior art it is known through biofeedback procedures regarding stimuli to be discriminated, few studies have investigated the effects on the rate of learning due to a change of some aspect of the feedback signal mode of presentation. Furthermore, there are not many studies where the same information has been fed back simultaneously through plural sense modalities. When different information of a symbolic nature is simultaneously presented through the visual and auditory channels, generally only one of them can be attended to. Nevertheless, comprehension of symbolic information is incremented when the same information is presented in both visual and auditory forms. This redundency of information through two or more channels may increment the discriminability of the biofeedback signal. Taking into ccount those considerations, a series of pilot experiments and a final exploratory experiment were carried out to determine the informative and motivating and intrinsic properties of auditory and visual stimuli that could be used in biofeedback.

A device was developed which allows the presentation of stimuli, intrinsically motivating and siumltaneously informative. Furthermore, the device allows the presentation of the feedback stimuli through two sense modalities. The modalities chosen were the auditory and visual.

Accordingly, it is another object of this invention to provide a device which presents stiumli which is intrinsically motivating and simultaneously informative.

It is a further object of this invention to provide a device which allows the simultaneous presentation of feedback stimuli through two sense modalities.

It is yet a further object of this invention to provide a device in which the modalities are both auditory and visual and redundant in nature.

More specifically, the biofeedback device of the present invention is based on the masking with white noise of an auditory stimulus, such as a repeating phrase, to the point that the phrase cannot be perceived. As a certain physiological parameter changes in the desired direction, the intensity of the repeating phrase is automatically incremented while that of the noise automatically decreases; this increases intelligibility until the subject can clearly perceive the meaning of the phrase. Similarly, a visual stimulus is masked (by mixing) with visual noise (such as snow on a TV screen); the image gets clearer or less intelligible as a function of the physiological parameter.

It is a further object of this invention to provide a device and technique which is effective in the conditioning of definite human parameters such as hand temperature, heart rate, galvanic skin response, etc.

It is yet a further object of this invention to provide a device which provides the same information for both the visual and auditory processes iteratively so that there is the perception of linear response to changes in that parameter exisiting concomitantly to both the auditory and visual senses.

It is yet a further object of this invention to provide a device which benefits from such system redundancy wherein the audio and visual channels transmit the same information at least as perceived and interpreted by the subject being tested so that changes in the subject's parameter will be equally discernible both visually and auditorially.

It is a further object of this invention to provide a device as characterized above in which the motivation of the subject is enhanced both by visual and auditory means, wherein said means define a redundancy and are interrelated such that parameter changes are reflected equally by both media.

It is known that written and spoken language fulfills the requirement of being "isomorphic" and "isofunctional" information in that they are fully redundant. Accordingly, the instant device has as a further primary objective a presentation of any visual or auditory stiumli as mentioned hereinabove operated in concert and synchronized to provide redundancy similar to that which is experienced between the written and spoken word. Thus, real life, dynamic stimuli can be effective in the conditioning of physiological parameters so that isofunctionality of information fed through different sense modalities will produce a greater increase in the rate of learning due to its intrinsic redundancy.

The concomitant technological complexity required for the instant feedback device is clearly much greater than that which was previously employed on traditional devices, yet the flexibility gained makes a qualitative difference over any known prior art device since in the first place, it permits the use of any visual or auditory stimulus. Secondly, it provide for a valid, reliable and objective quantification of informative uncertainty (i.e. index of motivation) of the subject. Thus, these characteristics become possible because feedback information is presented as a signal to noise ratio (S/N). The S/N changes are determined, in turn, by those of the physiological parameters to be controlled. Moreover, the use of the S/N allows utilizing a different theoretical frame of reference for biofeedback such as information theory, in general, and signal detection theory, in particular. An associated, concomitant object and advantage at least for experimental purposes is that a 100% invariant noise stiumlus constitutes a "true" zero information control condition that could not be achieved by any other means. In other words, while visual or auditory noise is neither motivating nor informative, it does maintain occupied the corresponding sensory channel. Accordingly, it is easy to obtain an experimental control condition that is effectively equal to all others, except that the feedback information, being completely random (by white noise) is truly zero.

These and other objects will be made manifest when considering the following detailed specification when taken in conjunction with the appended drawing FIGURE.

BRIEF DESCRIPTION OF THE DRAWING

The single drawing FIGURE is a schematic block view of the apparatus according to the present invention.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing now, wherein like reference numerals refer to like parts throughout the drawing FIGURE, reference numeral 10 is directed to the biofeedback apparatus according to the present invention.

More particularly, the sole FIGURE shows an audio input (A), a video input (V) and a physiological signal input (F). The physiological input (F) encounters initially a square root circuit 1 which alters the signal (F) by automatic and instantaneous modulation of the physiological signal (for example, hand temperature) which may have an output range of 0 to 4 Volts. The square root circuit also modulates this signal (F) by inversion 180.degree. out of phase so that the output as shown in the drawing diagram is F.sup.1/2 and F.sup.-1/2. This corresponds to the square root of the deviation from the base line from the physiological parameter, and it is desired that the audio amplitude and video amplitude vary as a function of this signal.

Accordingly, both the audio input A and the video input V are conditioned by the square root of the physiological input (F) at stations 3 and 4 respectively so that the quantity of each of these signals has imprinted thereon variations of the physiological signal input and more particularly, the square root of the deviation from the base line of the physiological parameter. The audio output A thus conditioned is denoted as A.sub.i and the video output is similarly labeled V.sub.i.

In addition, a white noise generator 2 is provided having an output N which is conditioned by the

180.degree. out of phase signal F.sup.-1/2 at station 5. The white noise generator extends itself from the audio to the video end of the frequency spectrum. Thus, the white noise signal N when treated by the signal F.sup.-1/2 has an output of N.sub.i. Thus, while the video and audio amplitude increases as a function of the square root of the deviation from the base line of the physilogical parameter, the amplitude of the white noise is decremented with an inverse function. Thereafter, the modulated audio signal A.sub.i is added to the modulated noise signal N.sub.i in station 6 so that the auditory stiumli 11 could be varied over such a sufficient range from total inability to perceive the auditory message to total clarity of the auditory message. Similarly, the modulated video signal was added to the modulated noise signal at station 7 and the initialized video stimuli shown on the screen 12 varies from total inability to discern the video program, to that of total clarity.

A signal to noise ratio power meter 13 is also provided which provides a ratio of the modulated audio signal to the modulated noise signal or alternatively the ratio of the modulated video signal to the modulated video noise signal at station 8. For this purpose, a switch 9 is provided allowing selection of either modulated output A.sub.i or V.sub.i.

It is pertinent to mention at this point that the desired weighing of the S/N coefficient contains only those portions of the signal and the noise perceived by the human observer, with the exclusion of all video information pertinent to the intrinsic function of the television set (i.e. the compound television signal). For measurement then, it is necessary to remove all coding and synchronizing information present in the video signal and set to zero for that time interval. Of course, the same intervals of time are equally removed and set to zero in the noise signal to be mixed with the video. The procedure was realized in such a way that the integrated signal and noise energies that form the S/N ratio corresponded only to those parts visible to the human observer. On the other hand, the video monitor used for presentation of the stimuli would not have worked in the absence of that information. Therefore, that information was reintegrated after the S/N measurement stage. This procedure was not required for the auditory presentation.

It should be clear that a subject could be exposed to either stimuli separately or both stimuli simultaneously. Other forms of stimuli could equally have well be chosen. However, when more than one stiumli is provided in response to the biofeedback of a single parameter, it is desirable to synchronize the abatement or increase of the white noise (or inversely the clarity of the auditory of visual stimuli) so that which is perceived receives the same rate of change for each sense as the parameter measured changes. Additionally, in order to verify the effectiveness of this new technique, determining the kind of visual and auditory program to be employed was studied so that the auditory and visual information discerned is compatible and equal as set forth above. It is stipulated that the chosen program stimuli should produce a feeling of interest to facilitate the process of orientation and attention and to guarantee this feeling without previous subject validation. The human face and voice fulfill this requirement due to an innate preferential disposition towards these stimuli.

It was also investigated whether information which was purely informative would be as effective a feedback stimuli as stiumli which was simultaneously informative and intrinsically motivating. This was evaluated with hand temperature as the physiological parmeter to be controlled. In addition, a comparison was made between the effectiveness of simultaneous presentation of the same information to the auditory and visual channels with the effectiveness of the same information presented to each channel separately.

In one case, the auditory stiumlus, delivered by means of a pair of earphones, consisted of a voice repeatedly pronoucing a phrase masked with the white noise. The ratio of the mean power of the voice signal with respect to the noise could be varied from complete unintelligibility to complete clearness. That is, a gradual masking or distortion of the voice was produced varying the signal to voice ratio S/N depending on the increment or decrement of the variations of the physiological parameter to be controlled. In this way, the intelligibility of the voice and the amplitude of the voice represented the informative aspect of the feedback signal while the meaning of the words represented the motivational aspect.

The variation in the signal to voice relationship in the auditory presentation was made exponential (Fti the alpha when alpha=1/2) to produce the subjective experience of being approximately linear. This incremented the dynamic range of auditory intensity susceptible of being presented, allowing the subject's interest to be maintained for a greater range of increments.

The visual stimulus was presented through a color television screen and consisted of a human face masked or distorted with visual "noise" (snow). Visual noise is analogous to auditory noise and has been described as small blinking spots flashing over a dark field. The S/N was determined by a change of the physiological parameter, in the same manner as for the auditory stimulus. The resulting presentation may start with the screen full of visual noise, where the stimulus image was hidden "behind" the noise, barely above the threshold of perception. The sharpness of the image would increase as the subject showed a change in the physiological parameter in the desired direction. On the contrary, if the change shown occurred in the opposite direction, the sharpness of the image would deteriorate. Thus a change in S/N represented the informative aspect of the biofeedback signal, while the meaning (that the image had to the subject) represented the motivational aspect. In other words, from the point of view of the subject, the clearness and definition of the image as well as the amount in contrast in the noise was what constituted the new biofeedback information.

Due to the marked difference in the auditory and visual channels, it is also desirable to take into account the psychophysical and cognitive characteristics of the visual stiumlus. Taking these data into account, and for practical reasons, the rate of change of the visual S/N was made exponential F to the alpha where alpha=1/2.

For the specific example in which the parameter being monitored was that of hand temperature, the combined audio visual technique proved effective. It is clear that the written and spoken language fulfills the requirement of being isomorphic and isofunctional information since both vehicles provide the same information and are therefore fully redundant. However, providing a visual display of the written language does not necessarily harness the benefits capable of being derived from the visual stimulus as should be evident. An interesting question therefor was to determine what constitutes the same information for both visual and auditory channels, with the view towards taking advantage of a fully redundant experiment, since the information had to be interpreted by the subject as being equal, visually and auditorily. Isofunctional visual and aduitory inormation that is real dynamic stimuli are believed to be effective in the conditioning of physiological parameters. It is speculated that the isofunctionality of information fed through different sense modalities will accordingly produce a greater increase in the rate of learning due to its inherent redundancy.

Nothwithstanding, it is clear that while the technical complexity required of the new feedback device is much greater than previously employed on traditional devices, the flexibility gained makes a qualitative difference from any such prior art device since firstly it permits the use of any visual or auditory stiumlus and secondly, it provides for a valid, reliable and objective quantification of informative uncertainty (for example, the index of motivation of the subjects). These characteristics become readily identifiable because the feedback information is presented as a signal to noise ratio S/N. The S/N changes are determined in turn by those of the physiological parameter to be controlled. Furthermore, the use of the S/N ratio opens the possibility of utilizing a different theoretical frame of reference for biofeedback such as information theory in general and signal detection theory in particular. A further benefit for experimental purposes at least is that a 100% invariant noise stimulus constitutes a true zero information, controlled condition that could not be achieved by any other means. In other words, visual or auditory noise is neither motivating nor informative but it does maintain occupied the corresponding sensory channel. It is thus very easy to obtain an experimental control condition that is effectively equal to all others, except that the feedback information, being completely random white noise is truly zero.

Having thus described the invention, it should be apparent that numerous structural modifications are contemplated as being a part of this invention as set forth hereinabove and as defined hereinbelow by the claims.

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| **United States Patent** | ***4,609,931*** |
| **Koike** | **September 2, 1986** |

# Input protection MOS semiconductor device with zener breakdown mechanism


### Abstract

A p.sup.- -type well region is formed in a n.sup.- -type semiconductive substrate. An n-channel metal oxide semiconductor field effect transistor (N-MOSFET) is formed in the p.sup.- -type well region. The p.sup.- -type well region is electrically insulated from an external potential such as the ground potential. The gate electrode of the N-MOSFET is connected to the p.sup.- -type well region. When the N-MOSFET is used as an input protective device of a CMOS integrated circuit, an n.sup.+ -type layer corresponding to the source electrode of the N-MOSFET is grounded, while another n.sup.+ -type layer corresponding to the drain electrode thereof is connected to an input terminal of the CMOS integrated circuit through a resistor.



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| **Intern'l Class:** | H01L 029/94; H01L 029/90 |
| **Field of Search:** | 357/41,42,13,23.13,23.14 307/304 361/91 |



**References Cited [Referenced By]**

**U.S. Patent Documents**

| | | | |
|---|---|---|---|
| 3469155 | Sep., 1969 | VanBeek | 357/23. |
| 3470390 | Sep., 1969 | Lin | 357/23. |
| 3512058 | May., 1970 | Khajezadeh et al. | 357/23. |
| 3739238 | Jun., 1973 | Hara | 357/23. |
| 3806773 | Apr., 1974 | Watanabe | 357/23. |
| 4282556 | Aug., 1981 | Ipri | 357/42. |

**Foreign Patent Documents**

| | | | |
|---|---|---|---|
| 2435606 | Feb., 1976 | DE | 307/304. |



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***Parent Case Text***

This application is a continuation of application Ser. No. 398,355 filed July 15, 1982 now abandoned.

## *Claims*

What is claimed is:

1. A semiconductor device to provide overvoltage protection at an input terminal of an integrated circuit, said device comprising:

a semiconductor substrate of a first conductivity type and having a first surface portion on which said integrated circuit is formed, and a second surface portion;

a semiconductor well region of a second conductivity type formed in said second surface portion of said substrate; and

a metal oxide semiconductor field effect transistor formed in said well region and having a grounded source layer of said first conductivity type, a drain layer of said first conductivity type connected to said input terminal, and a gate layer electrically connected to said semiconductor well region, whereby, when an abnormally large voltage appears at the input terminal, Zener breakdown occurs between said well region and said source or drain layer and the well region potential approaches the potential of said drain or source layer according to the polarity of said abnormally large voltage.

2. A semiconductor device according to claim 1 further comprising a semiconductive layer of the second conductivity type formed in said well region, and wherein said gate layer of said field effect transistor is directly connected to said semiconductor layer.

3. A semiconductor device according to claim 2, wherein said device further comprises:

an oxide layer formed in said well region between said drain layer and said semiconductor layer; and

means for electrically connecting said semiconductor layer to said gate layer.

4. A semiconductor device according to claim 3, further comprising:

a resistor connected between said drain layer of said transistor and said input terminal of said integrated circuit.

5. A semiconductor device to provide overvoltage protection at an input terminal of an integrated circuit, said device comprising:

an Insulating substrate havIng a first surface portion on which said integrated circuit is formed, and a second surface portion; and

a metal oxide semiconductor field effect transistor formed in said surface portion of said substrate, said field effect transistor having a grounded source layer of a first conductivity type, a drain layer of the first conductivity type connected to said input terminal, a channel layer of a second condutivity type formed between said source and drain layer on said substrate, and a gate layer electrically connected to said channel layer, whereby, when an abnormally large voltage appears at said input terminal, Zener breakdown occurs between said channel layer and said source or drain layer and the channel layer potential approaches the potential of said drain or source layers, according to the polarity of said abnormally large voltage.

6. A semiconductor device according to claim 5, wherein said field effect transistor comprises an insulating layer formed between said gate layer and said channel layer, and said insulating layer having a contact hole through which said gate layer is directly connected to said channel layer.

7. A semiconductor device according to claim 6, wherein said insulating substrate comprises a sapphire substrate.

## *Description*

## BACKGROUND OF THE INVENTION

The present invention relates to a semiconductor device and, more particularly, to an input protective semiconductor device of a complementary metal oxide semiconductor (CMOS) integrated circuit.

A semiconductor device, especially, a CMOS integrated circuit may operate erroneously or be broken due to an abnormal input such as static electricity, resulting in undesirable phenomena. In order to prevent the undesirable phenomena, a protective circuit is generally arranged in an input stage of the semiconductor integrated circuit. However, most of the conventional input protective circuits mainly serve to prevent electrostatic breakdown of the CMOS. Therefore, the protective circuits cannot sufficiently prevent the erroneous operation and the local damage which may occur prior to the electrostatic breakdown.

An abnormal input voltage applied to the integrated circuit from the outside has a positive or negative voltage polarity. However, the conventional protective circuit only protects the semiconductor integrated circuit from the abnormal input voltage of either polarity. For example, in an input protective circuit for protecting the semiconductor integrated circuit from a positive voltage, the semiconductor integrated circuit cannot be sufficiently protected from an abnormal negative voltage in a required manner. Thus, the conventional protective circuits cannot protect the semiconductor integrated circuit from both the negative and positive voltages.

## SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a new and improved semiconductor device suitable for an input protective circuit which protects a semiconductor integrated circuit from an abnormal input voltage regardless of the polarity of the input voltage.

A semiconductor device according to the present invention has at least two first regions which are close to each other and which have a predetermined conductivity type. At least one second region has a conductivity type opposite to that of the first regions. The second region is formed between the first regions and electrically insulated from an external voltage. An electrically conductive layer is formed substantially above the second region and is at a potential the same or substantially the same as that of the second region. When the semiconductor device of the above arrangement is used for input protection of an integrated circuit which includes MOSFETs, one first region is grounded and the other first region is connected to at least one input terminal of the integrated circuit through a resistor.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a circuit diagram of a conventional basic input protective circuit;

FIG. 2 is a sectional view of an integrated semiconductor device having one substrate on which the conventional input protective circuit in FIG. 1 is formed;

FIG. 3 is a circuit diagram of an input protective circuit according to one embodiment of the present invention;

FIG. 4 is a sectional view of an integrated semiconductor device having one substrate on which the input protective circuit according to one embodiment of the present invention is formed;

FIG. 5 is a circuit diagram of an input protective circuit according to another embodiment of the present invention;

FIG. 6 is a sectional view of an integrated semiconductor device on which the input protective circuit shown in FIG. 5 is formed;

FIG. 7 is a graph showing the voltage-current characteristics of an n-channel metal oxide semiconductor field effect transistor (to be referred to as an N-MOSFET hereinafter);

FIG. 8 is a plan view of a modification of the N-MOSFET in FIGS. 5 and 6, showing a silicon-on-sapphire (SOS) structure excluding oxide layers and the like; and

FIG. 9 is a sectional view of the N-MOSFET when taken along the line IX--IX in FIG. 8.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In order to facilitate the understanding of the invention, a basic input protecting circuit will be first described with reference to FIGS. 1 and 2. An input terminal 10 is connected through a protective resistor 12 to a complementary metal oxide semiconductor inverter 14 (to be referred to as a CMOS inverter hereinafter) which includes a p-channel metal oxide semiconductor field effect transistor (to be referred to as a P-MOSFET hereinafter) and an n-channel metal oxide semiconductor field effect transistor (to be referred to as an N-MOSFET hereinafter). The P-MOSFET is connected to a power source terminal 16 to which a power source voltage +Vcc is applied. The N-MOSFET is grounded (potential Vss). An input terminal of the CMOS inverter 14 is grounded through an input protective N-MOSFET 18.

As shown in FIG. 2, the N-MOSFET 18 is formed on a p.sup.- -type well region 20 which is formed in an n.sup.- -type semiconductor substrate 21. A gate electrode 22 is separated from drain and source regions 24 and 26 of n.sup.+ conductivity type through an oxide film. A p.sup.+ -type layer 30 is formed in the p.sup.- -type well region 20 adjacent to and in contact with the source region 26. The well region 20 is connected to the ground potential Vss through the p.sup.+ -type layer 30 and the metal electrode 32. The gate electrode 22 is connected to the metal electrode 32 through a lead wire 34, so that the gate electrode 22 is connected to the p.sup.- -type well region 20, the source electrode 26 and the ground potential Vss. The CMOS inverter 14 is placed adjacent to the N-MOSFET 18.

When an abnormal negative input voltage is supplied through the input terminal 10 to the conventional input protective circuit with the above arrangement, an p-n junction between the n.sup.+ -type layer 24 corresponding to a drain electrode of the N-MOSFET 18 and the p.sup.- -type well region 20 is forward-biased since the p.sup.- -type well region 20 is grounded through the p.sup.+ -type layer 30 and maintained at the ground potential Vss. A large current flows from the n.sup.- -type semiconductor substrate 21 to the input terminal 10 to cause the resistor 12 to be destroyed and disconnected.

Under this condition, electrons injected from the n.sup.+ -type layer 24 into the p.sup.- -type well region 20 further flow into the n.sup.- -type semiconductor substrate 21. A potential slope is thus established in the n.sup.- -type semiconductor substrate 21. Holes are emitted from a p.sup.+ -type layer 36, which is relatively close to the p.sup.- -type well region 20 and connected to the power source terminal 16, of the P-MOSFET included in the CMOS inverter 14 and migrate at last into the p.sup.- -type well region 20. Therefore, an undesirable latch-up phenomenon which causes an erroneous operation occurs.

Referring now to FIGS. 3 and 4, there is illustrated an improved input protective circuit according to one embodiment of the present invention. An input terminal 60 is connected through the protective resistor 62 to a CMOS inverter 64 which includes a P-MOSFET 66 and an N-MOSFET 68. The P-MOSFET 66 has a source electrode connected to a power source terminal 70 to which the power source voltage +Vcc is applied. The source electrode of the N-MOSFET 68 is grounded. The drain electrodes of the P-MOSFET 66 and the N-MOSFET 68 are connected to each other and further connected to an output terminal 72 of the CMOS inverter 64. The gate electrodes of the P-MOSFET 66 and the N-MOSFET 68 are connected to each other and further connected to the input terminal 60 through the resistor 62.

A common node 74 between the resistor 62 and the gate electrodes of the P- and N-MOSFETs 66 and 68 included in the CMOS inverter 64 is grounded through first and second input protective N-MOSFETs 78 and 80. To be more specific, the common node 74 is connected to the drain electrode of the first N-MOSFET 78. A gate electrode of the first N-MOSFET 78 is connected to a source electrode thereof which is connected to a drain electrode of the second N-MOSFET 80. The gate electrode of the first N-MOSFET 78 is further connected to a gate electrode of the second N-MOSFET 80. The gate electrode of the first N-MOSFET 78 is electrically insulated from an external voltage such as the ground potential Vss. A source electrode of the second N-MOSFET 80 is connected to ground whose potential is designated by Vss.

FIG. 4 is a sectional view of the integrated semiconductor device on which the input protective circuit shown in FIG. 3 according to the present invention is formed. In FIG. 4, a p.sup.- -type well region 90 is formed in an n.sup.- -type semiconductor substrate 92. The first and second input protective N-MOSFETs 78 and 80 are formed on the p.sup.- -type well region 90. The first N-MOSFET 78 has n.sup.+ -type layers 94 and 96 corresponding to the drain and source electrodes thereof, respectively, and a polycrystalline silicon layer 98 corresponding to the gate electrode which is electrically insulated from the n.sup.+ -type layers 94 and 96 through a gate oxide film 100. A metal layer 102 of aluminum or the like is deposited on the n.sup.+ -type layer 94 and further connected to the resistor 62 and the input terminal 60. The n.sup.+ -type layer 96 of the first N-MOSFET 78 serves not only as the source electrode of the first N-MOSFET 78 but also as the drain electrode of the second N-MOSFET 80. The second N-MOSFET 80 has an n.sup.+ -type layer 104 corresponding to the source electrode. A polycrystalline silicon layer 106 is electrically insulated from the n.sup.+ -type layers 96 and 104 through a gate oxide film 108. The polycrystalline silicon layer 106 corresponds to the gate electrode of the second N-MOSFET 80. The n.sup.+ -type layer 104 corresponding to the source electrode of the second N-MOSFET 80 is grounded through a metal layer 110 of aluminum or the like. Since this source electrode has an n.sup.+ conductivity type, the p.sup.- -type well region 90 is substantially electrically insulated or isolated from the ground potential Vss. The N-MOSFETs 78 and 80 are electrically insulated from circuit elements integrated on the n.sup.- -type semiconductor substrate 92 through field oxide films 112. A metal layer 114 is deposited over the region extending between the adjacent first and second N-MOSFETs 78 and 80. The polycrystalline silicon layers 98 and 106 corresponding to the gate electrodes are electrically connected by the metal layer 114 to the n.sup.+ -type layer 96 which corresponds to the source electrode of the first N-MOSFET 78 and the drain electrode of the second N-MOSFET 80.

The P-MOSFET 66 and the N-MOSFET 68 which are included in the CMOS inverter 64 are formed in a surface portion of the n.sup.- -type semiconductor substrate 92 and are substantially adjacent to the first and second N-MOSFETs 78 and 80 (the N-MOSFET 68 is not visible in FIG. 4). The P-MOSFET 66 has p.sup.+ -type layers 120 and 122 which respectively correspond to the drain and source electrodes thereof. The P-MOSFET 66 further has a polycrystalline silicon layer 124 which is electrically insulated or separated from the p.sup.+ -type layers 120 and 122 through an oxide film 126 and functions as the gate electrode. The p.sup.+ -type layer 122 corresponding to the source electrode of the P-MOSFET 66 is connected to the power source terminal 70 through a metal layer 128 of aluminum or the like. Note that reference numeral 130 denotes a field oxide film and reference numeral 132 denotes an insulating film.

In the input protective circuit with the above arrangement according to one embodiment of the present invention, assume that an abnormal negative input voltage from the input terminal 60 is applied to the n.sup.+ -type layer 94 corresponding to the drain electrode of the first N-MOSFET 78. Since the p.sup.- -type well region 90 is not connected to the ground potential Vss, the p.sup.- -type well region 90 is set at a negative potential in accordance with the potential of the n.sup.+ -type layer 94. The potential of the n.sup.+ -type layer 96 is higher (V.sub.IN +V.sub.THN) than that of the n.sup.+ -type layer 94 by a threshold voltage V.sub.THN of the N-MOSFET 78. The p-n junction between the n.sup.+ -type layer 104 corresponding to the source electrode of the second N-MOSFET 80 and the p.sup.- -type well region 90 is reverse-biased. The depletion layer in the p.sup.- -type well region 90 is formed as indicated by a dotted line 138 in FIG. 4. When the reverse-bias voltage exceeds a predetermined breakdown voltage, holes are injected from the n.sup.+ -type source electrode 104 of the second MOSFET 80 into the p.sup.- -type well region. However, most of holes migrate toward the input terminal 60 since the potential at the p.sup.- -type well region 90 is higher than that at the input terminal 60. The holes are not injected in the semiconductor substrate 92. Therefore, the undesirable latch-up phenomenon does not occur. Under this condition, the p.sup.- -type well region 90 is set at a negative potential, and the p-n junction between the p.sup.- -type well region 90 and the n.sup.+ -type drain electrode 94 of the first N-MOSFET 78 may not be forward-biased. Even if a negative surge voltage is applied to the input terminal 60, a forward large current does not flow. The protective resistor 62 may not be destroyed and disconnected. According to the input protective circuit of one embodiment of the present invention, the integrated semiconductor device may not break down and/or erroneously operate due to the positive and negative input surge voltage applied from the outside.

FIGS. 5 and 6 show an input protective circuit according to another embodiment of the present invention. The same reference numerals as in the first embodiment denote the same parts in the second embodiment, and a detailed description thereof will be omitted. The common node 74 between the CMOS inverter 64 and the resistor 62 is grounded through a single N-MOSFET 150. The N-MOSFET 150 is provided on the p.sup.- -type well region 90 formed in the n.sup.- -type semiconductor substrate 92. The drain and source electrodes of the N-MOSFET 150 comprise N.sup.+ -type layers 152 and 154. The gate electrode of the N-MOSFET 150 comprising a polycrystalline silicon layer 156 is electrically insulated from the drain and source electrodes through an oxide film 158. The n.sup.+ -type drain electrode 152 is subsequently connected to the resistor 62 and the input terminal 60 through a metal layer 160 made of a metal such as aluminum. The n.sup.+ -type layer 154 corresponding to the source electrode is grounded through the metal layer 162.

A p.sup.+ -type layer 164 is electrically insulated from the N-MOSFET 150 through a field oxide film 166. A metal layer 168 is deposited on the p.sup.+ -type layer 164. The metal layer 168 is connected to the gate electrode 156 of the N-MOSFET 150 through a lead wire 170. The p.sup.+ -type layer 164 functions to electrically connect the p.sup.- -type well region 90 to the gate electrode 156. Therefore, the potential of the p.sup.- -type well region 90 is substantially the same as that of the gate electrode 156 of the N-MOSFET 150.

The mode of operation of the N-MOSFET 150 will be described. When a positive voltage is applied to the drain electrode 152 of the N-MOSFET 150 and the source electrode 154 thereof is grounded, a potential on the p.sup.- -type well region 90 is drawn in a manner to follow the ground potential Vss of the source electrode 154 and held substantially at a level equal to that of the ground potential Vss. At this time, the p-n junction between the n.sup.+ -type drain electrode 152 and the p.sup.- -type well region 90 is reverse-biased. When the drain voltage is lower than a predetermined voltage, no current flows between the drain and source electrodes of the N-MOSFET 150. However, when the drain voltage is higher than the predetermined voltage, the Zener breakdown phenomenon occurs in the p-n junction between the n.sup.+ -type drain electrode 152 and the p.sup.- -type well region 90. Therefore, a current flows between the drain and the source electrodes. Since the drain and source electrodes of the N-MOSFET 150 are equivalent, the voltage (V.sub.DS)-current (I.sub.DS) characteristics as shown in FIG. 7 are obtained.

In the input protective circuit including the N-MOSFET 150 shown in FIGS. 5 and 6, when a positive surge voltage is applied to the input terminal 60, Zener breakdown occurs in the p-n junction between the p.sup.- -type well region 90 and the n.sup.+ -type drain electrode 152 of the N-MOSFET 150. As a result, the holes are injected from the n.sup.+ -type drain electrode 152 to the p.sup.- -type well region 90. The holes are diffused into the p.sup.- -type well region 90 and migrate from the n.sup.+ -type source electrode 154 to the ground. Thus, as the holes do not remain in the p.sup.- -type well region 90 and flow to the ground, the latch-up phenomenon is prevented.

When a negative surge voltage is applied to the input terminal 60, Zener breakdown occurs in the p-n junction between the p.sup.- -type well region 90 and the n.sup.+ -type layer 154 corresponding to the source electrode of the N-MOSFET 150. A depletion layer is formed in the p.sup.- -type region 90 as indicated by a dotted line 172 in FIG. 6. The holes are then injected in the p.sup.- -type region 90 and diffused thereinto. The holes flow into the input terminal 60 through the n.sup.+ -type layer 152.

According to the input protective circuit of the second embodiment of the present invention, even if the positive or negative surge voltage is applied to the input terminal 60, the latch-up phenomenon does not occur. Further, even if a low negative dc voltage is applied, a current does not flow to semiconductor substrate 92. The protective resistor 62 may not be destroyed and disconnected. Further, in the input protective circuit according to the second embodiment of the present invention, only one MOSFET is used. Therefore, the pattern area of the integrated semiconductor device can be decreased.

A modification of the above-mentioned N-MOSFET 150 is shown in FIGS. 8 and 9. An N-MOSFET 180 has a silicon-on-sapphire (SOS) structure. Reference numeral 182 denotes a sapphire substrate 182 on which a monocrystalline silicon layer 184 of p.sup.- conductivity type is formed by the epitaxial growth method. Monocrystalline silicon layers 186 and 188 of n.sup.+ conductivity type are formed at both sides of the p.sup.- -type silicon layer 184 on the substrate 182. One n.sup.+ -type layer 186 functions as a drain electrode of the N-MOSFET 180 and the other n.sup.+ -type layer 188 functions as a source electrode thereof. The p.sup.- -type layer 184 formed between the n.sup.+ -type layers 186 and 188 corresponds to a channel region of the N-MOSFET 180. A polycrystalline silicon layer 190 corresponding to a gate electrode of the N-MOSFET 180 is electrically insulated from the p.sup.- -type layer 184 and the n.sup.+ -type layers 186 and 188 through an oxide film 192. Reference numeral 194 denotes an insulating layer. Metal layers 196 and 198 are deposited on the n.sup.+ -type layers 186 and 188 corresponding to the drain and source electrodes, respectively. As shown in FIG. 9, the metal layer 196 is connected to the input terminal 60 through the resistor 62, and the metal layer 198 is connected to ground.

Referring to FIG. 8, a contact hole 200 is formed to electrically connect the gate electrode 190 with the p.sup.- -type channel region 184. A contact hole 202 is formed to electrically connect the metal layer 198 with the n.sup.+ -type source electrode 188. A contact hole 204 is formed to electrically connect the metal layer 196 with the n.sup.+ -type drain electrode 186. The N-MOSFET 180 having the SOS structure is equivalent to the N-MOSFET 150 as seen from FIG. 5. The voltage-current characteristic of the N-MOSFET 180 is the same as that shown in FIG. 7.

Although the present invention has been shown and described with respect to particular embodiments, nevertheless, various changes and modifications which are obvious to a person skilled in the art to which the invention pertains are deemed to lie within the spirit, scope, and contemplation of the invention. For example, the conductivity type of the semiconductor substrate shown in FIGS. 4 and 6 may be of the opposite type. Although the semiconductor device according to the present invention is suitable for an input protective circuit of the CMOS integrate circuit element, the above-mentioned electrical characteristics may be utilized in a variety of applications.

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# The Range of Gauge Fields

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December 1964. Available online 24 October 2002.

# Abstract

It is proved that all spherically symmetric gauge fields can by a gauge transformation be thrown in Coulomb form, for any gauge group. This generalizes Ikeda and Miyachi's result for $O_3$ and shows that the static condition may be left out. The investigation uses the interpretation of gauge fields as internal curvature and the group properties of curvature. It is shown that every spherically symmetric internal holonomy group with at least one source-free region is abelian. We find that Ikeda and Miyachi's conditions for spherical symmetry of the gauge fields are sufficient but not necessary. There exists an overlooked family of spherically symmetric solutions which have a non-zero ($\theta$, $\varphi$) component of internal curvature tensor operator. This component does not contribute to the field equation but it does appear in the rest energy of the field. The latter is calculated from a conjectured force law which is a generalization of the electromagnetic force. Using a flat event space, the rest energy for a force-free spherically symmetric gauge field either diverges or vanishes; in the latter case the gauge group is non-compact. For two interacting particles, short-range effects show up in an example using a gauge group a subgroup of $SU_3$. At large distances the interaction is of Coulomb type. These findings give renewed hope that the gauge fields indeed have to do with strong interactions, notwithstanding the Coulomb like character of spherically symmetric solutions.

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## The r operator. Enabling Querying for Semantic Associations on the Semantic Web

Anyanwu, Kemafor and Sheth, Amit (2003) The r operator. Enabling Querying for Semantic Associations on the Semantic Web. In *Proceedings International WWW Conference*, Budapest, Hungary.

### *Abstract*

This paper presents the notion of Semantic Associations as complex relationships between resource entities. These relationships capture both a connectivity of entities as well as similarity of entities based on a specific notion of similarity called r-isomorphism. It formalizes these notions for the RDF data model, by introducing a notion of a Property Sequence as a type. In the context of a graph model such as that for RDF, Semantic Associations amount to specific certain graph signatures. Specifically, they refer to sequences (i.e. directed paths) here called Property Sequences, between entities, networks of Property Sequences (i.e. undirected paths), or subgraphs of r-isomorphic Property Sequences.The ability to query about the existence of such relationships is fundamental to tasks in analytical domains such as national security and business intelligence, where tasks often focus on finding complex yet meaningful and obscured relationships between entities. However, support for such queries is lacking in contemporary query systems, including those for RDF.

# Spin connection in general relativity by Hendricus G. Loos

Work supported by NASA under Contract NASw-967.
Giannini Scientific Corporation, Santa Ana, California, USA
February 1963.

# Abstract

The spin connection in the Riemann space of general relativity defines equivalence of two spinors at infinitesimally neighboring events, and evidently carries information about the environment of charged test particles of the fermion type. In this paper, we consider the spin connection in the four-dimensional space of events as fundamental, and study its concomitants and the consequences of its existence. We find that, if the spin connection permits the existence of a field of Dirac operators $\gamma k$ and as associated Riemann geometry, it leaves the $\gamma k$ undetermined by a family of continuous transformations generated by $\gamma^5$ with a uniform mangitude. If the physics of fermions could be expressed solely in terms of the spin connection, the mean values of all observables would have to be invariant under this family of transformations, and the two-component fermion description proposed by Feynman, Gell-Mann, Sudarshan, and Marshak would follow. Another indeterminancy of the $\gamma k$, for a fixed spin connection, consists of a family of scale transformations of uniform magnitude over the whole space of events. The transformations of this family are of no physical consequence, as they can be compensated by a uniform change in proper time scale. For a fixed spin connection, there are usually no other indeterminacies of the $\gamma k$ of the continuous kind. The existence of the spin connection implies a conservation law for a spin tensor density derived from the Dirac operators and the spin curvature tensor, whose trace is the Einstein tensor density.

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# Social Development Theory (L. Vygotsky)

## Overview:

The major theme of Vygotsky's theoretical framework is that social interaction plays a fundamental role in the development of cognition. Vygotsky (1978) states: "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals." (p57).

A second aspect of Vygotsky's theory is the idea that the potential for cognitive development depends upon the "zone of proximal development" (ZPD): a level of development attained when children engage in social behavior. Full development of the ZPD depends upon full social interaction. The range of skill that can be developed with adult guidance or peer collaboration exceeds what can be attained alone.

Vygotsky's theory was an attempt to explain consciousness as the end product of socialization. For example, in the learning of language, our first utterances with peers or adults are for the purpose of communication but once mastered they become internalized and allow "inner speech".

Vygotsky's theory is complementary to the work of Bandura on social learning and a key component of situated learning theory. Because Vygotsky's focus was on cognitive development, it is interesting to compare his views with those of Bruner and Piaget .

**Scope/Application:**

This is a general theory of cognitive development. Most of the original work was done in the context of language learning in children (Vygotsky, 1962), although later applications of the framework have been broader (see Wertsch, 1985).

**Example:**

Vygotsky (1978, p56) provides the example of pointing a finger. Initially, this behavior begins as a meaningless grasping motion; however, as people react to the gesture, it becomes a movement that has meaning. In particular, the pointing gesture represents an interpersonal connection between individuals.

**Principles:**

1. Cognitive development is limited to a certain range at any given age.

2. Full cognitive development requires social interaction.

**References**:

Vygotsky, L.S. (1962). Thought and Language. Cambridge, MA: MIT Press.

Vygotsky, L.S. (1978). Mind in Society. Cambridge, MA: Harvard University Press.

Wertsch, J.V. (1985). Cultural, Communication, and Cognition: Vygotskian Perspectives. Cambridge University Press.

# *PAVLOV USED A BELL* - Commentary on Littman on Pavlov-Bell

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ABSTRACT: Littman (1994) followed up Catania's (1994) about query whether Pavlov had ever used a bell as a conditioned stimulus (CS). Catania and Littman were unable to find evidence that Pavlov used a bell. Littman argued that the bell as the prototypical CS was likely attributable to V.M. Bekhterev and John B. Watson. Pavlov used a bell in an experiment reported in 1923 and retracted in 1927. It is unclear whether Littman's argument is affected.

KEYWORDS: conditioning, Watson, Bekhterev, behaviorism, Pavlov

1. In Science (1923), Pavlov published the following:

The latest experiments (which are not yet finished) show that the conditioned reflexes, i.e., the highest nervous activity, are inherited. At present some experiments on white mice have been completed. Conditioned reflexes to electric bells are formed, so that the animals are trained to run to their feeding place on the ringing of the bell. The following results have been obtained.

The first generation of white mice required 300 lessons. Three hundred times it was necessary to combine the feeding of the mice with the ringing of the bell in order to accustom them to run to the feeding place on hearing the bell ring. The second generation required, for the same result, only 100 lessons. The third generation learned to do it after 30 lessons. The fourth generation required only 10 lessons. The last generation which I saw before leaving Petrograd learned the lesson after 5 repetitions. The sixth generation will be tested after my return. I think it very probable that after some time a new generation of mice will run to the feeding place on hearing the bell with no previous lesson (Pavlov,1923, pp. 360-361).

Razran (1958) and McClearn (1963) also quoted the above and reported that Pavlov retracted the experiments in Anrep's (1927) translation of Pavlov's Conditioned Reflexes. A footnote on page 285 was a retraction of the mice/bell experiment, but the bell was not mentioned. It was also noted that the experiments had been communicated briefly at the Edinburgh International Congress of Physiology (1923) (p. 285), but it was not noted that they had also been communicated briefly in four articles published in English in 1923.

2. The material quoted above was the whole and the most complete of the published accounts of the mice/bell experiments. Pavlov's account of these experiments was a minor part (in terms of number of words) of more extensive addresses. The 1923 Science article, the source of the quotation above, was an address at the Battle Creek Sanitarium on July 7, 1923. According to Razran (1958), the address was also published in the Bulletin of the Battle Creek Sanitarium (1923, 19, 1). On July 5, 1923, Pavlov had given a somewhat different address at the University of Chicago that included a similarly abbreviated account of the mice/bell experiment. The Chicago address was published in Scientific Monthly in 1923. Further, according to Razran (1958, p. 759), "The Edinburgh address, identical with the one given in Chicago, was published in the transactions of the congress in the 1923 Supplement Volume of the Quarterly Journal of Experimental Psychology (pp. 39-43)."

3. Pavlov's Battle Creek Sanitarium address appeared in the November 9, 1923, issue of Science. An item that appeared in the July 20, 1923, issue of Science in the Scientific Events section may bear on Littman's thesis. According to the report, "Few persons knew [Pavlov] was in the country, for if they had he would have been welcomed by scientists here as a celebrated physiologist" (p. 45). Perhaps relevant to this claim, the same news report noted that Pavlov and his son, Vladimir, were seated in a train in Grand Central Station in New York City, when they were "set upon" by three men who robbed them of their money and passports. The report continued that they were "perplexed as to what they should do in their predicament...[and] finally got in touch with Dr. P.A. Levene of the Rockefeller Institute, and since then have been the guests of the institute" (p. 45). It was also reported that the British consulate would not reissue their British visas and that Pavlov "will not be able to attend the Edinburgh Congress of Physiologists where his presence was desired by fellow scientists" (p. 45). The Pavlovs were to sail from New York to France where "after a short stay... [they] will return to Russia" (p. 45).

4. Razran (1958) noted that the latter report needed to be emended as follows:

> ...the Central Government in London yielded to protests from American and British scientists and finally granted him the visa while he was on the high seas. (p. 760)

Razran reported that Pavlov's address was read in English by his son before a large Edinburgh audience while (according to other sources cited by Razran) Pavlov stood nearby, following every word, and occasionally nodding and muttering his assent.

5. It appears that Pavlov's mice/bell experiment was reasonably well known, but in view of the subsequent retraction, it might have provided a poor recommendation for the bell as a CS. How all this bears on Littman's thesis is unclear.

REFERENCES (Only those independently consulted)


Catania, A.C. (1994) Query: Did Pavlov's Research Ring a Bell? PSYCOLOQUY Newsletter, Tuesday June 7 1994.

Littman, R.A. (1994). Bekhterev and Watson Rang Pavlov's Bell: A Reply to Catania's Query. PSYCOLOQUY 5(49) pavlov-bell.1.littman.

McClearn, G.E. (1963). Inheritance of behavior. In L. Postman (Ed.). Psychology in the Making: Histories of Selected Research Problems (pp. 144-252). New York: Alfred A. Knopf.

Pawlow, I.P. (1923). The identity of inhibition with sleep and hypnosis. Scientific Monthly, 17, 603-608.

Pawlow, I.P. (1923). New researches on conditioned reflexes. Science, 58, 359-361.

Pavlov, I.P. (1927). Conditioned reflexes. (G. V. Anrep, Trans.). London: Oxford University Press (Original work published in 1926).

Professor Pavlov's visit to America. (1923). Science, 58, pp. 45-46.

Razran, G. (1958). Pavlov and Lamarck. Science, 128, 758-760.

## *The Nature of Human Conflicts* by Luria, A.R. Translated from Russian and Edited By W. Horsley Gantt Foreword By Adolf Meyer

New York, N.Y., U.S.A.: Washington Square Press, 1967. Mass Market Paperback First Thus. 12mo - over 6¾" - 7¾" tall Very Good/ 431pp. A very nice copy of a classic book of modern psychology. Sime minor edgewear and very minor creasing of the corners on the front cover. Inside, there is very mild creasing on a few of the pages in the upper right-hand corner, and VERY minor discoloration of the text block, although I believe this to be the original color of the paper. Inside, the pages are very clean and bright. This is an uncommon book originally written back in 1932, but has been reprinted many times in small runs. The initial study was based on extensive lab research at the State Institute of Experimental Psychology in Moscow. This research consisted (as taken from the back cover) a critical re-evaluation of Pavlovian behavioral mechanisms in the light of the broader concepts of science and society espoused by Marx, its hypothesis is that of a philosopher-scientist-psyhiatrist: that the study of human behavior can be brought within the techniques of natural science.

## *Loud Music Can Cause Lung Collapse*

*By Amy Norton*

NEW YORK (Reuters Health) - Blasting music can be hard on the ears and the neighbors, and now researchers say it can also pack enough punch to collapse a lung.

Reporting in the medical journal Thorax, they describe the cases of four young men who suffered a lung collapse -- technically called pneumothorax --that appeared to be triggered by loud music. Three of the men were at a concert or club when the pneumothorax occurred, while the fourth was in his car, which was outfitted with a 1,000-watt bass box because he "liked to listen to loud music."

A pneumothorax occurs when a small rupture in one of the lungs allows air to leak into the space between the lungs and the chest wall, causing the lung to collapse. Symptoms include breathlessness and chest pain on the affected side. A small, partial collapse may resolve on its own, but more severe cases may require the insertion of a chest tube to allow the air to escape the chest cavity. Often, an underlying lung disease or chest injury is the culprit in pneumothorax. But so-called primary spontaneous pneumothorax happens in the absence of an underlying disease, typically striking tall, thin, male smokers.

The cases described in the Thorax report suggest that loud music may be one cause of this type of pneumothorax. Though the report cites only a small number of patients, lead author Dr. Marc Noppen told Reuters Health he suspects more cases of music-induced pneumothorax will now be caught. Since the report's publication, he said, doctors in a few countries have told him they've seen similar cases. If more doctors routinely ask pneumothorax patients about their exposure to loud music, the number of injuries attributed to blasting tunes will likely go up, noted Noppen, who is with the Academic Hospital in Brussels, Belgium.

In two of the cases his team describes, the men were standing close to large loudspeakers when they suddenly felt chest pain.

A third case involved a 23-year-old smoker who had suffered several episodes of pneumothorax. During a follow-up medical visit, the doctors mentioned having seen two music-related pneumothorax cases, and the patient suddenly remembered that two of his attacks happened at heavy metal concerts. Noppen said he and his colleagues suspect that loud music may damage the lungs due to its booming bass frequency, which can be felt as a vibration going through the body. The lungs may essentially start to vibrate in the same frequency as the bass, which could cause a lung to rupture.

It's probably a good idea, according to Noppen, to stand back from the speakers at concerts and clubs and to ease up on that car-stereo bass. It might also save your hearing, he added.

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# CONTINUOUS POINTS OF INTEREST

Conversational Postulates
Transformational Grammar
Indirect associative focusing and indirect ideodynamic focusing-
Your present state of consciousness
Awareness ( map vs. territory)
Rapport (building or breaking)
Pacing and leading ( Matching, mirroring and modeling)
4-tuple (5-tuples- L, C and R operators)
Polarity
Hypnotic language patterns
Double binds - Triple binds
Direct and indirect forms of suggestion (simple-compound and implied directives)
Double-talk
Mixed state communication startegies
Yes sets
Induction
Interspersal technique
Not knowing, not doing
Two level communication

TOTEs - Plans and the Structure of Behavior: short sequence of behavior occurring at the unconscious level…. " An example of the utilization of a TOTE in the context of hypnosis is the interruption of the standard handshake as the first step in a kinesthetically based trance induction." P 6 patterns II

" In our experience, the Trance State which results from the interruption of a tote is typically profound, and deep trance phenomena are comfortably elicited. Further if care is taken to re-orient the client to the exact position at which the interruption occurred and the remainder of the TOTE is executed, the client will have no conscious representation that anything unusual has occurred. In other words, consistent with the interrupted pattern having attained the status of a single unit of behavior at the unconscious level of behavior, any experiences which occur in the interruption can have no conscious representation unless deliberate instructions are given the client to consciously recall those experiences upon awakening. P6-7 patterns II.

s/d strucutres/rep systm ovrlap,
Mixed state communication
Indirect forms of suggestion
Double Binds
Polarity games and Reverse psychology
Negatives & Double Negatives
Double talk and "REACH"- concepts
Ambiguity
Conversational postulates
Metaphor
Anchoring and Analogical Marking P 239-Structures I
Embedded commands & questions
Subliminal suggestion
Linkage & Casual Modeling (Pacing and Leading: verb/nonverbal cross beh-p/l)

1) Building resistance: Tactics for counteracting Manipulation and Unethicakl hypnosis in Totalistic Groups" by Steve K. Dubrow Eichel. This article appeared in SUGGESTION; The Journal of Professional and Ethical Hypnosis. I (Summer 1985), pp 34-44.

2) "Persuasion and Brainwashing Techniques being used on the public today" By Dick Sutphen Text version of World Congress of Professional Hypnotist Convention Las Vegas Nevada

3) Richard Bandler in " Magical Structures" Seminar at 44:07

4) Patterns I & II: Richard Bandler, John Grinder, Connirae Andreas- 1975-77

(15) Transformations: Bandler and Grinder // The process of overload and Confusion technique bring about unconscious processing…...
*Double-talk Page 182 Hynpnothererapy by Erickson and Rossi 1979*

*Double-talk Page 182 Hynpnothererapy by Erickson and Rossi 1979*

(16) Patterns and Hypnotic techniques of Milton Erickson vol I & II

The first us patent for a psi-based effect is Patent # 5830064 granted Nov 3, 1998-check if it's true..

Page 77- ReFraming-Neuro-linguistic Programming and the Transformation of meaning Bandler and Grinder real people press 1982. Mention of RAND Corp.

Introduction: The structure of magic II. Human modeling processes //Generalization, Deletion and Distortion.

Book that established transformational grammar was syntactic structures //noam chomsky 1957the hague:mouton

" The Hypnotist works to secure and hold the subject's attentional processes, thereby making it
possible to access unconscious processes to develop hypnotic experiences…..The Hypnotist uses distraction, confusion and boredom techniques." p101

**(54)**

I will begin this chapter by mentioning an Idea and Theory that explains, through scientific experimentation, how much information a person can typically hold in thought before the unconscious takes over processing. Often, it occurs when overloaded or confused (15). In 1956, George A. Miller was a Professor at MIT and wrote his great paper called " The Magical Number Seven, Plus or minus Two: Some limits on our capacity for processing information." This work explained how much information a human being can hold in consciousness before becoming making mistakes. The ramifications of what that meant is obvious today. He called it the magic number " 7 +/- 2" because of the amount of " Chunks" the average human could hold into consciousness before experiencing what NLP pioneers Bandler & Grinder . Read a copy of " Trance-formations" by Bandler and Grinder to learn more about overload, stacking realities and the confusion technique. They all depend on how much your conscious mind can focus or pay attention to before your unconscious takes over. This is just an idea about the human mind and how much it can pay attention to before it shuts off. Research and applied hypnosis is being used to create TV Commercials. We'll talk about this later in "Methods and Technique."

**(54a)**

So it's all about what we are paying attention to and to that which we are not. Hypnosis has been mentioned throughout this book and has yet to be fully defined in a manner that encompasses all possible definitions. Until now, that is to say that hypnosis obviously is just a word. The meaning we impart it comes from within us usually. It can mean nothing, just something people talk about but isn't true. Or hypnosis can mean anything else. A moment filled with all possible outcomes.

101

……. As with any Ericksonian technique, the hypnotist needs to capture and maintain the subjects conscious attention and must therefore speak meaningfully, impressively and congruently. In addition, because the intent is to create and then use informational overload, the hypnotist begins with a relatively quick tempo, increases and intensifies it even more when the subject starts to get confused, but then dramatically reduces it ( to a slower, softer voice) right at he point of utilization. Finally it is quite useful to employ special tonal markings to suitability emphasize both in directional and ambiguous terms (e.g., right/left) and (b) the several embedded regarding paying attention and dropping into trance. When these and other nonverbal techniques are judiciously applied, the story will work quite well as an induction device. ……

One final techniques for depotentiating conscious processes is boredom. As Erickson used to say, " I've got an unconscious mind, and they've got an unconscious mind. Therefore, as long as we're in the room together, sooner or late they'll go into trance. And if nothing else works, I'll bore them into trance. It might take them 5 minutes, one hour, several hours, or many hours. That's fine, I can wait. " And, boy, could he ever wait. You might tell two or three hours of metaphorical stories, gradually wearing down the person to the point that he/she is unable or unwilling to offer any conscious resistances to shifting into trance. In fact, many people retreat.

## There is manner of communicating that uses process language

**(1) Thomas Braden, *Saturday Evening Post* (20th May, 1967)**
In the early 1950s, when the cold war was really hot, the idea that Congress would have approved many of our (CIA) projects was about as likely as the John Birch Society's approving Medicare.
**(2) John Playford, Political Scientists and the CIA, *Australian Left Review* (1968)**
The role of US trade unions and student bodies in Cold War, projects inspired and financed by the huge, international agency of subversion known as the Central Intelligence Agency, is now widely known in Australia. Far less publicity has been given to the ties that were shown to exist between the CIA and the US Information Agency (USIA), the propaganda arm of the US government, while nothing at all has appeared in the press on the links revealed between the USIA and Dr. Evron M. Kirkpatrick, Executive Director of the prestigious American Political Science Association (APSA), which has a membership of about 16,000. 4 Before being appointed the first full-time Executive Director of APSA in 1954, Kirkpatrick held a succession of senior posts in the State Department: Chief of the External Research Staff 1948-52, Chief of the Psychological Intelligence and Research Staff 1952-54, and Deputy Director of the Office of Intelligence Research 1954. In 1956 he edited Target: The World Communist Propaganda Activities in 1955, which was published by the Macmillan Co. of New York. In the Preface, he drew attention to the fact that the US Government had devoted systematic attention to research on Communist propaganda: "Many social scientists are aware of the work the government is doing and have seen some of its results; many have participated in it. The present volume has been made possible only by drawing upon this government research, and it is the product, therefore, of the work of many people." In the following year, Kirkpatrick edited and Macmillan published a companion volume entitled Year of Crisis - Communist Propaganda Activities in 1956. Both works bear all the earmarks of a USIA operation...

Kirkpatrick has also been President of Operations and Policy Research, Inc. (OPR) since its formation in 1955. A non-profit research organisation set up by a group of social Scientists, lawyers and businessmen to help the USIA distribute more persuasive and polished literature both in the US and abroad, OPR reads and gives expert opinion on books which USIA then plants with publishers, without the sponsorship being publicized. It employed on a part-time basis, according to Kirkpatrick, more than a hundred social scientists, many of them members of APSA. Sol Stern has correctly summed up OPR as "a Cold War-oriented strategy organization."
Kirkpatrick's wife, Mrs. Jean J. Kirkpatrick, is a staff member of Trinity College in Washington DC, a Catholic women's college conducted by the Sisters of Notre Dame de Namur. From 1951 to 1953 she had been an intelligence research analyst in the State Department, and since 1956 she has been a consultant to OPR. Mrs. Kirkpatrick has also had close connections with the USIA. She edited and wrote the introductory essay for The Strategy of Deception: A Study in World-Wide Communist Tactics, which was published in 1963 by Farrar, Straus and Co. of New York, and made a "special alternate selection" by the Book-of-the-Month Club. At no time was it mentioned that the USIA subsidised the book's creation. The USIA described its venture into covert publishing as the "book development program," of which the USIA official then in charge of it, Reed Harris, stated in testimony before the House of Representatives Appropriations Subcommittee in March 1964:

This is a program under which we can have books written to our own specifications, books that would not otherwise be put out, especially those books that have strong anti-communist content, and follow other themes that are particularly useful for our program. Under the book development program, we control the thing from the very idea down to the final edited manuscript.
Subsequently, the Director of the USIA, Leonard Marks, appeared before the same body in September 1966 and was asked why it was wrong "to let the American people know when they buy and read the book that it was developed under government sponsorship?" His reply was straight to the point: "It minimises their value."

The USIA did not pay Farrar, Straus; it paid $US 16,500 to The New Leader, whose editor, the late S. M. Levitas, conceived of the book and sold the idea to the USIA. A liberal militantly anti-Communist journal, The New Leader was for more than thirty years under the editorship of Levitas, "a bitter anti-Communist out of the East European Socialist tradition" who died in 1961. In recent years, The New Leader has lost much of the blind anti-Communism which allowed it to accept too readily the positions of the "China Lobby" and the "Vietnam Lobby."

**(3) Nina Burleigh, *A Very Private Woman: The Life and Unsolved Murder of Presidential Mistress Mary Meyer* (1998)**
The social connections with journalists were a crucial part of the CIA's propaganda machine. Chief among CIA friends were the Alsop brothers. Joseph Alsop wrote a column with his brother Stewart for the *New York Herald Tribune* and they occasionally penned articles at the suggestion of Frank Wisner, based upon classified information leaked to them. In exchange, they provided CIA friends with observations gathered on trips abroad. Such give-and-take was not unusual among the Georgetown set in the 1950s. The CIA also made friends with *Washington Post* publisher Phil Graham, Post managing editor Alfred Friendly, and *New York Times* Washington bureau chief James Reston, whose next-door neighbor was Frank Wisner. Ben Bradlee, while working for the State Department as a press attache in the American embassy in Paris, produced propaganda regarding the Rosenbergs' spying conviction and death sentence in

cooperation with the CIA... Some newspaper executives - Arthur Hays Sulzberger, publisher of the *New York Times*, among them - actually signed secrecy agreements with the CIA...

When Carl Bernstein reported that one CIA official had called Stewart Alsop a CIA agent, Joe Alsop defended his brother to Bernstein, saying: "I dare say he did perform some tasks-he just did the correct things as an American.... The Founding Fathers (of the CIA) were close personal friends of ours.... It was a social thing, my dear fellow."

Cord Meyer developed and nurtured his own friendships among journalists. He seconded the nomination of Washington Post writer Walter Pincus for membership in the Waltz Group, a Washington social organization. Pincus went on to become the Post's premier intelligence reporter. Cord also maintained friendly ties with William C. Baggs of the Miami News and foreign-affairs writer Herb Gold. Cord's ties to academia served him when he needed favors from publishers and journalists. In some accounts, he and Time writer C. D. Jackson together recruited Steinem. According to his journal, Cord dined at the Paris home of American novelist James Jones. He was also close to Chattanooga Times writer Charles Bartlett throughout his life.

**(4) Thomas Braden, interview included in the Granada Television program, *World in Action: The Rise and Fall of the CIA* (June, 1975)**

It never had to account for the money it spent except to the President if the President wanted to know how much money it was spending. But otherwise the funds were not only unaccountable, they were unvouchered, so there was really no means of checking them - "unvouchered funds" meaning expenditures that don't have to be accounted for.... If the director of CIA wanted to extend a present, say, to someone in Europe - a Labour leader - suppose he just thought, This man can use fifty thousand dollars, he's working well and doing a good job - he could hand it to him and never have to account to anybody... I don't mean to imply that there were a great many of them that were handed out as Christmas presents. They were handed out for work well performed or in order to perform work well.... Politicians in Europe, particularly right after the war, got a lot of money from the CIA....
Since it was unaccountable, it could hire as many people as it wanted. It never had to say to any committee - no committee said to it - "You can only have so many men." It could do exactly as it pleased. It made preparations therefore for every contingency. It could hire armies; it could buy banks. There was simply no limit to the money it could spend and no limit to the people it could hire and no limit to the activities it could decide were necessary to conduct the war - the secret war.... It was a multinational. Maybe it was one of the first.

Journalists were a target, labor unions a particular target - that was one of the activities in which the communists spent the most money. They set up a successful communist labor union in France right after the war. We countered it with Force Ouvriere. They set up this very successful communist labor union in Italy, and we countered it with another union.... We had a vast project targeted on the intellectuals - "the battle for Picasso's mind," if you will. The communists set up fronts which they effectively enticed a great many particularly the French intellectuals to join. We tried to set up a counterfront. (This was done through funding of social and cultural organizations such as the Pan-American Foundation, the International Marketing Institute, the International Development Foundation, the American Society of African Culture, and the Congress of Cultural Freedom.) I think the budget for the Congress of Cultural Freedom one year that I had charge of it was about $800,000, $900,000, which included, of course, the subsidy for the Congress's magazine, Encounter. That doesn't mean that everybody that worked for Encounter or everybody who wrote for Encounter knew anything about it. Most of the people who worked for Encounter and all but one of the men who ran it had no idea that it was paid for by the CIA.

**(5) Angus Mackenzie, *Secrets: The CIA War at Home* (1997)**
Following the buildup of U.S. troops in Vietnam and the assassination of Diem, Sheinbaum decided it was his patriotic duty to publicize information that he hoped might put the brakes on U.S. involvement. Writing about the connections between Michigan State University, the CIA, and the Saigon police (with the help of Robert Scheer, a young investigative reporter), the Sheinbaum story was to appear in the June 1966 issue of Ramparts magazine. The article disposed that Michigan State University had been secretly used by the CIA to train Saigon police and to keep an inventory of ammunition for grenade launchers, Browning automatic rifles, and .50 caliber machine guns, as well as to write the South Vietnamese constitution. The problem, in Sheinbaum's view, was that such secret funding of academics to execute government programs undercut scholarly integrity. When scholars are forced into a conflict of interest, he wrote, "where is the source of serious intellectual criticism that would help us avoid future Vietnams?"

Word of Sheinbaum's forthcoming article caused consternation on the seventh floor of CIA headquarters. On April 18, 1966, Director of Central Intelligence William F. Raborn Jr. notified his director of security that he wanted a "run down" on Ramparts magazine on a "high priority basis." This strongly worded order would prove to be a turning point for the Agency. To "run down" a domestic news publication because it had exposed questionable practices of the CIA was clearly in violation of the 1947 National Security Act's prohibition on domestic operations and meant the CIA eventually would have to engage in a cover-up. The CIA director of security, Howard J. Osborn, was also told: "The

Director [Raborn] is particularly interested in the authors of the article, namely, Stanley Sheinbaum and Robert Scheer. He is also interested in any other individuals who worked for the magazine."

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Osborn's deputies had just two days to prepare a special briefing on Ramparts for the director. By searching existing CIA files they were able to assemble dossiers on approximately twenty-two of the fifty-five Ramparts writers and editors, which itself indicates the Agency's penchant for collecting information on American critics of government policies. Osborn was able to tell Raborn that Ramparts had grown from a Catholic lay journal into a publication with a staff of more than fifty people in New York, Paris, and Munich, including two active members of the U.S. Communist Party. The most outspoken of the CIA critics at the magazine was not a Communist but a former Green Beret veteran, Donald Duncan. Duncan had written, according to then CIA Deputy Director Richard Helms, "We will continue to be in danger as long as the CIA is deciding policy and manipulating nations." Of immediate concern to Raborn, however, was Osborn's finding that Sheinbaum was in the process of exposing more CIA domestic organizations. The investigation of Ramparts was to be intensified, Raborn told Osborn.

At the same time, Helms passed information to President Lyndon Johnson's aide, William D. Moyers, about the plans of two Ramparts editors to run for Congress on an antiwar platform. Within days, the CIA had progressed from investigating a news publication to sending domestic political intelligence to the White House, just as a few members of Congress had feared nineteen years earlier.

Upon publication, Sheinbaum's article triggered a storm of protests from academicians and legislators across the country who saw the CIA's infiltration of a college campus as a threat to academic freedom. The outcry grew so loud that President Johnson felt he had to make a reassuring public statement and establish a task force to review any government activities that might endanger the integrity of the educational community. The task force was a collection of political statesmen--such as Attorney General Nicholas Katzenbach and Secretary of Health, Education, and Welfare John Gardner--but also included Richard Helms, the CIA official who himself had been dealing in political espionage. The purpose of the task force, it soon became clear, was to forestall further embarrassment and preclude any congressional investigation of CIA operations. Helms, furthermore, organized an internal task force of directorate chiefs to examine all CIA relationships with academic institutions but that review, from all appearances, was designed only to ensure that these operations remained secret...

Meanwhile, CIA officers spent April and May of 1966 identifying the source of Ramparts's money. Their target was executive editor Warren Hinckle, the magazine's chief fund-raiser and a man easy to track. He wore a black patch over one eye and made no secret of the difficult state of the magazine's finances as he continually begged a network of rich donors for operating funds. The agents also reported that Hinckle had launched a $2.5 million lawsuit against Alabama Governor George Wallace for calling the magazine pro-Communist (information that Osborn dutifully passed on to Raborn). The real point of the CIA investigation, however, was to place Ramparts reporters under such dose surveillance that any CIA officials involved in domestic operations would have time to rehearse cover stories before the reporters arrived to question them.

Next, Raborn broadened the scope of his investigation of Ramparts's staff by recruiting help from other agencies. On June 16, 1966, he ordered Osborn to "urge" the FBI to "investigate these people as a subversive unit." Osborn forwarded this request to the FBI, expressing the CIA's interest in anything the FBI might develop "of a derogatory nature." One CIA officer, who later inspected the CIA file of the Ramparts investigation, said that the Agency was trying to find a way of shutting down the magazine that would stand up in court, notwithstanding the constraints of the First Amendment...

On March 4, 1967, Richard Ober got a report from a person who attended a Ramparts staff meeting at which magazine reporters had discussed their interviews of high executive branch government officials and their attempts to meet with White House staff members. Now Ober knew who was saying what to whom. Three days later, Ober's task force found out that a Ramparts reporter was going to interview a CIA "asset": that is, someone under CIA control. In preparation, CIA officers told the asset how to handle the reporter, and after the interview the asset reported back to the CIA.

On March 16, two of Ober's men drove from CIA headquarters to a nearby airport to pick up a CIA agent who was a good friend of a Ramparts reporter. They went to a hotel, where the CIA agent was debriefed. Then the agent and his case officers reviewed his cover story, which he went on to tell his Ramparts contact as a means of obtaining more information. During the same period Ober was trying to recruit five former Ramparts employees as informants. "Maybe they were unhappy," a CIA agent would later explain. On April 4, Ober completed a status report on his Ramparts task force. His men had identified and investigated 127 Ramparts writers and researchers, as well as nearly 200 other American civilians with some link to the magazine.

Three more CIA officers joined Ober's team, bringing to twelve the number of full-time or part-time officers coordinating intelligence and operations on Ramparts at the headquarters level. On April 5, 1967, the task force completed its tentative assessment and recommendations, setting forth future actions--which, the CIA was still insisting in 1994, cannot be released under the Freedom of Information Act. CIA officer Louis Dube described the recommendations as "heady shit" but refused to be more specific.
It is known that Ober became fascinated with Ramparts advertisers. "One of our officers was in contact with a source who provided us with information about Ramparts's advertising," Dube admitted. On April 28, a CIA analyst working for Ober tried to learn if the CIA had any friends who might have influence with Ramparts advertisers, apparently with the intention of getting them to drop their accounts.

**(6) Final Report of the Select Committee to Study Government Operations With Respect to Intelligence Activities (April, 1976)**
The Covert Use of Books and Publishing Houses: The Committee has found that the Central Intelligence Agency attaches a particular importance to book publishing activities as a form of covert propaganda. A former officer in the Clandestine Service stated that books are "the most important weapon of strategic (long-range) propaganda." Prior to 1967, the Central Intelligence Agency sponsored, subsidized, or produced over 1,000 books; approximately 25 percent of them in English. In 1967 alone, the CIA published or subsidized over 200 books, ranging from books on African safaris and wildlife to translations of Machiavelli's The Prince into Swahili and works of T. S. Eliot into Russian, to a competitor to Mao's little red book, which was entitled Quotations from Chairman Liu.
The Committee found that an important number of the books actually produced by the Central Intelligence Agency were reviewed and marketed in the United States:

* A book about a young student from a developing country who had studied in a communist country was described by the CIA as "developed by (two areas divisions) and, produced by the Domestic Operations Division... and has had a high impact in the United States as well as in the (foreign area) market." This book, which was produced by the European outlet of a United States publishing house was published in condensed form in two major U.S. magazines."

Another CIA book, The Penkorsky Papers, was published in United States in 1965. The book was prepared and written by omitting agency assets who drew on actual case materials and publication rights to the manuscript were sold to the publisher through a trust fund which was established for the purpose. The publisher was unaware of any US Government interest.

In 1967, the CIA stopped publishing within the United States. Since then, the Agency has published some 250 books abroad, most of them in foreign languages. The CIA has given special attention to publication and circulation abroad of books about conditions in the Soviet Bloc. Of those targeted at audiences outside the Soviet Union and Eastern Europe, a large number has also been available in English.

Domestic "Fallout": The Committee finds that covert media operations can result in manipulating or incidentally misleading the American public. Despite efforts to minimize it, CIA employees, past and present, have conceded that there is no way to shield the American public completely from "fallout" in the United States from Agency propaganda or placements overseas. Indeed, following the Katzenbach inquiry, the Deputy Director for Operations issued a directive stating: "Fallout in the United States from a foreign publication which we support is inevitable and consequently permissible."

The domestic fallout of covert propaganda comes from many sources: books intended primarily for an English-speaking foreign audience; CIA press placements that are picked up by an international wire service; and publications resulting from direct CIA funding of foreign institutes. For example, a book written for an English-speaking foreign audience by one CIA operative was reviewed favorably by another CIA agent in the New York Times. The Committee also found that the CIA helped create and support various Vietnamese periodicals and publications. In at least one instance, a CIA supported Vietnamese publication was used to propagandize the American public and the members and staff of both houses of Congress. So effective was this propaganda that some members quoted from the publication in debating the controversial question of United States involvement in Vietnam.
The Committee found that this inevitable domestic fallout was compounded when the Agency circulated its subsidized books in the United States prior to their distribution abroad in order to induce a favorable reception overseas.

The Covert Use of 11.5. Journalists and Media Institutions on, February 11, 1976, CIA Director George Bush announced new guidelines governing the Agency's relationship with United States media organizations: "Effective immediately, CIA will not enter into any paid or contractual relationship with any full-time or part-time news correspondent accredited by any U.S. news service, newspaper, periodical, radio or television network or station."

Agency officials who testified after the February 11, 1976, announcement told the Committee that the prohibition extends to non-Americans accredited to specific United States media organizations.

The CIA currently maintains a network of several hundred foreign individuals around the world who provide intelligence for the CIA and at times attempt to influence opinion through the use of covert propaganda. These individuals provide the CIA with direct access to a large number of newspapers and periodicals, scores of press services and news agencies, radio and television stations, commercial book publishers, and other foreign media outlets.

Approximately 50 of the assets are individual American journalists or employees of US media organizations. Of these, fewer than half are "accredited" by US media organizations and thereby affected by the new prohibitions on the use of accredited newsmen. The remaining individuals are non-accredited freelance contributors and media representatives abroad, and thus are not affected by the new CIA prohibition.

More than a dozen United States news organizations and commercial publishing houses formerly provided cover for CIA agents abroad. A few of these organizations were unaware that they provided this cover.
The Committee notes that the new CIA prohibitions do not apply to "unaccredited" Americans serving in media organizations such as representatives of US media organizations abroad or freelance writers. Of the more than 50 CIA relationships with United States journalists, or employees in American media organizations, fewer than one half will be terminated under the new CIA guidelines.
The Committee is concerned that the use of American :journalists and media organizations for clandestine operations is a threat to the integrity of the press. All American journalists, whether accredited to a United States news organization or just a stringer, may be suspects when any are engaged in covert activities.

**(7) Alex Constantine, *Mockingbird: The Subversion Of The Free Press By The CIA* (2000)**

It was conceived in the late 1940s, the most frigid period of the cold war, when the CIA began a systematic infiltration of the corporate media, a process that often included direct takeover of major news outlets.

In this period, the American intelligence services competed with communist activists abroad to influence European labor unions. With or without the cooperation of local governments, Frank Wisner, an undercover State Department official assigned to the Foreign Service, rounded up students abroad to enter the cold war underground of covert operations on behalf of his Office of Policy Coordination. Philip Graham,a graduate of the Army Intelligence School in Harrisburg, PA, then publisher of the Washington Post, was taken under Wisner's wing to direct the program code-named Mockingbird...
"World War III has begun," Henry's Luce's *Life* declared in March, 1947. "It is in the opening skirmish stage already." The issue featured an excerpt of a book by James Burnham, who called for the creation of an "American Empire," "world-dominating in political power, set up at least in part through coercion (probably including war, but certainly the threat of war) and in which one group of people ... would hold more than its equal share of power."

George Seldes, the famed anti-fascist media critic, drew down on Luce in 1947, explaining that "although avoiding typical Hitlerian phrases, the same doctrine of a superior people taking over the world and ruling it, began to appear in the press, whereas the organs of Wall Street were much more honest in favoring a doctrine inevitably leading to war if it brought greater commercial markets under the American flag."

On the domestic front, an abiding relationship was struck between the CIA and William Paley, a wartime colonel and the founder of CBS. A firm believer in "all forms of propaganda" to foster loyalty to the Pentagon, Paley hired CIA agents to work undercover at the behest of his close friend, the busy grey eminence of the nation's media, Allen Dulles. Paley's designated go-between in his dealings with the CIA was Sig Mickelson, president of CBS News from 1954 to 1961.

The CIA's assimilation of old guard fascists was overseen by the Operations Coordination Board, directed by C.D. Jackson, formerly an executive of Time magazine and Eisenhower's Special Assistant for Cold War Strategy. In 1954 he was succeeded by Nelson Rockefeller, who quit a year later, disgusted at the administration's political infighting. Vice President Nixon succeeded Rockefeller as the key cold war strategist...

The commercialization of television, coinciding with Reagan's recruitment by the Crusade for Freedom, a CIA front, presented the intelligence world with unprecedented potential for sowing propaganda and even prying in the age of Big Brother. George Orwell glimpsed the possibilities when he installed omniscient video surveillance technology in 1948, a novel rechristened 1984 for the first edition published in the U.S. by Harcourt, Brace. Operation Octopus, according to federal files, was in full swing by 1948, a surveillance program that turned any television set with tubes into a broadcast transmitter. Agents of Octopus could pick up audio and visual images with the equipment as far as 25 miles away. Hale Boggs was investigating Operation Octopus at the time of his disappearance in the midst of the Watergate probe...

In the 1950s, outlays for global propaganda climbed to a full third of the CIA's covert operations budget. Some 3,000 salaried and contract CIA employees were eventually engaged in propaganda efforts. The cost of disinforming the world cost American taxpayers an estimated $265 million a year by 1978, a budget larger than the combined expenditures of Reuters, UPI and the AP news syndicates.

In 1977, the Copely News Service admitted that it worked closely with the intelligence services - in fact, 23 employees were full-time employees of the Agency.

**(8) Deborah Davis, interviewed by Kenn Thomas of Steamshovel Press (1992)**
Kenn Thomas: Let's get back to Ben Bradlee. I know part of what's in the book and part of what upset those forces that caused the withdrawal of its first publication is what you've said about Ben Bradlee and his connection to the Ethyl and Julius Rosenberg trial. Would you talk about that a bit?

Deborah Davis: In the first edition, the one that was recalled and shredded, I looked in State Department lists for '52 and '53 when Bradlee was serving as a press attache supposedly in the American embassy in Paris. This was during the Marshall Plan when the United States over in Europe had hundreds of thousands of people making an intensive effort to keep Western Europe from going Communist. Bradlee wanted to be part of that effort. So he was over in the American embassy in Paris and the embassy list had these letters after his name that said USIE. And I asked the State Department what that meant and it said United States Information Exchange. It was the forerunner of the USIA, the United States Information Agency. It was the propaganda arm of the embassy. They produced propaganda that was then disseminated by the CIA all over Europe. They planted newspaper stories. They had a lot of reporters on their payrolls. They routinely would produce stories out of the embassy and give them to these reporters and they would appear in the papers in Europe. It's very important to understand how influential newspaper stories are to people because this is what people think of as their essential source of facts about what is going on. They don't question it, and even if they do question it they have nowhere else to go to find out anything else. So Bradlee was involved in producing this propaganda. But at that point in the story I didn't know exactly what he was doing.

I published the first book just saying that he worked for USIE and that this agency produced propaganda for the CIA. He went totally crazy after the book came out. One person who knew him told me then that he was going all up and down the East Coast having lunch with every editor he could think of saying that it was not true, he did not produce any propaganda. And he attacked me viciously and he said that I had falsely accused him of being a CIA agent. And the reaction was totally out of proportion to what I had said.
Kenn Thomas: You make a good point in the book that other people who have had similar kinds of--I don't even know if you want to call them accusations--but reports that they in some way cooperated with the CIA in the '5Os, that the times were different and people were expected to do that kind of thing out of a sense of patriotism and they blow it off.

Deborah Davis : That's right. People say, yeah, this is what I did back then, you know. But Bradlee doesn't want to be defined that way because, I don't know, somehow he thinks it's just too revealing of him, of who he is. He doesn't want to admit a true fact about his past because somehow he doesn't want it known that this is where he came from. Because this is the beginning of his journalistic career. This is how he made it big.

Subsequent to my book being shredded in 1979, early 1980, I got some documents through the Freedom of Information Act and they revealed that Bradlee had been the person who was running an entire propaganda operation against Julius and Ethyl Rosenberg that covered forty countries on four continents. He always claimed that he had been a low level press flack in the embassy in Paris, just a press flack, nothing more. Julius and Ethyl Rosenberg had already been convicted of being atomic spies and they were on death row waiting to be executed. And the purpose of Bradlee's propaganda operation was to convince the Europeans that they really were spies, they really had given the secret of the atomic bomb to the Russians and therefore they did deserve to be put to death.
The Europeans, having just very few years before defeated Hitler, were very concerned that the United States was going fascist the way their countries had. And this was a very real fear to the Europeans. They saw the same thing happening in the United States that had happened in their own countries. And so Bradlee used the Rosenberg case to say, "No this isn't what you think it is. These people really did this bad thing and they really do deserve to die. It doesn't mean that the United States is becoming fascist." So he had a very key role in creating European public opinion and it was very, very important. This was the key issue that was going to determine how the Europeans felt about the United States.

Some of the documents that I had showed him writing letters to the prosecutors of the Rosenbergs saying "I'm working for the head of the CIA in Paris and he wants me to come and look at your files." And this kind of thing. So in the second edition, which came out in 1987, I reprinted those documents, the actual documents, the readers can see them and it's got his signature and it's very, very interesting. He subsequently has said nothing about it at all. He won't talk about it all. He won't answer any questions about it. So I guess the point about Bradlee is that he went from this job to being European bureau chief for Newsweek magazine and to the executive editorship of the Post. So this is how he got where he is. It's very clear line of succession. Philip Graham was Katharine Graham's husband, who ran the Post in the '50s and he committed suicide in 1963. That's when Katharine Graham took over. Bradlee was close friends with Allen Dulles and Phil Graham. The paper wasn't doing very well for a while and he was looking for a way to pay foreign correspondents and Allen Dulles was looking for a cover. Allen Dulles was head of the CIA back then and he was looking for a cover for some of his operatives so that they could get in and out of places without arousing suspicion. So the two of them hit on a plan: Allen Dulles would pay for the reporters and they would give the CIA the information that they found as well as give it to the Post. So he helped to develop this operation and it subsequently spread to other newspapers and magazines. And it was called Operation Mockingbird. This operation, I believe, was revealed for the first time in my book.

**(9) Evan Thomas**, *The Very Best Men: The Early Years of the CIA* (1995)

He (Frank Wisner) considered his friends Joe and Stewart Alsop to be reliable purveyors of the company line in their columns, and he would not hesitate to call Cyrus Sulzberger, the brother of the publisher of the *New York Times*. "You'd be sitting there, and he'd be on the phone to Times Washington bureau chief Scotty Reston explaining why some sentence in the paper was entirely wrong. "I want that to go to Sulzberger!" he'd say. He'd pick up newspapers and edit them from the CIA point of view," said Braden.

**(10) Deborah Davis, *Katharine the Great* (**1979)

The Washington Post was in many ways like other "companies," as Walter Lippmann called the news organizations, fighting deadlines, living uneasily with unions, suffering with "technical conditions (that) do not favor genuine and productive debate." But the Post was also unique among news companies in that its managers, living and working in Washington, thought of themselves simultaneously as journalists, businessmen, and patriots, a state of mind that made them singularly able to expand the company while promoting the national interest. Their individual relations with intelligence had in fact been the reason that the Post Company had grown as fast as it did after the war; their secrets were its corporate secrets, beginning with MOCKINGBIRD. Philip Graham's commitment to intelligence gave his friends Frank Wisner and Allen Dulles an interest in helping to make the Washington Post the dominant news vehicle in Washington, which they did by assisting with its two most crucial acquisitions, the Times-Herald and WTOP. The Post men most essential to these transactions, other than Phil, were Wayne Coy, the Post executive who had been Phil's former New Deal boss, and John S. Hayes, who replaced Coy in 1947 when Coy was appointed chairman of the Federal Communications Commission.

**(11) Mary Louise, *Mockingbird: CIA Media Manipulation* (2003)**

Starting in the early days of the Cold War (late 40's), the CIA began a secret project called Operation Mockingbird, with the intent of buying influence behind the scenes at major media outlets and putting reporters on the CIA payroll, which has proven to be a stunning ongoing success. The CIA effort to recruit American news organizations and journalists to become spies and disseminators of propaganda, was headed up by Frank Wisner, Allen Dulles, Richard Helms, and Philip Graham (publisher of The Washington Post). Wisner had taken Graham under his wing to direct the program code-named Operation Mockingbird and both have presumably committed suicide.

Media assets will eventually include ABC, NBC, CBS, Time, Newsweek, Associated Press, United Press International (UPI), Reuters, Hearst Newspapers, Scripps-Howard, Copley News Service, etc. and 400 journalists, who have secretly carried out assignments according to documents on file at CIA headquarters, from intelligence-gathering to serving as go-betweens. The CIA had infiltrated the nation's businesses, media, and universities with tens of thousands of on-call operatives by the 1950's. CIA Director Dulles had staffed the CIA almost exclusively with Ivy League graduates, especially from Yale with figures like George Herbert Walker Bush from the "Skull and Crossbones" Society.

Many Americans still insist or persist in believing that we have a free press, while getting most of their news from state-controlled television, under the misconception that reporters are meant to serve the public. Reporters are paid employees and serve the media owners, who usually cower when challenged by advertisers or major government figures. Robert Parry reported the first breaking stories about Iran-Contra for Associated Press that were largely ignored by the press and congress, then moving to Newsweek he witnessed a retraction of a true story for political reasons. In 'Fooling America: A Talk by Robert Parry' he said, "The people who succeeded and did well were those who didn't stand up, who didn't write the big stories, who looked the other way when history was happening in front of them, and went along either consciously or just by cowardice with the deception of the American people."

Major networks are primarily controlled by giant corporations that are obligated by law, to put the profits of their investors ahead of all other considerations which are often in conflict with the practice of responsible journalism. There were around 50 corporations a couple of decades ago, which was considered monopolistic by many and yet today, these companies have become larger and fewer in number as the biggest ones absorb their rivals. This concentration of ownership and power reduces the diversity of media voices, as news falls into the hands of large conglomerates with holdings in many industries that interferes in news gathering, because of conflicts of interest. Mockingbird was an immense financial undertaking with funds flowing from the CIA largely through the Congress for Cultural Freedom (CCF) founded by Tom Braden with Pat Buchanon of CNN's Crossfire.

Media corporations share members of the board of directors with a variety of other large corporations including banks, investment companies, oil companies, health care, pharmaceutical, and technology companies. Until the 1980's, media systems were generally domestically owned, regulated, and national in scope. However, pressure from the IMF, World Bank, and US government to deregulate and privatize, the media, communication, and new technology resulted in a global commercial media system dominated by a small number of super-powerful transnational media corporations (mostly US based), working to advance the cause of global markets and the CIA agenda.

**(12) David Guyatt, *Subverting the Media* (undated)**

In an October 1977, article published by Rolling Stone magazine, Bernstein reported that more than 400 American journalists worked for the CIA. Bernstein went on to reveal that this cozy arrangement had covered the preceding 25 years. Sources told Bernstein that the New York Times, America's most respected newspaper at the time, was one of the CIA's closest media collaborators. Seeking to spread the blame, the New York Times published an article in December 1977, revealing that "more than eight hundred news and public information organisations and individuals," had participated in the CIA's covert subversion of the media.

"One journalist is worth twenty agents," a high-level source told Bernstein. Spies were trained as journalists and then later infiltrated – often with the publishers consent - into the most prestigious media outlets in America, including the New York Times and Time Magazine. Likewise, numerous reputable journalists underwent training in various aspects of "spook-craft" by the CIA. This included techniques as varied as secret writing, surveillance and other spy crafts. The subversion operation was orchestrated by Frank Wisner, an old CIA hand who's clandestine activities dated back to WW11. Wisner's media manipulation programme became known as the "Wisner Wurlitzer," and proved an effective technique for sending journalists overseas to spy for the CIA. Of the fifty plus overseas news proprietary's owned by the CIA were The Rome Daily American, The Manilla Times and the Bangkok Post.

Yet, according to some experts, there was another profound reason for the CIA's close relations with the media. In his book, "Virtual Government," author Alex Constantine goes to some lengths to explore the birth and spread of Operation Mockingbird. This, Constantine explains, was a CIA project designed to influence the major media for domestic propaganda purposes. One of the most important "assets" used by the CIA's Frank Wisner was Philip Graham, publisher of the Washington Post. A decade later both Wisner and Graham committed suicide – leading some to question the exact nature of their deaths. More recently doubts have been cast on Wisner's suicide verdict by some observers who believed him to have been a Soviet agent.

**(13) Michael Hasty, *Secret Admirers: The Bushes and the Washington Post* (5th February , 2004)**

In an article published by the media watchdog group, Fairness and Accuracy in Reporting (FAIR), Henwood traced the Washington Post's Establishment connections to Eugene Meyer, who took control of the Post in 1933. Meyer transferred ownership to his daughter Katherine and her husband, Philip Graham, after World War II, when he was appointed by Harry S. Truman to serve as the first president of the World Bank. Meyer had been "a Wall Street banker, director of President Wilson's War Finance Corporation, a governor of the Federal Reserve System, and director of the Reconstruction Finance Corporation," Henwood wrote.

Philip Graham, Meyer's successor, had been in military intelligence during the war. When he became the Post's publisher, he continued to have close contact with his fellow upper-class intelligence veterans - now making policy at the newly formed CIA - and actively promoted the CIA's goals in his newspaper. The incestuous relationship between the Post and the intelligence community even extended to its hiring practices. Watergate-era editor Ben Bradlee also had an intelligence background; and before he became a journalist, reporter Bob Woodward was an officer in Naval Intelligence. In a 1977 article in Rolling Stone magazine about CIA influence in American media, Woodward's partner, Carl Bernstein, quoted this from a CIA official: "It was widely known that Phil Graham was somebody you could get help from." Graham has been identified by some investigators as the main contact in Project Mockingbird, the CIA program to infiltrate domestic American media. In her autobiography, Katherine Graham described how her husband worked overtime at the Post during the Bay of Pigs operation to protect the reputations of his friends from Yale who had organized the ill-fated venture.

After Graham committed suicide, and his widow Katherine assumed the role of publisher, she continued her husband's policies of supporting the efforts of the intelligence community in advancing the foreign policy and economic agenda of the nation's ruling elites. In a retrospective column written after her own death last year, FAIR analyst Norman Solomon wrote, "Her newspaper mainly functioned as a helpmate to the war-makers in the White House, State Department and Pentagon." It accomplished this function (and continues to do so) using all the classic propaganda techniques of evasion, confusion, misdirection, targeted emphasis, disinformation, secrecy, omission of important facts, and selective leaks.

Graham herself rationalized this policy in a speech she gave at CIA headquarters in 1988. "We live in a dirty and dangerous world," she said. "There are some things the general public does not need to know and shouldn't. I believe democracy flourishes when the government can take legitimate steps to keep its secrets and when the press can decide whether to print what it knows."

**(14) Doug Henwood, *The Washington Post: The Establishment's Paper* (January, 1990)**

After World War II, when Harry Truman named this lifelong Republican as first president of the World Bank, Meyer made his son-in-law, Philip L. Graham, publisher of the paper. Meyer stayed at the Bank for only six months and returned to the Post as its chairman. But with Phil Graham in charge, there was little for Meyer to do. He transferred ownership to Philip and Katharine Graham, and retired. Phil Graham maintained Meyer's intimacy with power. Like many members of his class and generation, his postwar view was shaped by his work in wartime intelligence; a classic Cold War liberal, he was uncomfortable with McCarthy, but quite friendly with the personnel and policies of the CIA. He saw the role of the press as mobilizing public assent for policies made by his Washington neighbors; the public deserved to know only what the inner circle deemed proper. According to Howard Bray's Pillars of the Post, Graham and other top Posters knew details of several covert operations - including advance knowledge of the disastrous Bay of Pigs invasion - which they chose not to share with their readers.

When the manic-depressive Graham shot himself in 1963, the paper passed to his widow, Katharine. Though out of her depth at first, her instincts were safely establishmentarian. According to Deborah Davis' biography, Katharine the Great, Mrs. Graham was scandalized by the cultural and political revolutions of the 1960s, and wept when LBJ fused to run for reelection in 1968. (After Graham asserted that the book as "fantasy," Harcourt Brace Jovanovich pulled 20,000 copies of Katharine the Great in 1979. The book as re-issued by National Press in 87.)

The Post was one of the last major papers to turn against the Vietnam War. Even today, it hews to a hard foreign policy line - usually to the right of The New York Times, a paper not known or having transcended the Cold War.

There was Watergate, of course, that model of aggressive reporting by the Post. But even here, Graham's Post was doing the establishment's work. As Graham herself said, the investigation couldn't have succeeded without the cooperation of people inside the government willing to talk to Bob Woodward and Carl Bernstein.

These talkers may well have included the CIA; it's widely suspected that Deep Throat was an Agency man (or men). Davis argues that Post editor Ben Bradlee knew Deep Throat, and may even have set him up with Woodward. She produces evidence that in the early 1950s, Bradlee crafted propaganda for the CIA on the Rosenberg case for European consumption. Bradlee denies working "for" the CIA, though he admits having worked for the U.S. Information Agency - perhaps distinction without a difference.

In any case, it's clear that a major portion of the establishment wanted Nixon out. Having accomplished this, there was little taste for further crusading. Nixon had denounced the Post as "Communist" during the 1950s. Graham offered her support to Nixon upon his election in 1968, but he snubbed her, even directing his allies to challenge the Post Co.'s TV license in Florida a few ears later. The Reagans were a different story - for one thing, Ron's crowd knew that seduction was a better way to get good press than hostility. According to Nancy Reagan's memoirs, Graham welcomed Ron and Nancy to her Georgetown house in 1981 with a kiss. During the darkest days of Iran-Contra, Graham and Post editorial page editor Meg Greenfield - lunch and phone companions to Nancy throughout the Reagan years - offered the First Lady frequent expressions of sympathy. Graham and the establishment never got far from the Gipper.

**(15) Carl Bernstein, *CIA and the Media*, *Rolling Stone Magazine* (20th October, 1977)**

In 1953, Joseph Alsop, then one of America's leading syndicated columnists, went to the Philippines to cover an election. He did not go because he was asked to do so by his syndicate. He did not go because he was asked to do so by the newspapers that printed his column. He went at the request of the CIA.

Alsop is one of more than 400 American journalists who in the past twenty-five years have secretly carried out assignments for the Central Intelligence Agency, according to documents on file at CIA headquarters. Some of these journalists' relationships with the Agency were tacit; some were explicit. There was cooperation, accommodation and overlap. Journalists provided a full range of clandestine services - from simple intelligence- gathering to serving as go-betweens with spies in Communist countries. Reporters shared their notebooks with the CIA. Editors shared their staffs. Some of the journalists were Pulitzer Prize winners, distinguished reporters who considered themselves ambassadors-without-portfolio for their country. Most were less exalted: foreign correspondents who found that their association with the Agency helped their work; stringers and freelancers who were as interested it the derring-do of the spy business as in filing articles, and, the smallest category, full-time CIA employees masquerading as journalists abroad. In many instances, CIA documents show, journalists were engaged to perform tasks for the CIA with the consent of the managements America's leading news organizations.

The history of the CIA's involvement with the American press continues to be shrouded by an official policy of obfuscation and deception . . . .

Among the executives who lent their cooperation to the Agency were William Paley of the Columbia Broadcasting System, Henry Luce of Time Inc., Arthur Hays Sulzberger of the New York Times, Barry Bingham Sr. of the Louisville Courier-Journal and James Copley of the Copley News Service. Other organizations which cooperated with the CIA include the American Broadcasting Company, the National Broadcasting Company, the Associated Press, United Press International, Reuters, Hearst Newspapers, Scripps-Howard, Newsweek magazine, the Mutual Broadcasting System, the Miami Herald and the old Saturday Evening Post and New York Herald-Tribune.

By far the most valuable of these associations, according to CIA officials, have been with the New York Times, CBS and Time Inc....
The Agency's dealings with the press began during the earliest stages of the Cold War. Allen Dulles, who became director of the CIA in 1953, sought to establish a recruiting-and-cover capability within America's most prestigious journalistic institutions. By operating under the guise of accredited news correspondents, Dulles believed, CIA operatives abroad would be accorded a degree of access and freedom of movement unobtainable under almost any other type of cover.

American publishers, like so many other corporate and institutional leaders at the time, were willing us commit the resources of their companies to the struggle against "global Communism." Accordingly, the traditional line separating the American press corps and government was often indistinguishable: rarely was a news agency used to provide cover for CIA operatives abroad without the knowledge and consent of either its principal owner; publisher or senior editor. Thus, contrary to the notion that the CIA era and news executives allowed themselves and their organizations to become handmaidens to the intelligence services. "Let's not pick on some poor reporters, for God's sake," William Colby exclaimed at one point to the Church committee's investigators. "Let's go to the managements. They were willing". In all, about twenty-five news organizations (including those listed at the beginning of this article) provided cover for the Agency....

Many journalists who covered World War II were close to people in the Office of Strategic Services, the wartime predecessor of the CIA; more important, they were all on the same side. When the war ended and many OSS officials went into the CIA, it was only natural that these relationships would continue. Meanwhile, the first postwar generation of journalists entered the profession; they shared the same political and professional values as their mentors. "You had a gang of people who worked together during World War II and never got over it," said one Agency official. "They were genuinely motivated and highly susceptible to intrigue and being on the inside. Then in the Fifties and Sixties there was a national consensus about a national threat. The Vietnam War tore everything to pieces - shredded the consensus and threw it in the air." Another Agency official observed: "Many journalists didn't give a second thought to associating with the Agency. But there was a point when the ethical issues which most people had submerged finally surfaced. Today, a lot of these guys vehemently deny that they had any relationship with the Agency."

The CIA even ran a formal training program in the 1950s to teach its agents to be journalists. Intelligence officers were "taught to make noises like reporters," explained a high CIA official, and were then placed in major news organizations with help from management. "These were the guys who went through the ranks and were told, "You're going to be a journalist," the CIA official said. Relatively few of the 400-some relationships described in Agency files followed that pattern, however; most involved persons who were already bona fide journalists when they began undertaking tasks for the Agency...

At the headquarters of CBS News in New York, Paley's cooperation with the CIA is taken for granted by many news executives and reporters, despite the denials. Paley, 76, was not interviewed by Salant's investigators. "It wouldn't do any good," said one CBS executive. "It is the single subject about which his memory has failed."

Time and Newsweek magazines. According to CIA and Senate sources, Agency files contain written agreements with former foreign correspondents and stringers for both the weekly news magazines. The same sources refused to say whether the CIA has ended all its associations with individuals who work for the two publications. Allen Dulles often interceded with his good friend, the late Henry Luce, founder of Time and Life magazines, who readily allowed certain members of his staff to work for the Agency and agreed to provide jobs and credentials for other CIA operatives who lacked journalistic experience. At Newsweek, Agency sources reported, the CIA engaged the services of several foreign correspondents and stringers under arrangements approved by senior editors at the magazine...

After Colby left the Agency on January 28th, 1976, and was succeeded by George Bush, the CIA announced a new policy: "Effective immediately, the CIA will not enter into any paid or contract relationship with any full-time or part-time news correspondent accredited by any U.S. news service, newspaper, periodical, radio or television network or station." ... The text of the announcement noted that the CIA would continue to "welcome" the voluntary, unpaid cooperation of journalists. Thus, many relationships were permitted to remain intact.

**(16) David Guyatt, Subverting the Media (undated)**

In discussing the assassination of John F. Kennedy, Dan Rather, the well-loved anchorman for CBS Television, described the now famous Zapruder film that captured footage of the shot which killed President John F. Kennedy. The movie, taken by amateur cameraman, Abraham Zapruder, was quickly snapped-up by Life magazine for $250,000.00. Although Life published still frames of the movie, the 18 second film was kept under lock and key – not to be seen by Americans until 1975.

But Rather's remarks were misleading. He told his viewers that the film showed JFK falling forward – confirming the official view that Kennedy had been shot from behind. However, the film clearly showed Kennedy lurching violently backwards, evidence of a frontal shot. To add to the confusion, the Warren Commission report printed two frames of the film in reverse – again implying a rear shot - an accident the FBI typified as a "printing error."

Meanwhile, still pictures lifted from the Zapruder film were also published by Life magazine. Remarkably, they too were published in reverse order, thereby creating the impression that the President had been shot from behind by lone gunman Lee Harvey Oswald. Until the film was shown to Americans in its entirity, no one was the wiser. Following the broadcast in 1975, a massive controversy followed giving rise to ongoing allegations of conspiracy.

The Zapruder film clearly showed President Kennedy had also been shot from the front. The result immeasurably strengthened the charge - that had been bubbling in the background – that the President had been assassinated as a result of a well orchestrated conspiracy, and that this was covered-up to protect the guilty, who many now believe involved senior figures in the CIA and US military. Not least it was pointed out that Henry Luce, the founder of Life magazine was a close personal friend of Allen Dulles, the Director of the CIA. Moreover, the individual who purchased the Zapruder film for Life magazine was C.J. Jackson, formerly a "psychological warfare" consultant to the President.

Inevitably, these events were to lead to accusations that the media were culpable of the worst form of toadying and propaganda. This, in turn raised serious questions about the role and integrity of the mass media. Some years later, Washington Post reporter, Carl Bernstein – who came to fame with his colleague Bob Woodward, for their expose of the Nixon administration's illegal re-election campaign activities, known as "Watergate" – dropped a media bombshell on an unsuspecting America.

In an October 1977, article published by Rolling Stone magazine, Bernstein reported that more than 400 American journalists worked for the CIA. Bernstein went on to reveal that this cozy arrangement had covered the preceding 25 years. Sources told Bernstein that the New York Times, America's most respected newspaper at the time, was one of the CIA's closest media collaborators. Seeking to spread the blame, the New York Times published an article in December 1977, revealing that "more than eight hundred news and public information organisations and individuals," had participated in the CIA's covert subversion of the media.

"One journalist is worth twenty agents," a high-level source told Bernstein. Spies were trained as journalists and then later infiltrated – often with the publishers consent - into the most prestigious media outlets in America, including the New York Times and Time Magazine. Likewise, numerous reputable journalists underwent training in various aspects of "spook-craft" by the CIA. This included techniques as varied as secret writing, surveillance and other spy crafts.

The subversion operation was orchestrated by Frank Wisner, an old CIA hand who's clandestine activities dated back to WW11. Wisner's media manipulation programme became known as the "Wisner Wurlitzer," and proved an effective technique for sending journalists overseas to spy for the CIA. Of the fifty plus overseas news proprietary's owned by the CIA were The Rome Daily American, The Manilla Times and the Bangkok Post.

Yet, according to some experts, there was another profound reason for the CIA's close relations with the media. In his book, "Virtual Government," author Alex Constantine goes to some lengths to explore the birth and spread of Operation Mockingbird. This, Constantine explains, was a CIA project designed to influence the major media for domestic propaganda purposes. One of the most important "assets" used by the CIA's Frank Wisner was Philip Graham, publisher of the Washington Post. A decade later both Wisner and Graham committed suicide – leading some to question the exact nature of their deaths. More recently doubts have been cast on Wisner's suicide verdict by some observers who believed him to have been a Soviet agent.

Meanwhile, however, Wisner had "implemented his plan and owned respected members of the New York Times, Newsweek, CBS and other communication vehicles, plus stringers…" according to Deborah Davis in her biography of Katharine Graham – wife of Philip Graham - and current publisher of the Washington Post. The operation was overseen by Allen Dulles, Director of Central Intelligence. Operation Mockingbird continued to flourish with CIA agents boasting at having "important assets" inside every major news outlet in the country." The list included such luminaries of the US media as Henry Luce, publisher of Time Magazine, Arthur Hays Sulzberger, of the New York Times and C.D. Jackson of Fortune Magazine, according to Constantine.

But there was another aspect to Mockingbird, Constantine reveals in an Internet essay. Citing historian C. Vann Woodward's New York Times article of 1987, Ronald Reagan, later to become President of the US, was a FBI snitch earlier in his life. This dated back to the time when Reagan was President of the Actor's Guild. Woodward says that Reagan "fed the names of suspect people in his organisation to the FBI secretly and regularly enough to be assigned an informer's code number, T.10." The purpose was to purge the film industry of "subversives."

As these stories hit the news, Senate investigators began to probe the CIA sponsored manipulation of the media – the "Fourth Estate" that supposedly was dedicated to acting as a check and balance on the excesses of the executive. This investigation was, however, curtailed at the insistence of Central Intelligence Agency Directors, William Colby and George Bush – who would later be elected US President. The information gathered by the Senate Select Intelligence Committee chaired by Senator Frank Church, was "deliberately buried" Bernstein reported.

Despite this suppression of evidence, information leaked out that revealed the willing role of media executives to subvert their own industry. "Let's not pick on some reporters," CIA Director William Colby stated during an interview. "Let's go to the managements. They were witting." Bernstein concluded that "America's leading publishers allowed themselves and their news services to become handmaidens to the intelligence services." Of the household names that went along with this arrangement were: Columbia Broadcasting System, Copley News Service – which gave the CIA confidential information on antiwar and black protestors – ABC TV, NBC, Associated Press, United Press International, Reuters, Newsweek, Time, Scripps-Howard, Hearst Newspapers and the Miami Herald. Bernstein additionally stated that the two most bullish media outlets to co-operate were the new York Times and CBS Television. The New York Times even went so far as to submit stories to Allen Dulles and his replacement, John McCone, to vet and approve before publication.

Slowly, the role of Mockingbird in muzzling and manipulating the press began to be revealed. In 1974, two former CIA agents, Victor Marchetti and John D. Marks, published a sensational book entitled "The CIA and the Cult of Intelligence." The book caused uproar for the many revelations it contained. Included amongst them was the fact that the, until then, widely respected Encounter magazine was indirectly funded by the CIA. The vehicle used to covertly transfer funds to Encounter and many other publications, was the Congress for Cultural Freedom (CCF)– a CIA front. A decade earlier, in 1965, the CCF was renamed Forum World Features (FWF) and purchased by Kern House Enterprises, under the direction of John Hay Whitney, publisher of the International Herald Tribune and former US Ambassador to the United Kingdom.

The Chairman of Forum World Features was Brian Crozier, who resigned his position shortly before the explosive book went on sale. Crozier, a former "Economist" journalist, was a "contact" of Britain's Secret Intelligence Service (MI6). His employment to head up the CIA financed Forum World Features in 1965, caused a row with MI6 who felt the CIA had breached the secret agreement between the UK and USA by recruiting one of their own assets.

Crozier's media style was more discrete than Mockingbird. He preferred, when possible, to insert his pre-spun propaganda stories to unwitting members of the media, who would reprint them unaware of the bias they contained. In time, Crozier would go on to head up a shadowy anti subversive and dirty tricks group called the "61," that sought to counter communist propaganda. Another group of which he was a member was the Pinay Cercle – a right wing Atlanticist group funded by the CIA - that claimed credit for getting Margaret Thatcher elected as British Prime Minister.

Another propaganda operation, run from Lisburn barracks in Northern Ireland, and under nominal British Army control, participated in extensive media manipulation around the same time. Known as "Clockwork Orange" this involved the construction of propaganda material designed to discredit prominent members of the then Labour government as well as some in the Conservative shadow cabinet. Especially targeted was then Prime Minister Harold Wilson. Clockwork Orange relied heavily on forged documents that would be given to selected journalists for publication. Many of these forgeries sought to demonstrate secret communist ties – or east bloc intelligence affiliations – amongst high profile politicians.

The aim was to destabilise Wilson and the Labour government by falsely showing them to be soft on communism or even pro communist. This operation clearly favoured a right wing Conservative administration under the leadership of Mrs. Thatcher. In the event, Wilson resigned, said to have been sickened by the numerous personal snipe attacks against him. During the time he was under siege, Wilson experienced numerous break ins at his office, as well as having his phone lines tapped -courtesy of unnamed officials in the security service, it is believed. By 1979 the Conservative party was returned to power.
Yet, with the demise of the cold war the motive for media propaganda has collapsed. Or has it? James Lilly, former Director of Operations at the CIA later became Director of Asian studies at the American Enterprise Institute – a think tank heavily staffed by former intelligence types. Lilly, in giving testimony to a Senate committee during 1996 observed: “Journalists, I think, you don’t recruit them. We can’t do that. They’ve told us not to do that. But you certainly sit down with your journalists, and I’ve done this and the Station Chief has done it, others have done it…”

But even as the cold war rationale for subverting the media recedes into the distance, press manipulation continues anon. A classified CIA report surfaced in 1992, that revealed the Agency’s public affairs office “… has relationships with reporters from every major wire service, newspaper, news weekly, and television network in the nation.” The report added that the benefits of these continued contacts had been fruitful to the CIA by turning “Intelligence failure stories into intelligence success stories…” Basking in a glow of self satisfaction, the report continued “In many cases, we have persuaded reporters to postpone, change, hold or even scrap stories that could have adversely affected national security interests.”

But the last word goes to Noam Chomsky. A Professor of Linguistics at the Massachusetts Institute of Technology, Chomsky has extensively investigated the role of today’s media. His analysis is un-nerving. The democratic postulate, Chomsky says, “is that the media are independent and committed to discovering and reporting the truth…” Despite this axiom, Chomsky finds that the media supports “established power” and is “responsive to the needs of government and major power groups.” He additionally argues that the media is a mechanism for pervasive “thought control” of elite interests and that ordinary citizens need to “undertake a course of intellectual self-defence to protect themselves from manipulation and control…” The covert role of the media has now apparently shifted its focus. One time expediter of the “cold war,” it now clamours for the extension of “corporate power.”

**(17) Steve Kangas, *The Origins of the Overclass* (1998)**
The wealthy have always used many methods to accumulate wealth, but it was not until the mid-1970s that these methods coalesced into a superbly organized, cohesive and efficient machine. After 1975, it became greater than the sum of its parts, a smooth flowing organization of advocacy groups, lobbyists, think tanks, conservative foundations, and PR firms that hurtled the richest 1 percent into the stratosphere.

The origins of this machine, interestingly enough, can be traced back to the CIA. This is not to say the machine is a formal CIA operation, complete with code name and signed documents. (Although such evidence may yet surface - and previously unthinkable domestic operations such as MK-ULTRA, CHAOS and MOCKINGBIRD show this to be a distinct possibility.) But what we do know already indicts the CIA strongly enough. Its principle creators were Irving Kristol, Paul Weyrich, William Simon, Richard Mellon Scaife, Frank Shakespeare, William F. Buckley, Jr., the Rockefeller family, and more. Almost all the machine's creators had CIA backgrounds.

During the 1970s, these men would take the propaganda and operational techniques they had learned in the Cold War and apply them to the Class War. Therefore it is no surprise that the American version of the machine bears an uncanny resemblance to the foreign versions designed to fight communism. The CIA's expert and comprehensive organization of the business class would succeed beyond their wildest dreams. In 1975, the richest 1 percent owned 22 percent of America’s wealth. By 1992, they would nearly double that, to 42 percent - the highest level of inequality in the 20th century.

How did this alliance start? The CIA has always recruited the nation’s elite: millionaire businessmen, Wall Street brokers, members of the national news media, and Ivy League scholars. During World War II, General "Wild Bill" Donovan became chief of the Office of Strategic Services (OSS), the forerunner of the CIA. Donovan recruited so exclusively from the nation’s rich and powerful that members eventually came to joke that "OSS" stood for "Oh, so social!"
Another early elite was Allen Dulles, who served as Director of the CIA from 1953 to 1961. Dulles was a senior partner at the Wall Street firm of Sullivan and Cromwell, which represented the Rockefeller empire and other

mammoth trusts, corporations and cartels. He was also a board member of the J. Henry Schroeder Bank, with offices in Wall Street, London, Zurich and Hamburg. His financial interests across the world would become a conflict of interest when he became head of the CIA. Like Donavan, he would recruit exclusively from society's elite...

Although many people think that the CIA's primary mission during the Cold War was to "deter communism," Noam Chomksy correctly points out that its real mission was "deterring democracy." From corrupting elections to overthrowing democratic governments, from assassinating elected leaders to installing murderous dictators, the CIA has virtually always replaced democracy with dictatorship. It didn't help that the CIA was run by businessmen, whose hostility towards democracy is legendary. The reason they overthrew so many democracies is because the people usually voted for policies that multi-national corporations didn't like: land reform, strong labor unions, nationalization of their industries, and greater regulation protecting workers, consumers and the environment...

Journalism is a perfect cover for CIA agents. People talk freely to journalists, and few think suspiciously of a journalist aggressively searching for information. Journalists also have power, influence and clout. Not surprisingly, the CIA began a mission in the late 1940s to recruit American journalists on a wide scale, a mission it dubbed Operation MOCKINGBIRD. The agency wanted these journalists not only to relay any sensitive information they discovered, but also to write anti-Communist, pro-capitalist propaganda when needed.

The instigators of MOCKINGBIRD were Frank Wisner, Allan Dulles, Richard Helms and Philip Graham. Graham was the husband of Katherine Graham, today's publisher of the Washington Post. In fact, it was the Post's ties to the CIA that allowed it to grow so quickly after the war, both in readership and influence.
MOCKINGBIRD was extraordinarily successful. In no time, the agency had recruited at least 25 media organizations to disseminate CIA propaganda. At least 400 journalists would eventually join the CIA payroll, according to the CIA's testimony before a stunned Church Committee in 1975. (The committee felt the true number was considerably higher.) The names of those recruited reads like a

Who's Who of journalism...

The CIA also secretly bought or created its own media companies. It owned 40 percent of the Rome Daily American at a time when communists were threatening to win the Italian elections. Worse, the CIA has bought many domestic media companies. A prime example is Capital Cities, created in 1954 by CIA businessman William Casey (who would later become Reagan's CIA director). Another founder was Lowell Thomas, a close friend and business contact with CIA Director Allen Dulles. Another founder was CIA businessman Thomas Dewey. By 1985, Capital Cities had grown so powerful that it was able to buy an entire TV network: ABC.
For those who believe in "separation of press and state," the very idea that the CIA has secret propaganda outlets throughout the media is appalling. The reason why America was so oblivious to CIA crimes in the 40s and 50s was because the media willingly complied with the agency. Even today, when the immorality of the CIA should be an open-and-shut case, "debate" about the issue rages in the media...

In the mid-1970s, at this historic low point in American conservatism, the CIA began a major campaign to turn corporate fortunes around. They did this in several ways. First, they helped create numerous foundations to finance their domestic operations. Even before 1973, the CIA had co-opted the most famous ones, like the Ford, Rockefeller and Carnegie Foundations. But after 1973, they created more. One of their most notorious recruits was billionaire Richard Mellon Scaife. During World War II, Scaife's father served in the OSS, the forerunner of the CIA. By his mid-twenties, both of Scaife's parents had died, and he inherited a fortune under four foundations: the Carthage Foundation, the Sarah Scaife Foundation, the Scaife Family Foundations and the Allegheny Foundation. In the early 1970s, Scaife was encouraged by CIA agent Frank Barnett to begin investing his fortune to fight the "Soviet menace." From 1973 to 1975, Scaife ran Forum World Features, a foreign news service used as a front to disseminate CIA propaganda around the world. Shortly afterwards he began donating millions to fund the New Right.

# Sneak Pitch - " SP" *advertising technique*

Thresholds of recognition: Sneak pitch is mesmerizing, hypnotically fascinating and irresistibly interesting…

Thanks again for reading up until here. I think by now you realize how confusing this may all seem. By now I'm sure you're capable of realizing how good some have become at manipulating the unconscious. If you were to check the motives of groups like the Board of Broadcasting Directors, you'd begin to see a pattern emerging. Few can see how deep total information and communication can go.

The next segment below is a small piece, a collection of jumbled leads and directions pointed in the right way. They all cover Psychotronic Devices and Scientific Mindcontrol Technology.

Wilhelm Wundt who coined the word " Psychology" . His major laboratory emphasis was on sensations and more comprehensive sensory experiences called perceptions "p7 . If I went as far back as Greek Philosophy, Plato and Aristotle would be a good start in discussing the invisible inner man. Some of our more modern ideas of mind, as well as the term psychology are derived from Greek philosophy. Plato (427-347 BC) was particularly interested in how one's mind (in the shape of ideas) controls his conduct. Aristotle's (384-322 BC) concept of mind as a function of bodily processes was an important step in the direction of making psychology a science. "p2 " The distinguishing feature of psychology is that it observes and attempts to understand the behavior of organisms. It is concerned with their responses to the world around them. ""Psychology is therefore a social as well as biological science. ""

Activation is in response to minimal cues, multi-level communication and indirect suggestion (357-Zieg)

psi-based effect is Patent # 5830064 granted Nov 3, 1998-check if it's true..

Mention of RAND Corp. Page 77- ReFraming-Neuro-linguistic Programming and the Transformation of meaning Bandler and Grinder 1982.

Introduction .. The structure of magic II.Human modeling processes //Generalization, Deletion and Distortion.

Book that established transformational grammar was syntatic structures //noam chomsky 1957the hague:mouton

" The Hypnotist works to secure and hold the subject's attentional processes, thereby making it possible to access unconscious processes to develop hypnotic experiences…..The Hypnotist uses distraction, confusion and boredom techniques." p101

Shor,R. Hypnosis and the concept of the generalized reality-orientaion. American Journal of Psychotherapy, 1959,13,582-602.

1961 - Psychology-The Fundamentals of Human adjustment, Fourth Edition 1961 Norman L. Munn, Bowdoin College, Houghton Mifflin Company Boston, The Riverside Press, Cambridge Massachusetts.

It had a lot of technical information regarding the testing of the human limits of consciousness. Covert American Science has openly investigated the structure and limits of the human mind for many years. The power of hypnosis was mentioned through the text. It stated on page 16 " One reason for calling hysteria a functional disorder is that it's symptoms can be produced during hypnosis. The hypnotist merely tells the subject that he is paralyzed, for example, and the suggested symptom is thereby produced. Another reason is that such symptoms as above may disappear during hypnosis. The hysterically blind see again, and the paralyzed limb moves as suggested". (476)

So this book defined the power of hypnosis one way by it's ability to illicit a functional disorder. Subconscious: Generally speaking, what is below the level of awareness p737

Subliminal: Below the level of awareness, below the threshold of stimulation, as when an auditory or visual presentation is too weak to have an effect, or at least an effect of which the individual is aware. p737

To Lustig it also meant " Drowsiness and drifted attention from the usual fixed state". Others disagree by saying it means many different things. To some it represents years of study and newfound technology.

# *INDIRECT AND SUBLIMINAL COMMUNICATION*

**SILENT SUBLIMINAL PRESENTATION SYSTEM:** When I first heard of S it wasn't in a conversation, I found it researching patents. Technology really has come along way. So here goes...

"*S", Silent sound - Computer Simulated Subconscious Speech Language is also known as fwd feedback (accelerated speech). A technique of using optimized digitally sampled and edited phenomes appended together forwards with sentences structured with hypnotic suggestions.*

Since most of the research in creating "Tools of influence" has taken place, there's little reference material readily available explaining what just happened. Information is the most critical part of this adventure in learning. The information used to generate this book can be found in the Appendix. Among those references you'll find plenty legal and Governmental proof that these claims are true, exist and can be found. One brilliant example of a " Tool of Influence" is found in United States Patent # 5,159,703 which describes in detail as recorded by the U.S. Patent office a process of unconscious subliminal messaging referred to as " Silent Subliminal Presentation System." Did you ever think that something like this would be well known or talked about? No, but it's true and was patented in 1989 by Oliver M. Lowery from Norcross, Georgia. Nobody talks or thinks openly about this kind of stuff to avoid being out of the norm and who can blame them. Many inventions including "TV" were developed primarily for their mind control potential. How can we find out more?

This device runs on "Programming" which entertains, entrains and creates the rules by which some societies develop and most humans live. This tool or shall I say " Household appliance" doesn't teach us it's techniques. It uses them on us to further their cause without concern other than doing as they say and buying their product. It essentially teaches you, in small pieces and chunks, how to be like normal like " Us". It's good to be orderly and live in a harmonious society, but this is not about that, it's about the fact that to get there, we have to teach how the mind works instead of using this knowledge to condition and program citizens.

Do some research and check out US Patents # 3,060,795 and # 3,278,676. You'll begin to learn and understand how machines can subliminally implant ideas to illicit a behavior. This invention for subliminal persuasion notes: " The above mentioned media can be used in various fields of endeavor 1) Medicine, Psychiatry and Psychology (as diagnostic and therapeutic tool) 2) Education... 3) Advertising and marketing….. 4) Propaganda.. 5) Mind control potential. The implications of brainwashing are obvious. Learning about this can be alarming enough but when you realize there's not a lot of people you can talk to without appearing a little "Off", this whole matter starts changing your perspective right away. Nobody want's to give off a sense of being out of our minds but these are the facts. Sane people need proof in order to believe something and that makes sense to me. Because of this, I will again insist that you do your own research. Gather the facts yourself so your understanding can be really real (rR).

I think you are beginning to get the picture now, do your own research, *Facts speak for themselves*. We need to begin a new understanding of the mind and how it works. There are several books you can take the time to read to learn more but you'll find that most what they say is consistent. Now the conscious mind is just essentially a word that attempts to represent the inner workings of our human and spiritual psyche. It is center and has the power of reason, life and happiness. It's a tool that when understood yields countless bounty. So why is it still such a big mystery to most people?

*Now ad men have a new way to persuade you. They can pop a suggestion into your mind, using TV or movies, without your knowing it*

**TV's New Trick: Hidden Commercials**

By Wesley S. Griswold

PROBABLY you've heard about—perhaps even worried about—a revolutionary new way to beam messages into the human mind. Especially suited to TV and movies, the new idea-injecting technique is said to work while you, all unawares, are innocently enjoying the program. The idea-words appear superimposed on the picture images too fast and too dimly to be seen in the normal way. Yet they register on your mind.

Despite rejection by the national networks, uneasy skepticism by the F.C.C. and alarm from people who fear that this strange development may bring wholesale invasion of privacy and risk of political tyranny, two means of reaching people's subconscious minds by television are currently being tested.

This month one of them, called Precon TV, was scheduled to be tried out on a large audience of TV watchers in and around Los Angeles. It was to have been Precon TV's first big showing. Its rival, Subliminal Projection, about which almost no technical details have been released, has already ventured on the air in Bangor, Me., and on a Canadian national hookup. Results for Subliminal Projection: inconclusive.

For its debut on independent Station KTLA, Precon TV did not plan to use advertising. Instead, public-service messages—like "Drive Safely," "Support Your Community Chest," or "Don't Be a Litterbug"—were to be tucked away into the telecast picture. But after this plan was announced, so much public criticism of the new technique boiled up that the trial was postponed. Controversy over these idea-injecting systems has swirled around three issues: (1) Are they legally proper? (2) Are they ethically acceptable? (3) And do they really work at all?

PRECON TV has a long history behind it. (The trade name comes from the word "preconscious," meaning "below the level of conscious awareness." "Subliminal" means the same thing.) Its inventors, Dr. Robert E. Corrigan of Los Angeles and Prof. Hal C. Becker of New Orleans, both men now in their mid-thirties, have been testing the theories and working parts of Precon for the past eight years. Patents were applied for early in 1955, but have not yet been issued. Consequently, the inventors decline to tell everything about their creation, though they have revealed the essentials.

The basic equipment, the means of sprinkling television programs with invisible but receivable messages, is contained in a rectangular metal box about half the size of a standard table-top TV set. Its power unit, in a separate, much smaller container, runs on house current.

This equipment is a kind of electronic mixing bowl, where printed information can be subtly stirred in with pictures. Inside the main Precon TV cabinet, along with 17 vacuum tubes and a photo multiplier, is a little flying-spot scanner and, in front of its round face, a small frame for holding the text to be scanned. The text is printed on a transparent plastic slide, on a three-by-four-inch space.

Picture signals from image-orthicon tubes in studio cameras focused on live performances, or from iconoscopes recording filmed scenes, are piped into the Precon TV apparatus on their way to the station's antenna. To understand what happens to them in the Precon blender, remember that it takes one-thirtieth of a second for a cathode-ray tube to project one complete picture image on a television screen. In that time it has to scan the picture twice, each perusal taking one-sixtieth of a second.

INSIDE the Precon TV cabinet, with the aid of the pulsed light emitted by the flying-spot scanner, the printed message is superimposed on the incoming picture signals every other one-sixtieth of a second. (The rate of mixture can be varied, as can the intensity of the pulsed light, which normally is less than one-third as bright as that of the picture signals.) The well-mixed video brew then flows on to the station's antenna, to which the program's sound signals, not involved in Precon TV, proceed independently.

Prof. Becker, an electronics engineer and physicist who teaches experimental neurology at Tulane University, points out a fascinating quirk: When you suspect you're watching a Precon program, you can find out what the hidden message is by spreading the fingers of one hand and moving them rapidly up and down in front of your eyes. By varying the rate of this movement, you'll soon find and match the rate at which the Precon message is being pulsed. Then you'll be able to read it.

"THE two questions we are most often asked about Precon," said Dr. Corrigan, a former fighter pilot who is now a psychologist for the Douglas Aircraft Co., are 'How do you know that it works?' and 'Is it dangerous?'

"We have found ample proof that it works," he continued, "in exhaustive experiments at Tulane University that we have been conducting since 1950. In the course of finding that proof, we also became convinced that the Precon technique of communication can't be dangerous. There is no possibility of brainwashing by means of Precon, for each man is his own censor. His preconscious mind responds to Precon messages in complete accord with his likes and dislikes. There is no better chance of putting something over on his preconscious mind than there is of hoodwinking his conscious mind."

Corrigan and Becker discovered people's built-in censorship in tests in which three different types of words were very rapidly projected on a screen. Some of the words were neutral—like "stove," "table" and "rug." Some had emotional impact—"scream," "blood," "hate." Others were obscene words.

In repeated trials, the speed at which each word was flashed on the screen was slowed until the person being tested could say that he definitely had seen it. The researchers found that the emotional and obscene words had to be shown two or three times slower than the neutral words before people watching the screen could recognize them. Corrigan and Becker took this as firm evidence that the people were resisting and censoring upsetting words.

Next, in addition to calling out when they could identify a word, the subjects were asked to press a little lever as well. It was then discovered that not only did they push the lever sooner than they reported seeing the word—thus proving preconscious perception—but they reacted preconsciously to emotional and obscene words precisely as they did when conscious of them. They were censoring them without being aware of it.

FURTHER tests showed, they contend, that people can be taught preconsciously. Corrigan and Becker arranged to give their subjects tiny electric shocks whenever certain neutral words were flashed on the screen. Then the shocks were stopped, but when the words that had been associated with them appeared again, the subjects reacted to them preconsciously as if they were words highly charged with emotion. They had learned, without realizing it, to attribute a new and painful meaning to harmless words.

The Precon developers gave groups of people jumbled letters to rearrange into actual words. Before the test began, they showed the answers on a screen, too fast for anyone in the room to see. Preconsciously they were seen, however, and comparative tests indicated that the subjects solved the puzzles 15 to 46 per cent faster when the answers had been slipped to their subconscious minds in advance.

Finally, Corrigan and Becker expanded their experiments to theater-size audiences. They showed movies—color cartoons—in which printed information was hidden from conscious view. In one case, geometric symbols — a triangle, a circle and a square — were used. In the other, gasoline trade names were used.

After the audiences had seen the films, they were asked to tell whether they liked, felt indifferent to, or disliked each movie. They were then shown the symbols and the trade names and asked to give their reactions to them. The results suggested that the way people had reacted to the symbols and trade names influenced the way they reacted to the movies. If they felt "positive" toward the preconscious information, they liked the movie; if they felt "negative" about the information, they objected to the movie.

The Precon inventors feel this point, then, is amply proved: Our preconscious likes and dislikes are the same as our conscious ones. Nobody, they contend, is going to convince us by Precon TV to buy something we don't want to buy, or do something we don't want to do.

Corrigan and Becker began their experiments with Precon apparatus with the thought that the technique would be wonderfully useful in education (training films) and psychotherapy (reaching the consciously withdrawn patient by tapping him on the subconscious). They still are ardently convinced of this.

The commercial possibilities occurred to them later. Already the inventors, through the newly created Precon Process & Equipment Corp. of New Orleans, have marketed a counter-top or window-display electrical device for flashing Precon advertising at passersby who think they are merely looking at an attractive illuminated color photograph. There is a strong likelihood that there'll be Precon movies, too.

Dr. Corrigan is convinced that if emotion-charged words suitable to the action of a movie are included in the film but are not consciously visible to its audience, the movie will gain in impact. Prof. Becker says the trick can be turned by superimposing the words on a master print of the film, but that a better way would be to synchronize a special Precon movie projector with each theater projector. A leading motion-picture studio has indicated seriously that it would like to be shown how a Precon movie could be made. And a wag has already suggested what to call it—a "feelie."

**filmography**

1. Date with Death (1959) (precon process engineer)
   ... aka Blood of the Man Devil (USA)

2. My World Dies Screaming (1958) (executive)
   ... aka Terror in the Haunted House

## ***RECOVERED MEMORY THERAPY AND FALSE MEMORY SYNDROME***

By John Hochman, M.D.

Contents:



Thousands of patients (mostly women) in the United States have undergone or are undergoing attempted treatment by psychotherapists for a non-existent memory disorder. As a result, these same therapists have unwittingly promoted the development of a real memory disorder: False Memory Syndrome. To make sense of this unfortunate situation, I need to offer a few definitions. Some psychotherapists believe that childhood sexual abuse is the specific cause of numerous physical and mental ills later in life. Some term this Incest Survivor Syndrome (ISS). There is no firm evidence that this is the case, since even where there has been documented sexual abuse during childhood, there are numerous other factors that can explain physical or emotional complaints that appear years later in an adult.

These therapists believe that the children immediately repress all memory of sexual abuse shortly after it occurs, causing it to vanish from recollection without a trace. The price for having repressed memories is said to be the eventual development of ISS.

Therapists attempt to "cure" ISS by engaging patients in recovered memory therapy (RMT), a hodge-podge of techniques varying with each therapist. The purpose of RMT is to enable the patient to recover into consciousness not only wholly accurate recollections of ancient sexual traumas, but also repressed body memories (such as physical pains) that occurred at the time of the traumas.

In actuality, RMT produces disturbing fantasies which are misperceived by the patient and misinterpreted by the therapist as memories. Mislabeled by the therapist and patient as recovered memories, they are actually false memories.

The vast majority of false memory cases developing from RMT are in women, which is why this article assumes patients to be female.

Initiation of Patients into RMT

A woman consults a psychotherapist for relief of various emotional complaints. The therapist informs her that she may have been molested as a child and does not know it, and this could explain her symptoms. Some patients think this idea is absurd and go to another therapist; others accept the therapist's suggestions and stay on. More than a few women have heard about repressed memories from talk shows or tabloids even prior to coming to the therapists office, and may even make the appointment believing they too could be "victims."

Though the patient has no memories of abuse, she becomes motivated for "memory recovery" since she is told this will cure her symptoms. The therapist will offer encouragement that "memories" will return. Suggestive dreams or new pains are interpreted by the therapist as proof that repressed memories are lurking. The therapist may refer the patient to a "survivor recovery group." There she will meet women who further encourage her to keep trying to remember. Attendance at these support groups, as well as assigned reading in self-help books, surrounds the patient with validation for the therapist's theories.

The vast majority of women with FMS are white, middle class, and above average in education. This corresponds to the profile of a typical woman who enters long term psychotherapy, and who perceives such activity as an important way to solve life's problems.

Generating False Memories

Unlike courts of law which obtain objective evidence where allegations of evil-doing are made, RMT solely directs the patient to attend toward her inner world for "proof" she was sexually abused. Such RMT techniques may include: * Meditation on fantasy production, such as pictures drawn in "art therapy," dreams, or stream of consciousness journal writing. * Hearing or reading about the "recovered memories" of other women which can serve as inspirations.* Amytal interviews ("truth serum") and/or hypnosis (including "age regression" where the patient is told she is temporarily being transformed into the way she was when she was five years old).* Telling the patient to review family albums; if she looks sad in some of her childhood photos, she is told this is further confirmation that abuse occurred.

The Dark Side of "Recovery"

Patients start out RMT with the hope that things will be better once they recover their repressed memories. But usually life becomes far more complicated. The FMS patient will often become estranged from the "perpetrator" (most often her father). If the patient has small children, they will be off limits to "perpetrators" as well. Relationships with other family members becomes contingent on their not challenging the patient's beliefs.

Therapists may urge parents to come for a "family conference" in order to allow the patient to surprise the "perpetrator" with a rehearsed confrontation. Family members are usually too shocked and disorganized to coherently respond to accusations. The rationale for this scenario is that since "survivors" feel powerless, they need "empowerment." FMS patients may file belated crime reports with local law enforcement agencies and may go on to sue "perpetrators." Such lawsuits demand compensation for bills from psychotherapists and possibly other doctors who treated adult medical problems that therapists somehow link to childhood traumas. Of course, there may be demands for "punitive damages." Spouses of "perpetrators" (usually the patient's mother) may be sued as well for being negligent, thus making householder's insurance into a courtroom piggy bank. Since FMS patients sincerely believe they have been victimized, more than a few juries have given verdicts sympathetic to them.

Preoccupied with the continuing chores of "memory recovery," the FMS patient may come to ignore more pressing problems with her marriage, family, schooling, or career. Often the time demands and expense of the therapy itself become a major life disruption. Some patients during the course of RMT develop "multiple personality disorder" (MPD). RMT therapists have claimed that they need to not only recover repressed memories, but also to uncover repressed personality fragments; some women come to believe they are repositories of dozens of hidden personalities ("alters"). "Alters" have their own names and characteristics, and may identify themselves as men or even animals. An increasing number of psychiatrists and psychologists are coming to view MPD as a product of environmental suggestion and reinforcement, since the diagnosis was hardly made prior to ten years ago. One area where there is no controversy: once MPD is diagnosed, therapy bills become astronomical.

Some FMS patients become convinced that their abuse was actually "satanic ritual abuse" (SRA), due to participation by relatives in a secret satanic cult. Some therapists believe SRA is the work of a vast underground cult network in these United States. No evidence beyond "recovered memories" has ever been offered as proof that satanic cults exist at this claimed level of frequency. Therapists who lecture on he topic have explained away the lack of evidence that such cults exist by claiming that no defectors speak out due to iron-clad secrecy via brainwashing and terror.

## The Care and Maintenance of False Memories

FMS involves a combination of mistaken perceptions and false beliefs. The fledgling FMS patient is encouraged to "connect" with an environment that will reinforce the FMS state, and is encouraged to "disconnect" from people or information that might lead her to question the results of RMT. The FMS subculture is victim-oriented. Even though they have not undergone anticancer chemotherapy or walked away from airplane crashes, FMS patients are told they too are "survivors." This becomes a kind of new identity, giving FMS patients the feeling of a strong bond with other "survivors" of abuse. Patients will often start attending "survivor" support groups, subscribe to "survivor" newsletters, or even attend "survivor" conventions (sometimes with their therapists).

They will read books found in "recovery" sections of bookstores. The best known book, The Courage to Heal, is weighty, literate, and thus appears authoritative. Authors Laura Davis and Ellen Bass have no formal training in psychology, psychiatry, or memory. This paperback, modestly priced at $20, has sold over 700,000 copies.

Patients are told to shy away from dialogue with skeptical friends or relatives, since this will hinder their "recovery." "Perpetrators" who proclaim their innocence cannot be taken seriously since they are "in denial" and incapable of telling the truth.

Aside from these social influences, people by nature often resist seeing themselves as being in error. It can be terribly painful to acknowledge having made a big mistake, particularly when harmful consequences have resulted. RMT exploits the tendency within each of us to blame others for our problems, and to latch onto simple answers for life's complicated problems. RMT therapists suggest that aside from entirely ruining childhoods, childhood sexual abuse can explain anything and everything that goes wrong during adulthood. RMT becomes the ultimate crybaby therapy.

### How Memory Really Works

In Freud's theory of "repression" the mind automatically banishes traumatic events from memory to prevent overwhelming anxiety. Freud further theorized that repressed memories cause "neurosis," which could be cured if the memories were made conscious. While all this is taught in introductory psychology courses and has been taken by novelists and screenwriters to be a truism, Freud's repression theory has never been verified by rigorous scientific proof. Freud, were he alive today, would be traumatized to see how RMT has redefined his pet concept. While Freud talked of the repression of single traumatic episodes, today's therapists maintain that dozens of similar traumatic episodes occurring over years are repressed with 100% efficiency.

The well known syndrome of Post Traumatic Stress Disorder shows us that verifiable traumatic events, rather than disappearing from memory, leave trauma victims haunted by intrusive memories in which the victim relives the trauma. For those who were in Nazi concentration camps or underwent torture as POWs in Vietnam, this can become a serious lifelong problem. People forget most of what occurs to them, including some events that were pleasant or significant to them at the time. If an event is lost from memory, there is no scientific way to prove whether it was "repressed" or simply forgotten. And there is no reason that memories of sexual abuse should be handled any differently than childhood memories of physical abuse or of emergency surgery.

Events that have slipped away from memory cannot be recalled with the accuracy of a videotape. Individuals forget not only insignificant events in their entirety, but also significant events. Some events (traumatic or not) are recalled, but with significant details altered.

A study of children whose school was attacked by a sniper showed that some who were not on the school grounds later insisted they had personal recollections of being in school during the attack. These false memories apparently were inspired by exposure to the stories of those who truly experienced the trauma.

Memories can be deliberately distorted in adults by presenting a display of visual information, and later exposing subjects to verbal disinformation about what they saw. This disinformation often becomes incorporated into memory, contaminating the ultimate memories that are recalled.

To be sure, some who enter therapy were abused as children, but they have always remembered this abuse. They do not need special help in "memory recovery" to tell the therapist what happened to them. Why Recovered Memory Therapy is Bad Therapy RMT purportedly is undertaken to help patients recover from the effects of sexual abuse from childhood; however, at the onset of RMT there is no evidence that such abuse ever occurred. Thus, instead of a therapist having some evidence for a diagnosis and then adopting a proper treatment plan, RMT therapists use the "treatment" to produce their diagnosis.

Some RMT therapists over-attribute common psychological complaints as signs of forgotten childhood sexual abuse. In their zeal to find memories, these therapists overlook any and all alternative explanations for the patient's complaints. RMT therapists ignore basic psychological principles that all individuals are suggestible, and that patients in distress seeking psychotherapy are particularly likely to adopt beliefs and biases of their therapist.

Many RMT therapists have studied neither basic sciences related to memory, nor the diagnosis of actual diseases of memory. Their knowledge is often based on a single weekend seminar, as opposed to years of formal training in any graduate program they attended to get their licenses.

Hypnosis and sodium amytal administration ("truth serum") are unacceptable procedures for memory recovery. Courts reject hypnosis as a memory aid. Subjects receiving hypnosis or amytal as general memory aids (even in instances where there is no question of sexual abuse) will often generate false memories. Upon returning to their normal state of consciousness, subjects assume all their refreshed "memories" are equally true. RMT therapists generally make no attempt to verify "recovered memories" by interviewing third parties, or obtaining pediatric or school records. Some have explained that they do not verify the serious allegations that arise from RMT because their job is simply to help the patient feel "safe" and "recover."

Many patients who have known all their lives that they were mistreated or neglected by their parents, decide as adults to be friends with the offending parents. By contrast, RMT therapists encourage their patients, on the basis of "recovered memories," to break off relationships with the alleged "perpetrators" as well as other relatives who disagree with the patient's views. This is completely at odds with the traditional goals of therapists: to allow competent patients to make their own important decisions, and to improve their patient's relationships with others. Patients undergoing RMT often undergo an increase of symptoms as their treatment progresses, with corresponding disruption in their personal lives. Few therapists will seek consultation in order to clarify the problem, assuming instead that it is due to sexual abuse having been worse than anyone might have imagined.

Other Kinds of FMS

Some individuals come to believe that they lived "past lives" as a result of having undergone "past life therapy." This phenomenon generally develops in participants who are grounded in the New Age zeitgeist and already open to "discovering" their past lives. They enroll in seminars which can run up to an entire weekend and will involve some measure of group hypnotic induction and guided meditations. This sort of FMS also involves continuing group reinforcement. In contrast to horrific images of sexual abuse, recollections of "past lives" are generally pleasant and interesting. Few participants will recall spending prior lives in lunatic asylums or dungeons. The whole experience is assumed to be therapeutic by helping participants better understand the situation of their present lives. A small number of individuals develop "recovered memories" of being abducted by aliens from outer space. Almost always these individuals had some curiosity about this area and were hardly skeptics before they fell into an alien abduction FMS.

In contrast to women who are plagued with concerns that they were sexually abused, these varieties of FMS are of a much more benign nature and do not disrupt personal functioning or family life. While some of these individuals suffer the ignominy of being perceived as "kooks," they may receive compensating group support from those who share their beliefs.

A Word About the Future

Increasing numbers of women who claimed to have recovered memories of sexual abuse have retracted their claims and now see themselves as having had FMS. This may spontaneously occur when women relocate to another locale and lose contact with their prior therapists and support group. Without the "positive reinforcement" from others to encourage false memory development and maintenance, some women begin to doubt the veracity of what they had believed was true. While some remain suspended in a twilight of doubt, others have fully recanted. These retractors may have a profound influence on getting women with an active FMS to re-evaluate their situation. While FMS patients learn from the FMS culture to dismiss critics as either "perpetrators" or their apologists, the voice of a woman who says she is recovering from FMS is more easily heard.

Although most influential among family counselors and social workers, RMT affected the practices of some licensed psychologists and psychiatrists, some of whom were practicing in special "dissociative disorders units" in psychiatric hospitals. These activities have gone on with little challenge, until recently.
The number of women with FMS who have become retractors is increasing. Some have sued their former therapists for malpractice (see Laura Pasley's story in this issue of Skeptic), and others are weighing the possibilities of doing so. One malpractice insurance carrier for clinical psychologists in California recently tripled its rates without explanation; this has led to speculation that the carrier is anticipating increasing numbers of lawsuits alleging that psychologists caused FMS.

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# Research Threads in Brainwashing

1988 book *Journey into Madness -- Medical Torture and the Mind Controllers* by Gordon Thomas published by Transworld Publishers Ltd. 61-63 Uxbridge Road, London, England W5 5SA.


Brown, J.R.C. , Techniques of Persuasion : From Propaganda to Brainwashing. London: Penguin Boos, 1963. (from J.Into Madness)

Hunter, Edward (1956) Brainwashing.

Sargant, William , Battle for the Mind, Privately printed edition. Ashford: The Invicta Press, 1984. (from J.Into Madness)

Sargant, William, The Mind Possessed,, Privately printed edition. Ashford: The Invicta Press, 1984. (from J.Into Madness)

Sargant, William, The Unquiet Mind, Privately printed edition. Ashford: The Invicta Press, 1984. (from J.Into Madness)**LT & MIND CONTROL**

Barker E (1984) The Making of a Moonie:choice of brainwashing? Oxford, NY (HR 121-A1)

Conydon B & Hubbard LR, Jr., messiah or madman ?, Secaucus, N.J., 1987 (GK445-A12)

L.Ron Hubbard LR (1978) The Science of Survival (see "Pain-Drug-Hypnosis" 1951/W.Bowart, p.74)

Robert Eringer (1985) Secret Agent Man. Rolling Stone ü£ë¬ÄRæ_

Intruders (1966?), see 1966 quoted by Senator Edward V. Long

Bowart,Walter (1978) Operation Mind Control and Operation Mind Control, How the Cryptocracy Will Psychocivilize You (1994)

Burdick, Dorothy (1982) Such Things Are Known. Vantage Press, NY

Bylinsky, Gene (1969) Mood Control. NY: Charles Scribner's Sons.

Chavkin, Samuel (1978) Mind Stealers (Houghton Mifflin CO., Boston)

Collins, Larry (1990) Mind Control Playboy, January 1990

Horrock N (1977) A dat show: 14 year project on controlling human behavior. New York Times 1977.7.21.

Hunt, Linda (1991) Secret Agenda. NY, St.Martin's Press. [ordered 940217]

Keeler, Anna (1989) Remote Mind Control Technology. Full Disclosure 15: 1-14.

Lawrence, Lincoln (1967) Were We Controlled? University Books, NY

London, Perry (1969) Behavior Control. New York, Harper & Row.

Moore, James (1975) Modern People, Aug.18, 1975 (re : RHIC-EDOM)

Marks, John (1977) The Search for the Manchurian Candidate

Pines, Maya (1973) The Brain Changers - Scientists & The New Mind Control. NY: Harcourt Brace Jovanovich, Inc.

Ranelagh, John (1986) The Agency. ISBN 0-671-44318-6

Ronald M. McRae (1984) Mind Wars (NY, St.Martin's Press)

Russell-Mannings, Betsy (1989) Mind Control in a Free Society.

Russell-Mannings, Betsy (1989) The Microwave Deception.

Scheflin A & Opton E (1978) The Mind Manipulators. London, Paddington Press.

Schrag, Peter (1978) Mind Control. NY: Pantheon Books. [Burdick(1981)]

Vankin, Jonathan (1990) Conspiracies, Cover-ups and Crimes (Dell)

Valenstein, Elliot (1973) Brain Control : A critical examination of brain stimulation and psychosurgery. NY, Wiley)

US News & World Report 1994.1.24 & letters 2.21. [drug/ele -->]

Watson P (1978) War on the Nind: The Military Uses and Abuses of Psychology. NY: Basic Books, Inc. [Burdick(1981)]

Weberman AJ (1980) Mind Control: The Story of Mankind Research Unlimited, Inc. Covert Action 9, June. [Burdick(1981)]

Zimbardo PG et al (1973) The Mind Is a Formidable Jailer: A Pirandellian Prison. New York Times Magazine 1973.4.8. [Burdick(1981)]

**vi2cult AND mIND coNTROLor Modification**

Alexander (1975) The search for a general theory of behavior. Behav. Sci. 20: 77-100.

BBS (1984) 7: 4 [B.F.Skinner]

Bijou SW & Ribes-Inesta E (1972) Behavior Modification: Issues and Extensions. NY: Academic Press. pp.157.

[review: Fed.Prob. 1974, 38:70]

Camellion R (1978) Behavior Modification. Paladin Press. pp.129.

Citizen's Inquiry on PCJII (1974) The future of parole. The Prison Journal. Spring-Summer 1974.

Hilts PJ (1974) Behavior Mod. NY: Harper's Magazine Press. pp.242. [review: Feb. Prob. 1975, 39: 66]

Holland JG (1974) Behavior Modification for prisoners, patients and other people as a prescription for planned society. The Prison Journal. Spring-Summer 1974. [review: Feb.Prob. 1976, 40: 68. re. START Program

**DRUGS**

Collins, Anne (1988) In the Sleep Room. ISBN 0-88619-198-X

Lee MA & Shlain B (1985) Acid Dreams: The CIA, LSD, and the Sixties. Groves Press. [Japanese version, 1992, pp.423.]

Thomas, Gordon (1989) Journey Into Madness (NY, Bantam)

Weinstein, Harvey (1988) A Father, A Son and the CIA ISBN 1-55028-116

**HYPNOSIS**

Edmonston, Jr.,W.E. (1986) The Induction of hypnosis, Ny. ü£SB 237-A11

Gindes, B.C. (1973) New Concepts In Hypnosis [W.Bowart(78), p.62]

Spanos NP (1986) Hypnotic behavior : a social-psychological interpretation of amnesia, analgesia, and "trance logic" BBS 9: 449-502 (BBS 11: 712-716 commentary)

Spiegel, N., Shor, J., & Fishman, S. (1945) An hypnotic ablation technique for the study of personality development, Psychosom, Med. 7, 273.[Penfield(1952)pp.192]

Zeig JK ed (1982) Ericksonian approaches to hypnosis and psychotherapy. NY. (M15-A6249)

HYPNOSIS & MIND CONTROL

Richard Condon (1958) Manchurian Candidate (McGrow Hill, NY)

Donald Bain (1976) The Control of Candy Jones

Claire Sterling (1983)The Time of the Assasin (NY: Holt, Rinehart and Winston)

Paul Henze (1983) The Plot to Kill the Pope (NY: Charles Scribners & Sons)

**Brain**

Bradshaw JL & Nettleton NC (1981) The nature of hemispheric specialization in man. BBS 4: 51-91.

Brodal A (1947) The hippocumpus and the sense of smell. A review. Brain 70: 179-222.

Calder, Nigel () The Mind of Man. [Akwei vs NSA]

Eccles & McIntyre (1951) Plasticity of mammalian monosynaptic reflexes. Nature 167, 466-468.

Ferguson M (1973) The Brain Revolution: The Frontiers of Mind Research. NY: Taplinger Publishing Co.

Heller, John H. (1963) Of Mice, Men and Molecules. [Akwei vs NSA]

Hooper, Judith () The 3-Pound Universe. [Akwei vs NSA]

Johnson, George () In the Palaces of Memory. [Akwei vs NSA]

McGlone J (1980) Sex differences in human brain asymmetry: a critical survey. BBS 3: 215-263.

Panksepp J (1982) Toward a general psychobiological theory of emotions. BBS 5: 407-467. [incl. commentaries of Delgado, Heath]

Ojemann GA (1983) Brain organization for language from the perspective of electrical stimulation mapping. BBS 6: 189-230.

Psaltis D. et al (1990) Holography in artificial neural networks. Nature 343, 325.

Puceetti R & Dykes RW (1978) Sensory cortex and the mind-brain problem. BBS 1: 337-375.

Restak, Richard () The Mind. [Akwei vs NSA]

Teylor TJ & DiScenna P (1984) The topological anatomy of the hippocampus: a clue to its fuction. Brain Res. Bull. 12: 711-719.

Uematsu S et al (1992) Localization of sensorimotor cortex: the influence of Sherrington and Cushing on the modern concept. Neurosurgery 30(6): 904-913.

US News and World Report 1/2/84 [EM brain stim]

Weiner RD (1984) Does electroconvulsive therapy cause brain damage ? BBS 7: 1-53. [incl. comment. by Health]

**EEG**

Berger, H. (1929) åber das elektrenkephalogramm des menschen, Archiv. Psychiatr.Nervenkrank, 87:527-570.

Berger, H. (1935) åber das elektrenkephalogramm des menschen, Archiv. Psychiatr.Nervenkrank, 103:444-454.

Berger, H. (1938) åber das elektrenkephalogramm des menschen, Archiv. Psychiatr.Nervenkrank, 108:407-431.

Elul, R. (1962) Dipoles of spontaneous activity in the cerebral cortex. Exp. Neurol 6, 285-299.

Elul, R. (1964) Specific site of generation of brain waves. Physiologist 7, 125.

Elul, R. (1972) The genesis of the EEG, Int. Rev. Neurobiology 15, 227-272.

Empson J (1986) Human brainwaves: the psychological significance of the electroencephalogram, Houndmills, Basingstoke, Hampshir, Mcmillan

Lippold O (1973) The Origin of the alpha rhythm, Edinburgh, C.Livingstones

**Endocrinology**

Benzinger TH (1969) Heat regulation: homeostasis of control temperature in man. Physiol. Rev. 49: 671-759.

Brown GM & Reeichlin S (1972) Psychologic and neural regulation of growth hormone secretion. Psychosom. Med. 34: 45-61.

Curtis GC (1972) Psychosomatics and chronobiology: possible implications of neuroendocrine rhythms. Psychosom. Med. 34: 235-256.

Daughaday WH (1971) Sulfation factor regulation of skeletal growth: a stable mechanism dependent on intermittent growth hormone secretion. Am. J. Med. 50: 277-280.

Deuguchi Takeo (1979) Circadian rhythms of serotomin N-acetyltransferase activity in organ culture of chicken pineal gland. Science 203, 1245-1247.

Delgado JMR & Hanai T (1966) Intracerebral temperature in freely moving cats.

Am. J. Physiol. 211: 755-769.

Frohman LA & Bernardis LL (1968) Growth hormone and insulin levels in weanling rats with ventromedial hypothalamic lesions. Endocr. 82: 1125-1132.

Frohman LA & Bernardis LL (1968) Hypothalamic stimulation of growth hormone secretion. Science 580-582.

Ganong WF, et al (1963) Penetration of light into the brain of mammals. Endocr. i72, 962-963.

Grant L et al (1971) Period of adjustment of rats used for experimental studies. Nature 232: 135.

Hanbury EM (1959) Thyroid function after trauma in man. Metabolism 8: 904-912.

Hardy JD (1973) Posterior hypothalamus and the regulation of body temperature. Fed. Proc. 32: 1564-1571.

Martin JB (1972) Plasma growth hormone (GH) in response to hypothalamic or extrahypothalamic electrical stimulation. Endocr. 91: 107-115.

Martin JB (1973) Neural regulation of growth hormone secretion. N. Eng. J. Med. 288: 1384-1393.

Martin JB et al (1973) Plasma GH responses to hypothalamic, hippocampal, and amygdaloid electrical stimulation; effects of variation of stimulation parameters and treatment with alpha methyl-p-tyrosine. Endocr. 91: 1354-1361.

Mason JW (1968) Overall hormonal balance as a key to endocrine organization. Psychosom. Med. 30(II): 791-808.

Mikolajxzyk H (1972) Hormone reactions and changes in endocrine glands under influence of mws. Med. Lotn. 39: 39-51.

Milroy WC & Michaelson SM (1972) Thyroid pathophysiology of microwave radiation. Aerospace Med. 43: 1126-1131.ü@

Moore, R.Y., et al (1968) Central control of the pineal gland: visual pathways. Arch Neurol 18 208-218.

Nir, I. (1978) Non-reproductive systems and the pineal gland. J Neural Transm Suppl 13, 225-244.

Preslock, J.P. (1984) The pineal gland: basic implications and clinical correlations, Endocrine Rev. 5, 282.

Rosenthal SH (1973) Alterations in serum thyroxine with cerebral electrotherapy (CET). Arch. Gen. Psychiat. 28: 28-29.

Schally AV et al (1973) Hypothalamic regulatory hormones. Science 179: 341-350.

Smuckler EA & Tata JR (1971) Changes in hepatic neclear DNA-dependent polymerase caused by growth hormone and tri-iodothyronin. Nature 234: 37-39.

Takahashi Y, et al (1968) Growth hormone secretion during sleep. J. Clin. Invest. 47: 2079-2090.

Wurtman, R.J. et al (1963) Melatonin synthesis in the pineal gland : control by light. Science 142, 1071.

**Brain Atlas**

Abraira, V., & Handler, P. (1978) Computerized stereotaxic brain atlas. Proc.of the DECUS Congress, 5, 539-541.[Delgado,1981]

Berman, A.L. (1968) The Brain Stem of the Cat : A Cytoarchitectonic Atlas with Stereotaxic Coordinates, Univ. of Wisconsin, Madison. [Liebenskind,et al(1973)]

DeLucchi, M.R., Dennis, B.J., & Adey, W.R. (1965) A stereotaxic Atlas of the Chimpanzee Brain (Pan Satyrus), Univ. Calif. Press, Berkeley, Calif., 78 pp.

Jasper, H.H., & Ajmone Marsa, C.A., (1954) Stereotaxic Atlas of the Diencephalon of the Cat, Nat.Res.Council Canada, Ottawa.[Siegel,et al(1972)]

Matsui, T., & Hirano, A. (1978) An atlas of the human brain for computerized tomography. Tokyo, Igaku-Shoin. [Delgado,1981]

Matsuno H et L (1988) Microsurgical anatomy of the posterior fossa cisterus. Neurosurgery 23(1): 58.

Oka et al (1985) Microsurgical anatomy of the sperficial veins of the cerebrum. Neurosurgery 17(5): 711.

Schaltenbrand, G. & Bailey, P. (Eds.) (1959) Introduction to stereotaxis with an atlas of the human brain. Grune and Stratton, New York, 493 p.

Snider, R.S., & Lee, J.C. (1961) A stereotaxic atlas of the monkey brain (Macaca mulatta). Univ. Chicago Press, Chicago.

Timurkaynak et al (1986) Microsurgical anatomy of the lateral ventricles. Neurosurgery 19(5)

Yamamoto et al (1981) Microsurgical anatomy of the 3rd ventricle. Neurosurgery 8(3)

Brain & Memory

Clark CR & Geffen GM (1989) Corpus callosum surgery and recent memory: a revew.Brain 112: 165-175.

Drachman DA & Arbit J (1966) Memory and the hippocampal complex. Is memory a multipel process ? Arch Neurol 15: 52-61.

Drachman D & Ommaya AK (1964) Memory and the hippocampal complex. Arch Neurol 10: 411-425.

Heit G, Smith ME, Halgren E (1990) Neuronal activity in human medial temporal lobe during recognition memory. Brain 113: 1093-1112.

Human memory (1987) Human Neurobiology 6(2) c£ Kesner, R.P. (1973) A neural system analysis of memory storage and retrieval. Psychlogical Bulletin, 80, 177-203.

McDonough, Jr., J.H. & Kesner, R.P. (1971) Ammesia produced by brief electrical stimulation of the amygdala or dorsal hippocampus in cats. J. comp. Physiol. Psychol. 77, 171-178.

McGaugh, J.L., & Dawson, R.G. (1966) Time-dependent processes in memory storage.Science, 153, 1351-1358. [ --> rat ]

Milner, B. (1954) Intellectual fuction of the temporal lobes, Psychol. Bull. 51, 42-62.

Routtenbert, A., & Holzman, N. (1973) Memory disruption by electrical stimulation of substantia nigra, pars compacta. Science, 181, 83-86. [ --> rat]

Spanis, C.W. (1981) A.J. Psychiat 138(9) , 1177. [ECT & memory]

Squire LR (1986) Mechanisms of memory. Science 232: 1612-1619.

Squire LR (1992) Memory and the hippocampus: a sythesis from findings with rats, monkeys and humans. Psychol. Rev. 99: 195-231, 582.

Tulving, E., & Watkins, M.J. (1973) Structure of memory traces. Psychological Review, 82, 261-275.ü£ü@1(1):1894.1- Z52-A39

Wilburn, M.W., & Kesner, R.P. (1972) Differential amnestic effects produced by electrical stimulation of the caudate nucleus and non-specific thalamic system. Experimental Neurology, 34, 45-50. [ --> cat ]

Wyers, E.J., Peeke, V.S., Willison, J.S. & Herz, M.J. (1968) Retroactive impairment of passive avoidance learning by stimulation of the caudate nucleus. Exp. Neurol. 22, 350-366.

Wyers, E.J., & Deadwyler, S.A. (1971) Duration and nature of retrograde amnesia produced by stimulation of caudate nucleus. Physiology and Behavior, 6, 97-103. [--> rat]

ELECTRICAL STIMULATION OF THE BRAIN (E.S.B.)

Adams, D.B, (1979) Brain mechanisms for offense, defense, and submission. he Behavioral and Brain Sciences, 2, 201-241.[Gallistel,1981]

Adams, J.R. & Prout, B.J. (1962) Transistorized R.F.-coupling unit for biological stimulators. J. Physiol., 162, 9P-10P.

Adey, W.R., Kado, R.T., & Didio, J. (1962) Impedance measurements in brain tissue of animals using microvolt signals.Exptl. Neurol. 5, 47-66.

Agnew, W.F., Yuen, T.G.H., Puderz, R.H., & Bullara, L.A.(1975) Electrical stimulation of the brain . IV. Untrastructural studies. Surgical Neurology, 4, 438-448. (from Delgado, Patterson ed., 1981)

Akert, K. & Andersson, B. (1951) Acta Physiol. Scand. 22, 281.[ --> cat => sleep]

Akert, K., Koella, W.P. & Hess, R. (1952) Sleep produced by electrical stimulation of the thalamus. Am. J. Physiol. 168T, 260-267.

Akimoto, H., Nomura, T., Matsui, I., Ishikawa, O., Nakagawa, K. & Mitsushita, T. (1954) On the syndrome induced by electrical stimulation on thalamus. [=> man's sleep] Physiological and Clinical Studies on the Diencephalon. Igaku Shoin, Tokyo.

Akimoto, H., Takeuchi, S., Shozuka, K. & Negishi,K. (1955) On recruiting Response induced by continuous electrical stimulation in thalamus of cat. Psychiatr. Neurol. Jap. 56.

Akimoto, H., Yamaguchi, N., Okabe, K., Nakagawa, T., Abe, K., Torii, H., & Masahashi, K. (1956) On the sleep induced through electrical stimulation on dog thalamus. Folia Psychiat. et Neurol. Japon. 10, 117-146.

Alexander, M., & Perachio, A.A. (1973) The influence of target sex and dominance on evoked attack in rhesus monkeys. Am.J.of Physical Anthropology, 38, 543-547.

Alonso de Florida, F., & Delgado, J.M.R. (1958) Lasting behavioral and EEG changes in cats induced by prolonged stimulation of amygdala. Am.J.of Physiol.193, 223-229.

Anand, B.K., & Brobeck, J.R.(1951) Hypothalamic control of food intake in rats and cats.Yale J.of Biology and Medicine, ,Vol.24, 123-140.

Anand, B.K., & Dua, S. (1956) Electrical stimulation of the limbic system of brain (visceral brain) in the waking animals. Indian J. Med. Res. 44, 107-119.

Andrian, E.D. (1921) Journal of Physiology (London), Vol.55, 193.

Anomymous.(1974) Electrical stimulation of the brain.Lancet, 2. 562-564.

Asanuma H & Sakata H (1967) Functional organization of cortical efferent system examined with focal depth stimulation in cats. J. Neurophysiol. 30: 35-54.

Baldwin, M. (1960) Electrical stimulation of the mesial temporal region. In Electrical Studies on the Unanesthetized Brain, 159-76 (Ramey, E.R., O'Doherty, D.S., Eds., Hoeber, New York, 423pp.)

Bonazzola, S., & Gualtierotti, (1960) Wireless tele-stimulation of the cat's motor cortex with constant stimulation of the cat's motor cortex with constant stimuli. J.Physiol. 150, 1-2.

Buchwald, N.A., & Ervin, R.R. (1956),Behavioral and action potential responses to stimulation of subcortical structures in the unaesthetized cat, Fed.Proc., 15, 27.

Bursten, B. & Delgado, J.M.R. (1958) Positive reinforcement induced by intracerebral stimulation in the monkey. J. comp. physiol. Psycho., 51, 6-10.

Campbell KSA, Ivans G & Gallistel CR (1985) A microcomputer-based method for physiologically interpretable measurement of the rewarding efficacy of brain stimulation. Physiology and Behavior. 35: 395-403.

Campbell, P.K., Jones, K.E., Huber, R.J., Horch, K.W., & Norman, R.A. (1991) A silicon-based, three-dimentional neural interface: manufacturing processes for an intracortical electrode array. IEEE Trans. BME, 38, No.8, 758-768.

Cannon, B. (1933) A method of stimulating autonomic nerves in the unanesthetized cat with observations on the motor and sensory effects. Am.J.Physiol, 105, 366-372.

Chaffee, E.L. & Light, R.U. (1934) Electrical excitation of the nervous system - ntroducitn a new system of remote control.Science 79, 299-300.

Chaffee, E.L., & Light, R.U. (1934) A method for the remote control of electrical stimulation of the nervous system, I. The history of electrical excitation. Yale J. of Biol. & Med., 7, 83-128. 83;441[coil --> coil]

Chaffee, E.L. & Light, R.U. (1935) Supplementary notes on the remote control of electrical stimulation of the nervous system.Yale J. Biol. Med., 7, 441-450.

Chardack, W.M., Gage, A.A., & Greatbatch, W. (1960) Surgery, 48, 643-654.[heart pacemaker w/o charging from outside]

Clarke, Edwin, & Kenneth Dewhurst (1972) An Illustrated history of brain function, Berkeley, University of California Press,, 154p. ü£(SC 364-37) Localisation. 113-148.

Clark, G. & Ward, J.W. (1949) Responses elicited by combined stimulation of pairs of fixed electrodes in the unanesthetized monkey. Am.J.Physiol.,158, 474.

Clark, S.L. & Ward, J.W. (1937) Electrical stimulation of the cortex cerebri of cats: Responses elicitable in chronic experiments through implanted elctrodes. Arch.Neurol.Pshychiat., 38, 927. [small induction coil]

Clark, S.L. (1941) Science, 94, 187.[the first electrode implant by Ewald]

Clark, S.L. & Ward, J.W. (1941) The influence of stimulus strength and duration on the responses from cortical stimulation through i mplanted electrodes. Am.J.Physiol., 131,650.

Clarke RH, (1920) Investigation of the Central Nercous System, Johns Hopkins Press, Baltimore, Md., pt. I, pp. 1-159, plates I-XXVII. [the stereotaxic instrument,Lilly(1958)]

Cohen BD, Brown, G.W., & Brown, M.L. (1956) Avoidance learning motivated by hypothalamic stimulation. Fed. Proc. 15, 37.

Cooper R (1966) Toxic effects of intracerebral electrodes. Med. biol. Engng 4, 575-581.

Crow, H.J., Cooper, R., & Philips, D.G. (1961) Controlled multifocal frontal leucotomy for psychiatric illness. J. Neurol. Neurosurg. Psychiat. 24, 353-360.

Curry,M.J.,"The effects of stimulating the somatic sensory cortex on single neurones in the posterior group (PO) of the cat," Brain Research, 44 (1972) 463-481.

Delgado, J.M.R., & Livingston, R.B. (1948) Some respiratory, vascular and thermal responses to stimulation of orbital surface of frontal lobe. J. of Neurophysiology, 11, 39-55.

Delgado, J.M.R. (1952) Permanent implantation of multilead electrodes in the brain. Yale J. of Biol.Med., 24, 351-358.

Delgado, J.M.R. (1952) Responses evoked in waking cat by electrical stimulation of motor cortex. Amer. J. Physiol., 171, 436-446.

Delgado, J.M.R., Hamlin, H., & Chapman, W.P. (1952) Technique of intracranial electrode implacement for recording and stimulation and its possible therapeutic value in psychotic patients. Confinia Neurologica, 12, 315-319.

Delgado, J.M.R. & Anand, B.K. (1953) Increase of food intake induced by electrical stimulation of the lateral hypothalamus. Am. J. Physiol., 172, 162-168.

Delgado, J.M.R., Roberts, W.W. & Miller, N.E. (1954) Learning motivated by electrical stimulation of the brain. Am. J. Physiol., 179, 587-593.

Delgado, J.M.R. (1955) Cerebral structures involved in transmission and elaboration of noxious stimulation. J. Neurophysiol.18, 261-275.

Delgado, J.M.R. (1955) Evaluation of permanent implantation of electrodes within the brain. EEG Clin. N. 7, 637-644.

Delgado, J.M.R., Rosvold, H.E., & Looney, E. (1956) Evoking conditioned fear by electrical stimulation of subcortical structures in the monkey brain .J. comp. physiol. Psychol. 49, 373-380.

Delgado, J.M.R. (1957) Brain stimulation in the monkey: technique and results (motion picture). Fed. Proc. 16, 29.

Delgado JMR & Hamlin H (1958) Direct recording of spontaneous and evoked seizures in epileptics. EEG Clin. N. 10: 463-486.ü£ôîæ_ê¶

Delgado, J.M.R. (1959) Prolonged stimulation of brain in awake monkeys, J.Neurophysiol., 22, 458-475.

Delgado, J.M.R. (1959) Transistor timing stimulator. EEG clin. N.

Delgado, J.M.R., & Hamlin, H. (1960) Spontaneous and evoked electrical seizures in animals and humans. In E.R.Ramey & E.S.O'Doherty (Eds.), Electrical Studies on the Unanesthetized Brain, New York, Hoeber, pp.133-158.

Delgado, J.M.R. (1960) Emotional behavior in animals and humans. Psych. Res. Rep. Am. psychiat. Ass., 12, 259-271.

Delgado, J.M.R. (1961) Chronic implantation of intracerebral electrodes in animals. In D.E. Sheer (Ed.), Electrical stimulation of the brain.

Delgado, J.M.R. (1961) Evolution of repeated hippocampal seizures in the cat.EEG clin. N. 13, 722-733.

Delgado, J.M.R. (1962) Pharmacological Analysis of Central Nervous Action. Oxford: Pergamon, pp.265-292.

Delgado JMR & Hamlin H (1962) Depth electrography. Confin. Neurol. 22: 228-235.

Delgodo, J.M.R. (1963) Telemetry and telestimulation of the brain. In: L.Slater (Ed.), Biotelemetry, Pergamon, New York, 231-249.

Delgado, J.M.R. (1963) Cerebral heterostimulation in a monkey colony. Science 141, 161-63.

Delgado, J.M.R. (1963) Social rank and radio-stimulated aggressiveness in monkeys. J. Nervous and Mental Diseases 114, 383-90.

Delgado, J.M.R. (1963) Effect of brain stimulation on task-free situations. EEG clin. N. Suppl. 24, 260-280.

Delgado, J.M.R. (1964) Electrodes for extracellular recording and stimulation. In N.L.Nastuk (ed.), Electrophysiological methods, Vol. V, Part A: Physical techniques in biological research. New York: Academic Press.

Delgado, J.M.R. (1964) Free behavior and brain stimulation. Int.Rev. Neurobiology, 6, 349-449. ü£ôîæ_ê¶èwòö

Delgado, J.M.R. (1965) Sequential behavior repeatedly induced by red nucleus stimulation in free monkeys Science, 148 , 1361-1363.

Delgado -->!! bull. New York Times 1965.5.17 p.1 & 20.

Delgado, J.M.R. (1965) Evolution of physical control of the brain, New York, Am.Museum of Natural History ü£ôîæ_

Delgado, J.M.R. (1965) Chronic radiostimulation of the brain in monkey colonies.

Proc. Intern. Union Physiol. Sci. 4, 365-371.

Delgado, J.M.R. (1966) Emotions. Self-Selection Psychology Textbook. W.C.Brown.Cubuque, Iowa, 56pp.

Delgado, J.M.R. (1966) Aggressive behavior evoked by radio stimulation in monkey colonies. Amer. Zool., 6, 669-681.

Delgado, J.M.R., & Mir, D. (1966) Infatigability ofpupillary constriction evoked by hypothalamic stimulation in monkeys. Neurology, 16, 939-950.[Doty&Bartlett,1981]

Delgado JMR (1967) Man's intervention in intracerebral functions. IEEE Int. Conv. Rec. 15(9): 143-150.

Delgado, J.M.R. (1967) Brain Function,5, 171.[Lancet, 1974]

Delgado, J.M.R. (1967) Limbic system and free behavior. In Progr. Brain Res. 27, 48-68.

Delgado, J.M.R. (1967) Social rank and radio-stimulated aggressiveness in monkeys. J. Nerv. Ment. Dis. , 144, 383-390.

Delgado, J.M.R., Mark, V., Sweet , W., Ervin, F., Weiss, G., Bach-y-Rita, G., & Hagiwara, R. (1968) Intracerebral radio stimulation and recording in completely free patients, J.of Nervous and Mental Disease, 147, 329-340.ü£ôîæ_ê¶

Delgado,J.M.R. (1969) Physical Control of the Mind (Harper and Row)

Delgado,J.M.R. (1969) "Offensive-defensive behavior in free monkeys and chimpanzees induced by brain radio stimulation." In S.Garattini and E.BSigg(Eds.), Aggressive Behavior. Proceedings of the Symposium on the Biology of Aggressive Behavior, Milan, May, 1968, Excerpta Medica, Amsterdam, 109-119.

Delgado,J.M.R., Bradley, R.J., Johnston, V.S., Weiss, G., and Wallace, J.D. (1969) Implantation of Multilead Electrode Assemblies and Radio Stimmulation of the Brain in Chimpanzees. Technical Documentary Report No. ARL-TR-69-2, Holloman Air Force Base, NM, 19pp.

Delgado, J.M.R. (1969) Radio stimulation of the brain in primates and in man. Anesth. Anlag. 48, 529-543.ü£ôîæ_ê¶

Delgado,J.M.R.,and Mir, D. (1969) Fragmental organization of emotional behavior in the monkey brain, Ann. N.Y. Acad. Sci., 159 , 731-751.

Delgado,J.M.R. (1970) Multichannel Transdermal Stimulation of the Brain. Technical Documentary Report No. ARL-TR-70-1, Holloman AirForce Base, NM, 24pp.

Delgado,J.M.R., V.S., Johnston, J.D.Wallace & R.J. Bradley (1970) Operant conditioning of amygdals spindling in the free chimpanzee,Brain Research,22,347-362.

Delgado,J.M.R., Maria Luisa Rivera & Diego Mir (1971) Repeated Stimulation of Amygdala in Awake Monkeys, Brain Research, Vol.27, No.1

Delgado, J.M.R. & Bracchitta, H. (1972) Free and instrumental behavioral in monkeys during radio stimulation of the caudate nucleus. Int. J. Psychobiol., 2, 233-248.

Delgado JMR (1972) [re. freewill] The Humanist. 1972. [Camellion (1978)]

Delgado, J.M.R., Obrador, S., & Martin-Rodriquez, J.G. (1973) Two-way radio communication with the brain in psychosurgical patients, In L.V.Laitinen & Livingston (ed.), Surgical approaches in psychiatry, Lancaster, England, Medical & Technical Publishing.

Delgado, J.M.R., Sanguinetti, A.M., & Mora, G. (1973) Aggressive behavior in gibbons modifies by caudate and central gray stimulation. Interntional Research Comunications System Medical Science, Spt., 16-2-32.

Delgado,J.M.R. & et al.(1975) Two-Way Transdermal Communication with the Brain, Am.Psychologist , March 1975.

Delgado, J.M.R. (1975) Inhibitory systems and emotions. In Levi Emotions - their parameters and measurement, pp.183-204 (Raven Press, New York 1975).

Delgado, J.M.R., Delgado-Garcia, J.M., & Grau, C. (1976) Mobility controlled by feedback cerebral stimulation in monkeys. Physiol. Behav. 16, 43-49.

Delgado, J.M.R. (1977) Therapeutic programmed stimulation of the brain in man. In W.Sweet, S.Obrador, & J.G. Martin-Rodriguez (Eds.), Neurosurgical treatment in psychiatry, pain, and epilepsy, Baltimore, MD, University Park Press, pp.615-637.

Delgado, J.M.R. (1977-78) Instrumentation, Working hypotheses, and clinical aspects of neurostimulation. Applied Neurophysiology, 40, 88-110.

Del Pozo, F., & Delgado, J.M.R. (1978) Hybrid stimulator for chronic experiments. IEEE Trans. on Biomedical Engineering, BME-25, 92-94.[Delgado,1981]

Dempsey, E.W. & Morison, R.S. (1942) The production of thythmically recurrent cortical potentials after localized thalamic stimulation. Am. J. Physiol. 135, 293-300..

Dhume, R.A., & Gogate, M.G. (1974) A miniature stimulator for behavioral studies in freely moving cats. Indian J. of Physiology and Pharmacology, 18, 123-125.

Donaldson, N. (1988) Comments on "Efficient transdermal links with coupling-insensitive gain", IEEE Trans. BME, 35, No.4, 280-281.

Doty, R.W. (1969) Electrical stimulation of the brain in behavioral context. Annual Review of Psychology, 20, 289-320.

Duffy, E. (1934) Is emotion a mere term of convenience ? Psychol. Rev. 41, 103-104.

Duffy, E. (1941) An explanation of "emotional" phenomena without the use of the concept "emotion." J. Genet. Psychol. 25, 283-293.

Dymond, A.M. (1976) Characteristics of the metal-tissue interface of stimulation electrodes, IEEE Trans. Biomed. Eng., BME-23, 274-280, July, 1976.

Egger, M.D., & Flynn, J.P. (1962) Amygdaloid suppression of hypothalamically elicited attack behavior. Science 136, 43-44.

ElenfthÄriou, B.E., & Scott, J.P. (Eds.). (1971) The physiology of aggression and defeat, New York, Plenum.[Delgado,1981]

Fender, F.A. (1936) Am.J.Physiol., 116, 47. [radio --> coil]

Fender, F.A. (1937) Prolonged splanchnic stimulation . Proc. of the Society for Exp.Biol.and Med., 36, 396-398.[radio --> coil]

Fender, F.A. (1937) Epileptiform convulsions from"remote" excitation. Arch.Neurol.Psychiat., 38, 259-267.

Fender, F.A. (1941) Arch.Neurol.Psychiat., 45, 617. [radio --> coil]

Flynn, J.P. & Wasman, M. (1960) Learning and cortically evoked movement during propagated hippocampal afterdischarges. Science 131, 1607-1608.

Flynn, J.P., Wasman, M., and Egger, M.D. (1963) "Behavior during propagated hippocampal after discharges. In EEG and Behavior. G.H.Glaser, Ed. Basic Books, New York, 134-148. [Delgado et al (1971)]

Flynn, J.P., Edwards, S.B. & Bandler, Jr., r.J. (1971) Changes in sensory and motor systems during centrally elicited attack. Behav.Sci., 16, 1-19.

Folkow, H. (1952) Impulse frequency in sympathetic vasomotor fibres correlated to the release and elimination of the trasmitter. Acta Physiologica Scandinavica, 25, 49-76.[Delgado,1981]

Fonberg, E., & Delgado, J.M.R. (1961) J.Neurophysiol., 24, 651.[Lancet,1974]

Frits, G., & Hitzig, E., (1870) Ueber die elektrische erregbarkeit des grosshirns. Archives fuer Anatomie und Physiologie, 37, 300-332.

Furman, S., & Schwedel, J.B. (1959) N.Engl.J.Med., 261, 943-948. [the first L-T heart pacemaker] ü£îçìâ

Galambos R (1961) Fed. Proc. 20: 603-608. [self-stimulation -->?]

Galvani, L. (1791) De viribus electricitatis in motu musculari. Commentarius. Proc.Academia Bologna, 7, 363-418.

Geddes, L.A., & Hoff, H.E. (1971) IEEE Spectrum, 8, 12,, 38-46.[Galvani vs.Volta]

Geddes LA (1984) A short history of the electrical stimulaiton of excitable tissue, including electrotherapheutic applications. The Physiologist, Supp. 2: 1-47.

Gengerelli, J.A. (1948) Stimulation of the brain by means of radiant energy. Amer. Psychol., 3, 340.

Gengerelli, J.A.,& Kallejian,, (1950) Remote stimulation of the brain in the intact animal. J. Psychol., 29, 263-269.

Garattini, S., & Sigg, E.B. (1969) (Eds.) Aggressive behavior. Amsterdam, Excerpta Med. [Delgado,1981]

Geschwind N (1979) Specializations of the human brain. Sci. Am. 241: 180.

Goddard, G.V., McIntyre, D.C., and Leech, C.K.," A permanent change in brain function resulting from daily electrical stimulation," Exp. Neurol., 25, 1969, 295-330.

Gold, J.H., Stoeckle, H., Schuder, J.C., West, J.A., & Holland, J.A. (1974) Selective tissue stimulation with microimplant. Transactions in Ame.Soc.for Artificial Internal Organs., 20, 430-436. [Delgado,1981]

Greer, M.A. & Riggle, G.C. (1957) Apparatus for chronic stimulation of the brain of the rat by radiofrequency transmitssion, EEG clin. Neurophysiol., 19, 151-156.

Greig, J. & Ritchie, A. (1944-45) A simple apparatus for remote nerve stimulation in the unanesthetized animal. J.Physiol., 103, 8P. [radio --> coil]

Harris, G.W., "The innervation and actions of the neuro-hypophsis; An investigation using the method of remote-control stimulation," Philosophical Transactions, 232B, 1946-47, 385-441. [Delgado, 1975]

Herberg, L.J., and Watkins, P.J. (1966) Epileptiform seizures induced by hypothalamic stimulation in the rat: resistance to fits following fits Nature, 209, 295-330.?

Hess, W.R. (1928) Stammganglien-Reizversuche. Berichte Gesamte weber die Physiologie und Experimentelle Pharmakologie, 42, 554-55.

Hess, W.R. (1928) Arch. f. Psychiat. 86, 289.

Hess, W.R. (1929) Arch. f. Psychiat. 88, 813.

Hess, W.R. (1931) Compt. rend. Soc. de biol. 107, 1333.

Hess, W.R. (1932) Beitrage zur Physiologie d. Hirnstammes. I. Die Methodik der lokalisierten Reizung und Ausschaltung subkortikaler Hirnabschnitte. Leipzig, Thieme.

Hess, W.R. (1944) Das Schlafsyndrom als Folge dienzephalen Reiaung. Helv. Physiol. Pharmacol. Acta, 2, 305.[ele -> cat => sleep]

Hess, W.R. (1954) Das Zwischenhirn (2nd ed.).Basel, Schwabe. [Gallistel,1981]

Hess, W.R. (1954) Diencephalon-autonomic and Extrapyramidal Functions. Gune and Stratton, New York.

Hess, W.R. (1957) The Functional Organization of the Diencephalon. Grune and Stratton, New York. [ ele --> cat's tha => sleep]

Higgins, J.W., Mahl, G.F., Delgado, J.M.R., & Hamlin, H. (1956) Behavioral changes during intracerebral electrical stimulation. Arch.Neurol.Psychiatry, 76, 399-419.

Hoagland, H.A. (1940) A simple method for recording electrocorticogram in animals without opening the skull. Science, 92, 537-538.

Hochmair, E. (1984) System optimization for improved accuracy in transcutaneous signal and power transmision, IEEE Trans. BME, 31, No.2, 177-186.

Honda, Y., et al (1989) Development of percutaneous intramuscular electrode for multichannel FFS system. IEEE Trans. BME, 36, No.7, 705.

Hunter, J. & Jasper, H.H. (1949) Effects of thalamic stimulation in unanesthetized animals. EEG Clin.Neurophysiol., 1, 305.

Jasper, H.H. (1960) Unspecific thalamocortical relations. Handbook Physiol.,Sect. 1, Neruophysiol. 2, 1307-1319.

Jechorek, W. & von Holst, E. (1956) Fernreizung freibeweglicher Tiere. Naturwissenschaften, 43, 455.

Kaada, B.R., Anderson, P.A., & Jansen, J. (1954) Stimulation of the amygdaloid nuclear complex in unanesthetized cats. Neurology. 4, 48-64.

Kahn, A. & Greatbatch, W. (1974) Physiologic electrodes; in Ray Medical engineering, pp.1073-1082 (Year Book, Chicago 1974).

Kelty, M.F. (1975) Study of the use of psychosurgery in the United States. Information request of the National Committe for Protection of Human Subjects of Biomedical and Behavioral Research. 4th Wld Congr. Psychiat. Surg., Madrid 1975.[Delgado 1977/78]

King, M.B., & Hoebel, B.G., (1968) Killing elicited by brain stimulation in rats. Comm.in Behav.Biol., 2, 73-177.[Alex&Perachio,1973]

Klemm,W.R."Effects of electric stimulation of brain stem reticular formation on hippocampal theta rhythm and muscle activity in unanesthetized, cervical- and midbrain-transected rats," Brain Research, 41 (1972) 331-344.

Kremer WF (1947) Autonomic and somatic reactions induced by stimulation of the cingular gyrus in dogs. J. Neurophysiol. 10: 371-379.

Lafferty, M.M. & Farrell, J.F. (1949) A technique for chronic remote nerve stimulation. Science, 110, 140-141. [radio ----> implanted coil]

Lashley, K.S. (1938) The thalamus and emotion. Psychol. Rev. 45, 42-61.

Leeper, R.W. (1948) A motivational therory of emotion to replace "emotion as disorganized response," Psychol. Rev. 55, 5-21.

Lewandowsky, M. (1903) Arch. Anat. Pshysiol., Lpz., p.129. [remote control]

Liebeskind, John C. et al.,"Analgesia fro electrical stimulation of the periaqueductal gray matter in the cat: behavioral observations and inhibitory effects on spinal cord interneurons," Brain Research, 50 (1973) 441-446.

Lilly, J.C., (1950) A.I.E.E.-I.R.E. Conference on Nucleonics and Medicine (S-33) (American Institute of Electrical Engineers, New York), pp.37-43.

Lilly, J.C., (1950) Electroenceph.Clin.Neurophysiol., 2,, 358.

Lilly, J.C., (1950) Proc. 18th Internat. Physiol. Cong., Copenhagen, p.340.

Lilly, J.C., (1950) Milbank Memorial Fund Symposium: The Biology of Mental Health and Disease, New York: Hoeber, p.206.

Lilly, J.C., Austin, G.M., & Chambers, W.W. (1952) Threshold movements produced by excitation of cerebral cortex and efferent fibers with some parametric regions of rectangular current pulses (cats and monkeys). J.of Neurophysiology, 15, 319-342.

Lilly, J.C., (1953) Fed.Proc., 12, 87.

Lilly, J.C., (1953) Proc. 19th Internat. Physiol. Cong., Montreal, p.564.

Lilly, J.C., (1953) Significance of motor maps of the sensorimotor cortex in the conscious monkey, Federation Proc. 12, No.1, 285.

Lilly, J.C., Hughes, J.R., Alvord, E.C., Jr., & Galkin, T.W. (1955) Brief noninjurious electric waveforms for stimulation of brain. Science, 121, 468-469.ü£Z53-A48

Lilly, J.C., Hughes, J.R., Galkin, T.W., & Alvord, E.C., (1955) EEG Clin.Neurophysiol., 7, 458.

Lilly, J.C., (1955) Univ.of Wisconsin Symposium: Interdisciplinary Research in the Behavioral, Biological, and Biochemical Sciences, August 1955, Madison: Univ. Wisconsin Press.

Lilly, J.C., Hughes, J.R., & Galkin, T.W., (1956) Fed.Proc., 15, 119.

Lilly, J.C., Hughes, J.R., & Galkin, T.W., (1956) Proc. 20th Internat. Physiol. Cong.,p.567.

Lilly, J.C., (1956) Science, 124, 937.

Lilly, J.C., (1957) Learning Elicited by Electric Stimulation of Subcortical Regions in the Unanesthetized Monkey, Science, 125, 748.

Lilly, J.C., (1957) Fed.Proc., 16, 81.

Lilly, J.C., (1957) paper presented at the "intern, Symposium on Reticular Formation of the Brain," Detroit, Mich.

Lilly, J.C., (1957) Proc. 1st Internat. Cong. Neurol. Sciences, 4th Internat. Cong. Electroencephalog. & Clin.Neurophysio., Brussels, p.161.

Lilly, J.C., (1957) International Symposium on the Reticular Formation of the Brain, Detroit, Mich., March 1957.

Lilly, J.C., (1957) Conference on Electrical Studies on the Unanesthetized Brain, Washington, D.C., June 1957.

Lilly, J.C. (1958) Henry Ford Hospital Intern. Symposium on the reticular formation of the Brain, Boston; Little. [ele --> monkey => self-stim]

Lilly, J.C. (1958) Electrode and cannulae implantation in the brain by a simple percutaneous method. Science, 127, 1181-1182.

Lilly, J.C., (1958) Development of a Double-Table-Chair Method of Restraining Monkeys for Physiological and Psychological Research, J.Appl.Physiol., 12, 134.

Lilly, J.C. (1958) Correlations between neurophysiological activity in the cortex ans short-term behavior in the monkey. In Biological and Biochemical Bases on Behavior, 83-100 (HARlow , H.F., Woolsey, C.N., Eds., Univ. Wisconsin Press, Madison, 476pp.)

Lilly JC (1958) Some considerations regarding basic mechanisms of positive and negative types of motivations. Am. J. Psychiat. 115: 498.

Lilly, J.C. (1960) Injury and excitation of brain by electrical current. In E.R. Ramey and D.S.O'Doherty (Eds), Electrical Studies of the unanesthetized brain, Hoeber, New York, pp.96-105.

Lilly, J.C. (1961) Injury and excitation by electric currents. A. The balanced pulse-pair waveform. In D.E.Sheer (Ed.), Electrical Stimulation of the Brain, Univ. Texas Press, Austin, 60-64.

Lilly JC & Miller AM (1962) Operant conditioning of the bottlenose dolphin with electrical stimulation of the brain. J. Comp. and Physiol. Psychol. 55: 73.

Lilly, J.C.(1978) The Scientist, (Philadelphia, J.B.Lippincott Company)

Ling, F., & Gerard, R.W. (1949) The normal membrane potential of frog sartorious fibers. J.of Cellular and Comparative Physiology, 34, 383-396.[Swett,1981] 'microelectrodes'

Loucks, R.B. (1933) Preliminary report of a technique for stimulation or destruction of tissues beneath the integument and the establishing of conditioned reactions with faradization of the cerebral cortex. J.comp.Psychol, 16, 439-44.

Loucks, R.B. (1934) A technique for faradic stimulation of tissues beneath the integument in the absence of conductors penetrating the skin. J.comp.Psychol.,18, 305.

Loucks, R.B. (1959) The erosion of electrodes by small currents. EEG clin. Neurophysiol. 11, 823-826.

MacDonnell, M., & Flynn, J.P. (1966) Control of sensory fields by stimulation of hypothalamus. Science, 152, 1406-1408. [Alex&Perachio,197

MacLean PD (1949) Psychosom. Med. 11, 338-353. [ --> emotion]

MacLean PD & Delgado JMR (1953) Electrical and chemical stimulation of frontotemporal portion of limbic system in the waking animal. EEG clin.N., 5, 91-100.ü£ôîæ_ê¶

MacLean PD, Flanigan, S., Flynn, J.P., Kim, C., & Stevens, J.R. (1955-56) Hippocampal function: tentative correlations of conditioning, EEG, drug, and radioautographic studies. Yale J. Biol. Med. 28, 380-395.

MacLean PD et al (1959) Trans. Am. Neurol. Ass. 84: 105.

[-> septal =>sex] ü£É_ì_ê¶ü@82-97, 99-106

MacLean PD, Ploog, D.W. (1962) Cerebral representation of penile erection.

J. Neurophysiol., 25, 29-55.

Mauro, A., Davey, W.L.M., & Scher, A.M. (1950) Central nervous stimulation by implanted high frequency receiver.. Fed.Proc. Balt.,9, 558.

Maurus, M., Mitra, J., Ploog, D.W. (1965) Cerebral representationof the clitoris in ovariectomized squirrel monkeys. Exptl. Neurol., 13, 283-88.

Maurus, M.(1967) Neue fernreizapparatus fur kleine primaten, Naturwissen., 54, 593.

Maurus, M. & Ploog, D. (1971) Social signals in squirrel monkeys: Analysis by cerebral radio stimulation. Experimental Brain Research, 12, 171-183. [Delgado,1981]

Maxim, P.E. (1972) Behavioral effects of telestimulating hypothalamic reinforcement sites in freely moving Rhesus monkeys, Brain Research, 42, 243-262.

Maxim, P.E., & Spelman, F.A. (1975) A radio-controlled constant current biphasic stimulator system for primate studies. Physiology and Behavior, 14, 663-667.

Mayer, D.J., Wolfle, T.L., Akil, H., Carder, B., & Liebeskind, J.D. (1971) Analgesia resulting from electrical stimulation in the brain stem of the rat, Science 174, 1351-1354.

Mazars, G, Merienne, L., & Cioloca, C. (1974) Implantable thalamus stimulators for the management of some types of intractable pain. Neurochirurgie 20, 117-124.

McNeal, D.R. (1977) 2000 years of electrical stimulation. In F.T.Hambrecht & J.B. Reswick (Ed.), Functional electrical stimulation. New York: Dekker, pp.3-25.[Swett,1981] ES therapy for pain by Roman.ü£SC71-184

Mihailovic, L., & Delgado, J.M.R. (1956) Electrical stimulation of the monkey brain with various frequencies and pulse dirations. J.Neurophysiology, 19, 21-36.

Moniz, E. (1936) Tentatives operatoires dans le traitment de certaines psychoses. Paris: Masson & Cie. [lobotomy]

Morison, R.S., & Dempsey, E.W. (1942) A study of thalamo-cortical relations. Am. J. Physiol. 135, 281-292.

Mortiner JT (1983) Electrical excitability: the basis for applied neural control. IEEE EMB 2(2): 12.

Moyer, K.E. (1976) (Ed.). Physiology of aggression and implications for control, New York, Raven.

Nakao, H. (1958) Emotional behavior produced by hypothalamic stimulation.

Am J. Physiol. 194, 411-418.

Nathan, Peter (1983) The Nervous System. Oxford New York. Oxford University Press. [Extract RCVD from RN. 1994.2.5]

Neafsey EJ,, Bold EL et al (1986) The organization of the rat motor cortex: a microstimulation mapping study. Brain Res. Rev. 11: 77-96.

Newman, H., Fender, F., & Saunders, W. (1937) High frequency transmission of stimulating impulses. Surgery (St.Louise), 2, 359-362.[radio --> coil]

Olds, J., & Milner, P. (1954) Positive reinforcement produced by electrical stimulation of the septal area and other regions of the rat brain.

J.of Comp.and Physiol.Psychology, 47, 419-428.

Olds, J. (1954) A neural model for sign-gestalt theory. Psychol.Rev.,61, 59-72.

Olds, J. (1956) Pleasure centers in the brain, Scientific American, 195, 105-116.

Olds, J. (1958) Satiation effects in self-stimulation of the brain, J.comp. physiol. Psychol., 51, 675-678.[Delgado et al (1971)]

Olds, J. (1960) In Electrical studies on the unanesthetized brain, E.R.Ramey & D.S.Doherty, Eds., Harper, New York, pp.17.

Olds, J. (1962) Hypothalmic substaits of reward . Physiol. Rev. 42, 554.

Olds, M.E. & A.Yuwiler, (1972) "Effect of brain stimulation in positive and negative reinforcing regions in the rat on content of catecholamines in hypothalamus and brain," Brain Research, 36, 385-398.

Olds ME & Fobes JL (1981) The central basis of motivation: intracranial self-stimulation studies. Annual Rev. Psyhology 32: 523-574.

Onard, B. et al (1984) Electrical properties of bioelectrodes. IEEE Trans. BME 31(12):827.

Papez, J.W. Arch. Neurol. Psychiat. 38, 725. [--> emotion]

Patterson, M.M. & Kesner, R.P. (ed.), Electrical stimulation research techniques, NY, Academic Press, 1981, 370p. (SC 364-A3)

Extracellular stimulation (James B.Ranck,Jr.) ü¢Intracellular stimulation ( John H.Bryne)

Microstimulation technique (Hiroshi Asanuma)

Stimulation of the brain via metallic electrodes (Robert W.Doty and John R. Bartlett)

Depth stimulation of the brain (JosÄ M.R.Delgado)#Subcortical stimulation for motivation and reinforcement (C.R.Gallistee)

Electrical stimulation as a tool in memory research (R.F.Berman and R.P.Kesmmer)

Brain stimulation effects related to those of lesions (Robert L.Isaacson)

Electroconvulsive therapy, who needs it ? (Duane Denney)

Electrical stimulation of peripheral nerve (John E.Swett and Charles M.Bourassa)

Grid and peripheral shock stimulation (Fred A. Masterson)

Perachio, A.A., Alexander, M., & Robinson, B.W. (1969) Sexual behavior evoked by telestimulation. In: Proc. 2nd Internatl. Cong. Primat. H.Hoffer, ed. Karger, Basel, New York, Vol. 3, pp.68-74.[Alex&Perachio,1973]

Ploog, E.W., Blitz, J., & Ploog, F. (1963) Studies on social and sexual behavior of the squirrel monkey (saimiri sciureus). Folia Primatologica, 1, 29-66.

Plotnick, R., Mir, D., & Delgado, J.M.R. (1968) Aggression, noxiousness and brain stimulation in unrestrained thesus monkeys.In Eleftherion, G.F., ed. Physiology of aggression and defeat, pp.143-221. New York: Plenum Press.ü£SB51-8

Pompeiano, O., & Swett, J.E. (1962) EEG and Behavioral manifestations of sleep induced by cutaneous nerve stimulation in normal cats. Archives Italiennes de Biologie,, 100, 311-342.

Porter, R.W., Conrad, D.G., and Brady, J.V. (1959) Some neural and behavioral correlates of electrical self-stimulation of the limbic system. J.exp. Anal. Behav., 2, 43-55.

Ranck JB (1975) Which elements are excited in electrical stimulation of mammalian central nervous system: a review. Brain Res. 98: 417-440.

Ray, C.D., (1974) Medical engineering. Chicago, Year Book Med.

Reynolds, D.V. (1969) Surgery in the rat during electrical analgesia induced by focal brain stimulation, Science 164, 444-445.

Roberts, W.W., Steinberg, M.L., & Means, L.W. (1967) Hypothalamic mechanisms for sexual, aggressive and other motivational behaviors in the oppossum, Didiphis virginiana. J.Comp.Physiol.Psychol., 64, 1-15.[Alex&Perachio,1973]

Robinson, B.W. (1962) Localization of intracerebral electrodes.

Experimental Neurology, 6, 201-233.

Robinson, B.W.,Warner,H.&Rosvold,H.E.(1964) A head-mounted remote-controlled brain stimulator for use on rhesus monkeys. EEG Clin.Neurophysiol., 17, 200-203.

Robinson, B.W., Mishkin, M. (1966) Ejaculation evoked by stimulation of the preoptic area in monkey. Physiol. Behav., 1, 269-72.ü£ôîæ_ê¶

Robinson, B.W., Alexander, M., & Bowne, G. (1969) Dominance reversal resulting from aggressive responses evoked by brain telestimulation. Physiology and Behvior, 4, 749-752.

Rosvold, H.E., & Delgado, J.M.R. (1953) The effect of the behavior of monkeys of electrically stimulating or destroying small areas within the frontal lobes. Am.Psyhologist, 8, 425-426.

Rosvold, H.E., & Delgado, J.M.R. (1956) J. comp. Physio. Psychol. 49, 365.ele -> monkey => sleep]

Routtenberg, A., Gardner, E.L., & Huand, Y.G. (1971) Self-stimulation pathways in the monkey, Macaca mulatta. Experimental Neurology, 33, 213-224. [Gallistel,1981]

Rubinstein, E.H., & Delgado, J.M.R. (1963) Inhibition induced by forebrain stimulation in the monkey. Am.J.of Physiology, 205, 941-948.

Rugh, J.D. (1971) A biphasic radio-controlled stimulator. Physiol. Behav., 6, 267-269.

Santic, A. et al (1982) Micropower electronic switches for implanted instrumentation, IEEE Trans. BME, 29, 583-589.

Saunders, F.A. Electrocutaneous displays. In F.A.Geldard (Ed), (1974) Cutaneous communication systems and devices, Austin, TX, Psychonomic Society,pp.20-26.

Sawyer, P.N. & Srinivasan, S. Metals and inplants. In C.D.Ray(Ed.). (1974) Medical engineering. Chicago, Year Book Med.,pp.1099-1110.

Schmitt, O.H. (1948) A radio frequency coupled tissue stimulator, Science 107, 432.

Schwan, H.P. (1984) The development of biomedical engineering : historical comments and personal observations. IEEE BME, 31, No.12, 730-736.

Segundo, J.P., Arana, R., & French, J.D. (1955) Behavioral arousal by stimulation of the brain in the monkey. IBJ. Neurosurg. 12, 601-613.

Seligman, L.J. (1982) Physiological stimulators: from electric fish to programable implants. IEEE Trans. Bio-med. Eng. BME -29, 270-284.

Senning , A. (1963) Mal.Cardiovas., 4, 503-512. [implantable heart pacemaker]

Sharpless, S.K., and Halpern, L.M. (1962) The electrical excitability of chronically isolated cortex studies by means of permanently implanted electrodes, EEG. clin.Neurophysio., 14, 244-255. [Delgado et al (1971)]

Sidman, M., Brady, J.V., Boren, J.J., Conrad, D.G., & Schulman, A. (1955) Reward schedules and behavior maintained by intracranial self-stimulation. Science, 122, 830-831.

Siegel,Allan , John Chabora, Raymond Troiano, "Effects of electrical stimulation of the pyriform cortex upon hypothalamically-elicited aggression in the cat," Brain Research, 47 (1972) 497-500.

Silverman, G., Ball, G.G., & Cohn, C.K. (1975) A new automatic constant current stimulator and its biological applications, IEEE Tras.on B.M.E., BME-22, 207-212.

Skinner, B.F. (1938) The behavior of organism. New York: D.Appleton-Century.

Slater, L., (ed.), Bio-telemetry, 1963 (NY: Pergamon Press)

Stachnik, T., Ulrich, R., & Mabry, J.H. (1966) Reinforcement of intra- and inter-species aggression with intracranial stimulation. Am. Zoologist 6, 663-668.

Sterman, M., & Clemente, C. (1962) Forebrain inhibitory mechanism: synchronization induced by basal forebrain stimulation. Exptl. Neurol.6, 91-102.[ele -> cat => sleep]

Sterman, M., & Clemente, C. (1962) Forebrain inhibitory mechanisms: sleep patterns induced by basal forebrain stimulation in the behaving cat. Exptl. Neurol.6, 103.

Stillings, D. (1974) Med. Instru., 8, 334.ü@[ele.acupuncture]

Straw, R., & Mitchell, C.A. (1966) A simple method of implanting electrodes for long-term stimulation of peripheral nerves, J.of Applied Physiology, 21, 712-714.

Symposium on stereotactic surgery. J. Neurosurg., 15, (3).

Szabo, Imre & Peter M.Milner (1972)Self-stimulation in Rats: Tip alignment influences the effectiveness of bipolar electrodes, Brain Research, 48 ,243-250.

Talbert, G.A. (1900) Arch. Anat. Physiol., Lpz., p.195.

Terell, W., & Maurer, D. (1974) Two design approaches to dual channel implantable neurostimulators. Proc.of the 7th Annual Meeting of the Neuroelectric Society.

Testerman, R.L., Hagfors, N.R., & Schwartz, S.I. (1971) Design and evaluation of nerve stimulating electrodes. Medical Research Engineering, 10, 6-11.

Ulrich, R.E., & Azrin, N.H. (1962) Reflexive fighting in response to aversive stimulation. J. Exptl. Anal. Behav. 5, 511-521.

Ulrich, R.E., Wolff, P.C., & Azrin, N.H. (1964) Shock as an elicitor of intra- and interspecies fighting behavior. Animal Behav. 12, 14-15.

Upson, J.D., King, F.A., & Roberts, L. (1962) A constant-amplitude transitorized unit for remote brain stimulation. Electroenceph. clin. Neurophysiol, 14, 928-930.

Valenstein, E.S., Hodos, S. & Stein, L. (1961) A simplified electrode assembly for implanting chronic electrodes in the brains of small animals. Amer. J. Psychol., 74, 125-128. ü£îç

Verzeano, M. & French, J.D. (1953) Transistor circuits in remote stimulation.

EEG clin. Neurophysiol., 5, 613-616.

Ward HP (1959) Stimulus factors in septal self-stimulation. Am.J. Physiology 196: 774-782.

Warner, H., (1962) "A remote control brain telestimulator system," Digest, 15th Annual Conf. on Engineering in Medicine and Biology, November 1962. pp.6.

Warner, H., Robinson, B.W., Rosvold, H.E., Wechsler, L.D., & Zampini, J.J. (1968) A remote control brain tele-stimulator with solar cell power supply. IEEE Trans. on Bio-Medical Engineering,15, 94-101.

Wasman, M., & Flynn, J.P. (1962) Directed attack elicited from hypothalamus. Archives of Neurology (Chicago), 6, 220-227.

Wauquier, A., & Rolls, E.T. (1976) Brain-stimulation reward, Amsterdam, North-Holland Publ.

Walker AE (1957) The development of the concept of cerebral localization in the ninteenth century. Bull. Hist. Med. 31: 99-121.

Welker W (1976) Mapping the brain. Historical trends in functional localization. Brain Behav. Evol. 13: 327-343.

Wetzel, M.C., Howell, L.G., & Bearie, K.J. (1969) Experimental performance of steel and platimum electrodes with chronic monophasic stimulation of the brain. J.of Neurosurgery, 31, 658-669.

Wiener, N. (1949) Cybernetics. New York, Wiley.

Willey, T.J., & Freeman, W.J. (1968) Alteration of prepyriform evoked response following prolonged electrical stimulation, Am.J.Physiol., 215, 1435-1441.

Woodworth, C.H. (1971) Attack elicited in rats by electrical stimulation of the lateralhypothalamus. Physiol.and Behav., 6, 345-355

Yamaguchi, N. (1956) Behavioral changes induced by electrical stimulation of the thalamus of unanesthetised dogs. Psychiatr. Neurol. Jap. 58.

Yeomans, John S (1990) Principles of Brain Stimulation. Oxford University Press, NY. pp.182 $35.00. [Library, Neurosurgery 29(3):475]

Young, P.T. (1961) Motivation and Emotion, John Wiley & Sons, Inc. New York, N.Y., 648 pp.

Zeier, H., Tschannen, G., Sietz, H., & Fideler, A. (1968) A device for wireless electric brain stimulation in operant conditioning situations. Physiol. Behav. 3, 587-590.

**ESB --** man & therapy

Adams JE & Rutkin BB (1970) Visual responses to subcortical stimulation in the visual and limbic systems. Confinia Neurologica 32: 158-164.

Adams, J.E., Hosobushi, Y., & Fields, H.L. (1974) Stimulation of internal capsule for relief of chronic pain, J. Neurosurg. 41, 740-744.

Adams, J.E., & Hosobushi, Y. (1977) Technique and technical problems [of ESB].Neurosurgery, 1, 196-199. (from Delgado, Patterson ed., 1981)

Adams, J.E., Hosobuchi, Y., & Linchitz, R. (1977) The present status of implantable intracranial stimulation for pain. Clinical Neurosurgery, 24, 347-361.[--->! pain]

Adams, J.E. (1977/78) Technique and technical problems associated with implantation of neuroaugmentive devices, Appl. Neurophysiol., 40, 111-123.[ele --> chronic pain]

Ajmone Marsan C & Van Buren J (1964) Functional relationship between frontal cortex and subcortical structures in man. EEG Clin. N. 16: 80-87.

Alberts, W.W., & Wright Jr., E.W., Levin, G., Feinstein, B. & Mueller, M. (1961) Threshold stimulation of the lateral thalamus and globus pallidus in the waking human. EEG clin. Neurophysiol.13, 68-74. Alberts,W.W., B.Feinstein, G.Levin & E.W.Wright,Jr. (1966) Electrical stimulation of therapeutic targets in waking dyskinetic patients. [--->! dyskinetic ]Ectroenceph.Clin.Neurophysiol., 20, 559-566.

Angeleri F, Ferro-Milone F & Parigi S (1964) Electrical activity and reactivity of the hinecephalic, pararhinecephalic, and thalamic structures: Prolonged implantation of electrodes in man. EEG Clin. N. 16: 100-129.

Babb MI & Dymond AM (1974) Electrode Implantation in the Human body. Univ. California, LA: Brain Information Service/Brain Res. Inst.

Bechtereva, N.P., Kambarova, D.K., Smirnov, V.M., & Shandurina, A.N. (1977) Using the brain's latent abilities for therapy: chronic intracerebral electrical stimulation , In Sweet, Obrador and Martin-Rodriquez Neurosurgical treatment in psychiatry, pain, and epilepsy, University Park Press, Baltimore.

Baldwin M (1960) Electrical stimulation of the mesial temporal region. In: Ramey ER, O'Doherty DS (eds) Electrical studies on the unanesthetized brain. Hoeber, New York

Bancaud J et al. (1994) Anatomical originof deja-vu and vivid 'memories' in human temporal lobe epilepsy. Brain 117: 71-90.

Bates JAV (1953) Stimulation of the medial surface of the human cerebral hemisphere after hemispherectomy. Brain 76: 405-447.

Becker, H.C. & Peacock (1954) Subcortical stimulaation techniques (including stimulation data sheets), in R.G.Heath and the Tulane University Dpt of Psychiatry and Neurology, Studies in Schnizophrenia. Cambridge, Harvard Univ. Press, 201-234.

Becker, H.C. & Peacock (1954) Improvements in teh technique of electrical stimulation, in R.G.Heath and the Tulane University Dpt of Psychiatry and Neurology, Studies in Schnizophrenia. Cambridge, Harvard Univ. Press, 201-234.

Becker, H.C., Founds, W.L., Peacock, S.M., Heath, R.G., Llewellyn, R.C., & Mickle, W.A. (1957) A roentgenographic stereotaxic technique for implantign and maintaining electrodes in the brain of man, EEG clin. Neurophuysiol. 9, 533-543.

Becker, H.C., Peacock, S.M., Heath, R.G. & Mickle, W.A. (1961) Methods of stimulation control and concurrent electrographic recording, in Electrical Stimulation of the Brain, D.E.Sheer, Ed. Austin, Univ. of Texas Press, 74-90.

Bickford, R.G., Petersen, M.C., Dodge, H.W., Jr., & Sem-Jacobsen, C.W. (1953) Observations on depth stimulation of the human brain through implanted electrographic leads. Mayo Clinic Proceedings, 28, 181-187. üú

Bickford RG, Mulder DW, et al (1958) Changes in memory function produced by electrical stimulation of the temporal lobe in man. Res Publ Nerv Ment Dis 36: 227-243.

Bickford RG, Dedge HW, Jr. & Uihlein A (1960) Electrographic and behavioral effects related to depth stimulation in human patients. In Ramey ER & O'Doherty DS eds. Electrical Studies on the Unanesthetized Brain pp. 248-259.

Bishop MP et al (1963) Intracranial self-stimulation in man. Science 140: 394.

Bland BH & Vanderwolf CH (1972) Electrical stimulation of the hippocampal formation. Behavioral and bioelectric effects. Brain Research, Amsterdam 43: 89-106.

Brazier, M.A.B. (1964) Evoked responses recorded from the depths of the human brain. Annals of the N.Y. Acad.of Sciences , 112, 33-59.

Brazier MAB (1966) Stimulation of the hippocampus in man using implanted electrodes. In: Brazier MAB (ed) RNA and brai funciton, memory and learning. Univ. of Calif., Berkeley, pp 299-310.

Brazier, M.A.B. (1971), Modern advances in the use of depth electrodes. In A. Winter (Ed.), The surgical control of behavior, Thomas, Springfield, IL, pp.5-20.

Brickner, R.M. (1940) A human cortical area producing repetitive phenomena when stimulated. J. Neurophysiol. 3, 128-130.

Burke D et al. (1992) Anodal and cathodal stimulation of the upper-limb area of the human motor cortex. Brain 115: 1497-1508.

Chapman WP, Livingston RB, Livingston KE (1949) Frontal lobotomy and electrical stimulation of orbital surface of frontal lobes Effect on respiration and on blood pressure in man. Arch Nerurol Psyhciatr 62: 701-716.

Chapman LE, et al (1967) Memory changes induced by stimulation of hippocampus or amygdala in epileptic patients with implanted electrodes. Trans Am Neurol Assoc 92: 50-56.

Cherlow DG et al. (1977) Evoked response and after-discharge thresholds to electrical stimulation in temporal lobe epileptics. Archives of Neurology 34: 527-531.

Cooper, I.S., (1973) Chronic stimulation of paleocerebellar cortex in man.Lancet , 1, 206. [Lancet,1974]

Cooper, I.S., Amin, I., Gilman, S. (1973) The effect of chronic cerebellar stimulation upon epilepsy in man. Trans. Amer. Neurol. Assn. , 98, 192-196.

Cooper, I.S., Crighel, E., & Amin, I. (1973) Clinical and physiological effects of stimulation of the paleocerebellum in humans. J.Am.Geriatr.Soc., 21, 40-43.

Cooper, I.S., Gilman, S. (1973) Chronic stimulation of the cerebellar cortex in the therapy of epilepsy in the human, in Neural Organization and its relevance to prosthetics. (W.S.Fields, ed.), Intercontinental Book Corp., New York.

Cooper, I.S., Riklan, M., & Snid, R.S. (1974) The cerebellum, epilepsy, and behavior, Plenum Press, New York.

Crandall PH, Water RD, Rand RW (1963) Clinical applications of studies of stereotactically implanted electrodes in temporal-lobe epilepsy. J. Neurosurgery 21: 827-840.

Crow, H.J., Cooper, R., & Philips, D.G. (1963) Progressive leucotomy. In Masserman (ed.), Current psychiatric therapies, vol.3, pp.100-113. New York: Grune & Stratton.

Crow, H.J., & Cooper, R. (1973) Stimulation, polarization and coagulation using intracerebral implanted electrodes during the investigation and treatment of psychiatric and other disorders. Medical Progress through Technology, 1, 92-102.

Damasio AR, Van Hoesen GW (1980) Structure and function of the supplementary motor area. Neurol 30: 359.

Daniel MS et al (1985) Psychological factors and outcome of electrode implantation for chronic pain. Neurosurgery 17(5): 773-777.

Douglas RJ (1967) The hippocampus and behavior. Psychological Bulletin 67: 416-442.

Dow, R.S. (1978) Summary and evaluation of chronic cerebellar stimulation in man. In I.S.Cooper (Ed.), Cerebellar stimulation in man, Raven, New York, pp.207-212.

Dreifuss JJ (1972) The effects of electrical stimulation of the amygdaloid complex on the ventromedial hypothalamus. In: The Neurobiology of the Amygdala. Edited by B.E.Eleftheriou. New York: Plenum.

Earle K.M., Baldwin, M. & Penfield, W. (1953) Incisural sclerosis and temporal lobe seizures produced by hippocampal herniation at birth, Arch.Neurol.Psychiat.(Chic.),69, 27-42.

Ervin, F.R., Brown, C.e. & Mark, V.H. (1966) Striatal influence on facial pain. Confin. Neurol. 27, 75-86. [ --> caudate -> carcinoma pain]

Ervin FR, Mark VH & Stevens J (1969) Behavioral and affective responses to brain stimulation in man. Proceeding so fhte American Psychopathological Association 58: 54-65.

Escueta AV,, Delgado-, Walsh GO (1982) The selection process for surgery of complex partial seizures: Surface EEG and depth electrography. Arch Neurol (in press [1982])

Fedio P & Ommaya AK (1970) Bilateral cingulum lesions and stimulation in man with lateralized impairment in short-term verbal memory. Exp Neurol 29: 84-91.

Feindel, W. & Penfield, W., (1954) Localization of discharge in temporal lobe automatism Arch.Neurol.Psychiat.(Chic.), 72, 605.

Feindel W (1982) The contributions of Wilder Penfield to the functional anatomy of the human brain. Human Beurobiol. 1: 231-234.

Feinstein, B., Alberts, W.W., Wright Jr., E.W. & Levin, G. (1960) A stereotaxic technique in man allowing multiple spatial and temporal approaches to intracranial targets. J. Neurosurg., 17, 708-720.

Feinstein G, Alberts WW, Levin G & Wright Jr. EW (1966) Some refinements of stereotaxic therapy for dyskinesia, and results of clinical evaluation. Confin. neruol. (Basel),

Ferguson SM, et al (1969) Similarities in mental content of psychotic states, spontaneous seizures, dreams, and responses to electrical brain stimulation in patients. Psychosom Med 31: 479-498.

Fields, H.L. & Adams, J.E. (1974) Pain after cortical injury relieved by electrical stimulation of the internal capsule. Brain 97, 169-178.

Flanigan HF, Nashold BS, et al (1978) Stimulation of the temporal lobe and thalamus in man and its relation to memory and behavior. In: Wauguier A, Rolls ET (eds) Brain-stimulation reward, Elsevier, NY, pp 521-526.

üóFox, S.S., & Rudell, A.P. (1968) Operant control of neural events. Formal and systematic approach to electrical coding of behavior in brain, Science, 162, 1299-1302.ü£îç

Glenn, W.W.L., Mauro, A., Longo, E., Lavietes, P.H., MacKay, F.J. (1959) Remote stimulation of the heart by radiofrequency transmission: clinical application to a patient with Stokes-Adams syndrome. N.Engl.J.Med., 261, 948-951.ü£îç

Glenn, W.W.L., Hageman, J.H., Mauro, A., Eisenberg, L., Flanigan, S., & Harvard, M. (1964) Electrical stimulation of excitabel tissue by r adio-frequency transmission. Annals of Surgery, 160, 338-350. [Delgado,1981]

Glenn, W.W.L., Holcomb, W.G., Gee, J.B.L., & Rath, R. (1970) Central hypoventilation, long-term ventilatory assistance by radiofrequency electrophrenic respiration. Ann.Surgery, 172, 755-773.[Swett,1981] 'subcutaneous antenna'.

Glenn, W.W.L., Holcomb, W.G., McLaughlin, A.J., Ohare, J.M., Hogan, J.F., & Yasuda, R. (1972) Total ventilatory support with RF-EPR. N.Engl.J.Med., 286, 513-516. [RF --> ele ->! respiratory paralysis]

Gloor P, et al (1982) The role of the limbic system in experiential phenomena of temporal lobe epileps.. Ann Neurol (in press)

Gloor P (1990) Experiential phenomena of temporal lobe epilepsy: facts and hypotheses. Brain 113: 1673-1694.

Goddard GB et al (1969) A permanent change in brain function resulting from daily electrical stimulation. Exp Neurol 25: 295-330.

Gol A (1967) Relief of pain by electrical stimulation of the septal area. J Neurol Sci 5: 115-120.

Gybels J, et al (1980) Electrical stimulation of the central grey for pain relief in human: autopsy data. Acta Neurochir Suppl. 30: 259-168.

Halgren E et al (1977) Post-EEG seizure depression of human limbic neurons is not determined by their response to probable hypoxia. Epilepsi 18: 89-93.

Halgren E et al (1978) Mental phenomena evoked by electrical stimulation of the human hippocampal formation and amygdala. Brain 101: 83-117.

Halgren E (1982) Mental phenomena induced by stimulation in the limbic system. Human Neurobiology 1: 251-260.

Halgren E, Wilson CL, Stapleton JM (1985) Human medial temporal lobe stimulation disrupts both formation and retrieval of recent memories. Brain and Cognition 4: 287-295.

Halgren E & Chauvel P (1992) Experiential phenomena evoked by human brain electrical stimulation. Ad. Neurol. 65: 87-104.

Hambrecht, F.T. & Reswick, J.B. (Ed.), (1977) Functional electrical stimulation. New York: Dekker[Swett,1981] ES therapy for pain by Roman.ü£SC71-184

McNeal, D.R., 2000 years of electrical stimulation , pp.3-25.

Gilman, S., et al., Clinical, morphological, biochemical, and physiological effects of cerebellar stimulation, pp.191-226.

Oakley, J., Preliminary analysis of chronic cerebellar stimulation of the control of epilepsy pp.227-240.

Penn, R., Cerebellar stimulation for motor disorders, pp.241-250.

Peports on the cerebellar stimulation panel, pp.251-258.

Brindley, G.s., & Rushton, D.N., Observations on the representation of the visual field on the human occipital cortex, pp.261-276.

Pollen, D.A., Andrews, B.W., & Levy, J.C., Electrical stimulation of the visual cortex in man and cat, pp.277-287.

Collins, C.C., Electrotactile visual prosthesis, pp.289-301.

Saunders, F.A., Recommende procedures for electrocutaneous displays, pp.303-

Report of the visual prosthesies panel, pp.311-317.

Merzenich & White, M.W., Cochlear implant: the interface problem, pp.321-340.

Mladejovsky, M.G., Eddington, D.K., Brackman, D.E., & Dobelle, W.H.,

Progress report and future directions of cochlear prostheses, pp.341-351.

Heath, R.G. & Hodes, R. (1952) Induction of sleep by stimulation of the caudate nucleus in Maccacus rhesus and man. Trans. Am. neurol. Ass. 77, 204-210, pp. 50-74.

Heath, R.G. & the Tulane University Department of Psychiatry and Neurology (1954) (Eds.). Studies in schizophrenia. A multidisciplinary approach to mind-brain relationships. Cambridge, MA, Harvard University Press.

Heath RG (1955) Correlation between levels of psychological awareness and physiological activity in the central nervous system. Psychosom. Med. 17: 383.

Heath RG (1958) Correlation of electrical recordings from cortical and subcortical regions of the brain with abnormal behavior in human subjects.Confinia Neurol. 18: 305

Heath, R.G. (1959) Physiological and biochemical studies in schizophrenia with particular emphasis on mind-brain relationships. Int. Rev. Neurobiol. 1, 299-331.

Heath, R.G. & Mickle, W.A. (1960) Evaluation of seven years experience with depth electrode studies in human patients, in Electrical Studies on the Unanesthetized Brain, E.R.Ramey and D.S.O'Doherty, Ed. New York: Hoeber, pp.214-247.

Heath, R.G. & Founds, W.L. (1960) A perfusion cannula for intracerebral microinjections, EEG clin. Neurophysiol. 12, 930-932.

Heath, R.G. & deBalbina Verster, F. (1961) Effects of chemical stimulation to descrete brain area. Am. J. Psychiat. 117, 980-990.

Heath, R.G., John, S.B. & Foss, O. (1961) Stereotaxic biopsy. Arch. Neurol. 4, 291-300.

Heath RG (1962) Common characteristics of epilepsy and schizophrenia: clinical observation adn depth electrode studies. Am. J. Psychiat. 118: 1013-1026.

Heath, R.G. (1963) Electrical self-stimulation of the brain in man. Am. J. Psychiat. 120, 571-577.

Heath, R.G. (1964) Developments toward new physiologic treatments in psychiatry. J. Neuropsychiat. 5, 318-331.

Heath, R.G. (1964) Pleasure response of human subjects to direct stimulation of the brain: Physiologic and psychodynamic considerations, in The Role of Pleasure in Behavior, R.G.Heath, Ed. New York: Hoeber Medical Division, Harper & Row, pp.219-243.

Heath, R.G. (1966) Schizophrenia: Biochemical and physiologic aberrations. Int. J. Neuropsychiat. 2, 597-610.

Heath, R.G. & Krupp, I.M. (1967) Schizophrenia as an immunologic disorder. Arch. Gen. Psychiat. 16, 1. ü£îç

Heath, R.G. (1967) Schizophrenis: studies of pathogenesis, in Biological and Clinical Aspects of the Central Nervous System, Symposium of Sandoz Ltd., Basle.

Heath, R.G. John, S.B. & Fontana, C.J. (1968) The pleasure response: Studies by stereotaxic technics in patients, in Computers and Electronic Devices in Psychiatry, N. Kline & E.Laska, Ed., New York: Grune and Stratton, 178-189.

Heath, R.G. (1970) Perspectives for biological psychiatry. Biolog. Psychiat. 2, 81-88.

Heath, R.G. (1972) Pleasure and brain activity. Deep and surface encephalograms during orgasm, Journal of Nervous and Mental Disease, 154:3-18.

Heath, R.G., Cox, A.W., & Lustick, L.S. (1974) Brain activity during emotional states.

Amer. J. Psychiat. 131, 858-862.

Heath, R.G. (1975) Brain function and behavior: I. Emotion and sensory phenomena in psychotic patients and in experimental animals. J.Nerv. Ment. Dis. 160, 159-175.

Heath, R.G., et al (1976) Stereotaxic implantation of electrodes in human brain: a method for long-term study and treatment. IEEE Trans. Bio-med. Eng. 23, 296-304.

HÄcaen H., Penfield, W. Bertrand C. & Malmo, R., (1956) The syndrome of apractognosia due to lesions of the minor cerebral hemisphere.Arch.Neurol.Psychiat.(Chic.), 75, 400.

Horowitz, M.M., Adams, J.E., & Rutkin, B.B. (1958) Visual imagery on brain stimulation. Archives of General Psychiatry, 19, 469-486.ü£îç

Hosobushi, Y., Adams, J.E., & Rutkin, B. (1973) Chronic thalamic stimulation for the control of facial anesthesia dolorosa, Arch. Neurol. 29, 158-161.

Hosobuchi Y, Adams JE, Linchitz R (1977) Pain relief by electrical stimulation of the central gray matter in humans and its reversal by naloxone. Science 197: 184-186.

Hosobuchi Y (1979) Elevation of B-endorphin-like substances and pro-opicortin (31K ACTH) by periaqueductal gray stimulation (PAGS) in humans. In: Hitchcok ER, Ballantine HT, Meyerson BA (eds) Modern Concepts in Psychiatric Surgery. Elsevier/North-Holland Biomedical Press, NY Vol I.

Hosobushi Y et al. (1979) Periaqueductal gray stimulation for pain suppression in humans. In: Bonica JJ (ed) Advances in pain research and therapy, Vol III. Raven Press, New York.

Hosobuchi Y (1980) The current status of analgesic brain stimulation.

Acta Neurochir Supp 30: 219-227.

Hosobuchi Y (1986) Subcortical electrical stimulation for control of intractable pain in humans : report of 122 cases (1970-1984) J. Neurosurg. 64: 543-553.

Iacono RP & Nashold BS (1982) Mental and behavioral effects of brain stem and hypothalamic stimulation in man. Human Neurobiology 1: 273-279.

Ishibashi R et al (1964) Hallucination produced by electrical stimulation of the temporal lobes in schizophrenic patients. Tohoku J Med 82: 124-139.

Jasper HH & Ramussen T (1958) Studies of clinical and electrical responses to deep temporal stimulation in man with some considerations of functional anatomy. Res Publ Assoc Res Nerv Ment Dis 36: 316-334.

Kumar K et al (1990) Deep brain stimulation for control of intractable pain in humans, present and future: a ten-yer follow-up. Neurosurg. 26(5): 7 74-782.

Laitinen LV (1979) Emotional responses to subcortical electrical stimulation in psychiatric patints. Clin Neurol Neurosurg 82: 148-157. Larson, S.J. et al. (1976) Cerebellar implant Studies. IEEE Trans. BME 23 (4) 319.

Levy RM et al. (1987) Treatment of chronic pain by deep brain stimulation : long term follow-up and review of the literature. Neurosurg. 21: 885-893.

Lewin, W. (1961) Observations on selective leucotomy. J. Neurol. Neurosurg. Psychiat. 24, 37-44.

Liberson, W.T., Scoville, W.B., & Dunsmore, R.H. (1951) Stimulation studies of the prefrontal lobe and uncus in man, EEG clin. Neurophysiol. 3,-8.

Libet B et al. (1964) Production of threshold levels of conscious sensation by electrical stimulation of human somatosensory cortex. J. Neurophysiology 27: 546-578.

Libet B et al. (1991) Control of the transition from sensory detection to sensory awareness in man by the duration of a thalamic stimulus. Brain 114: 1731-1757.

Livingston RB et al (1948) Stimulation of orbital surface of man prior to frontal lobotomy. Res Publ Assoc Nerv Ment Dis 27: 421-432.

Loeser, J.D., Black, R.G., & Christman, A. (1975) J.Neurosurg., 42, 308-315.

[ele ---> chronic pain]

Lustick, L.S. & Heath, R.G. (1970) Comparative study of intracranial electrodes for stimulation and recording. Biophys. Soc. Abstracts, 11, 165a.

Mahl GF, Rothenberg A, Delgado JMR & Hamlin H (1964) Psychological responses in the human to intracerebral electrical stimulation. Psychosom. Med. 26: 337-368.

Mark, V.H. & Ervin, F.R.. (1970) Violence and the brain (Harper & Row, New York).

Melzack, R. & Wall, P.D. (1965) Pain mechanisms: a new theory, Science 150, 971-979.

Meyer G, McElhaney M, Martin W, McGraw CP (1973) Stereotactic cingulotomy with results of acute stimulation and serial psychological testing. In: Laitinin LV, Livingston KE (eds) Surgical approaches in psychiatry. Medical and Technical Publishing Co.Ltd, Lancaster.

Milner B et al (1968) Further analysis of the hippocampal amnesic syndrome: 14 year follow up stidy of H.M. Neuropsychol 6: 215-234.

Moan CE & Heath RG (1972) Septal stimulation and initiation of heterosexual behavior in a homosexual male. J. Behav. Ther. Exp. Psychiat (In press)

Morgan JT (1982) The first reported case of electrical stimulation of the human brain.J Hist Med 37: 51-65.

Mullan S. & Penfield, W. (1959) Illusions of comparative interpretation and emotion. Arch.Neurol.Psychiat.(Chic.), 81, 269.

Mundinger F, Saldmao JF (1980) Deep brain stimulation in mesencephalic lemniscus medialis for chronic pain. Acta Neurochir Supp 30: 245-258.

Namba S et al. (1985) Sensory and motor responses to deep brain stimulation. Correlation with anatomical structures. J. Neurosurg. 63(2): 224-234.

Nashold BS, Wilson WP (1966) Central pain. Observations in man with chronic implanted electrodes in the midbrain tegmentum. Conf Neurol 27: 30-44.

Nashold BS, Gills J (1967) Ocular signs from brain stimulation and lesions.

Arch Ophthalmol 77: 609-618.

Nashold BS, Gills JP, Wilson WP (1967) Ocular signs of brain stimulation in the human. Conf Neurol 29: 169-174.

Nashold BS, Lanford GW (1968) A method for recording ocular reactions during stereotactic operations. Conf Neurol 30: 197-200.

Nashold BS, Wilson WP, Slaughter DG (1969) Sensations evoked by stimulation in the midbrain of man. J Neurosurg 30: 14-25.

Nashold BS (1970) Phosphenes resulting from stimulation of the midbrain in man.

Arch Ophthalmol 84: 433-435.

Nashold BS (1970) Ocular reaction from brain stimulation in conscious man. Neuroophthalmol 5: 92-103.

Nashold BS, Wilson WP (1970) Olfactory hallucinations evoked from stimulation of human thalamus. Confin Neurol 32: 298-307.

Nashold BS, Wilson WP, Slaughter DG (1974) The midbrain and pain.

Adv Neurol 4: 191-196.

Nashold BS, Slaugher DG, Wilson WP, Zorub D (1977) Stereotactic mesencephalotomy. Prog Neurol Surg 8: 35-49.

Nashold BS Jr, Wilson WP, Boone E (1979) Depth recordings and stimulation of the human brain: A twenty-year experience. In: Rasmussen T, Marino R (eds) Functional neurosurgery. Raven, New Yrok.

Nashold BS (1980) Brain stem stereotaxic procedures. In: Schaltenbrand (ed) Stereotaxy of the human brain. Thieme-Stratton, New York.

Ojemann G, Fedio P (1968) Effect of stimulation of the human thalamus and parietal and temporal white matter on short-term emmory. J Neurosurg 29: 51-59.

Ojemann G, Fedio P, & Van Buren JM (1968) Anomia fro pulvinar and subcortical parietal stimulation. Brain 91: 99-116.

Ojemann GA (1982) Models of the brain organization for higher integrative functions derived with electrical stimulation techniques. Huma Neurobiology 1: 243-249.

Ojemann G et al. (1989) Cortical language localization in left, dominant hemisphere. An electrical stimulation mapping investigation in 117 patients. J. Neurosurg. 71: 316-326.

Oliver A et al. (1987) Depth electrode implantation at the Montreal Neurological Institute and Hospital. In: Surgical Treatment of the Epilepsies. Engel J (ed) NY: Raven Press.

Ommayo AK, Feidio P (1972) The contribution of cingulum and hippocampal structures to memory mechanisms in man. Confin Neurol 34: 398-411.

Orthner H & Roeder F (1966) Further clinical and antomical experiences with stereotactic operations for relief of pain. Conf Neurol 27: 418-430.

Pampiglione G & Falconer MA (1960) Electrical stimulation of the hippocampus in man. In: Handbood of Physiology. Section 1. Neurophysiology, Volume 2. Edited by J.Field,et al., Washington, D.C.: American Physiological Society.

Penfield,W. & E.Boldrey (1937) Somatic motor and sensory representation in the cerebral cortex of man as studied by electrical stimulation, Brain, 60: 389-443.

Penfield, W. (1938) The cerebral cortex and consciousness.

Arch. Neurol.Psychiat. 40, 417-442.

Penfield, W. & Erickson, T.C. (1941) Epilepsy and Cerebral Localization.

Penfield, W. & Welch K., (1949), Instability of response to stimulation of the sensorimotor cortex of man. J.Physiol. (Lond.), 109, 358.

Penfield, W. & Rasmussen, T. (1949) Vocalization and arrest of speech.

Arch. Neurol. Psychiat. (Chicago) 61, 21-27.

Penfield, W. & Flanigin, H. (1950) Surgical therapy of temporal lobe seizures,

Arch. Neurol. Psychiat. (Chicago) 64, 491-500.

Penfield, P.W. (1950) Arch. Psychiat. Nervenkr. 185, 670.

Penfield, W. & Rasmussen (1950)The Cerebral Cortex of Man, MacMillan, New York.

Penfield, W. & Kristiansen, K. (1951) Epileptic Seizure Patterns, Springfield, Ill, Charles C Thomas, Publisher.

Penfield, W. & Welch, K. (1951) Arch. Neurol. Psychiat. 66, 289.

Penfield, W. & Baldwin, M. (1952) Temporal lobe seizures and the technic of subtotal temporal lobectomy, Ann. Surg. 136, 625-634.

Penfield, W. (1952) Epileptic automatism and the centrencephalic integrating system, Res. Publ. Ass. nerv. ment. Dis. 30, 513-528.

Penfield, W. (1952) Arch. Neurol. Psychiat. 67, 178.

Penfield, W. (1952) Memory mechanisms, AMA Arch. Neurol Psychiat. 67, 178-191.

Penfield, W. & Jasper H.H., (1954), Epilepsy and the Functional Anatomy of the Human Brain, Boston.

Penfield, W. (1954) Mechamisms of voluntary movement, Brain, 77, 1-17.

Penfield, W. (1955), Acta psychol. (Amst.), 11, 47.

Penfield, W., & Paine, K. (1955) Results of surgical therapy for focal epileptic seizures, Cand. M.A. J. 73, 515-531.

Penfield, W. (1955) Role of the temporal cortex in certain psychial phenomena,

ment. Sc. 101, 451-465.ü£îç

Penfield, W. & T.Rasmussen (1957) The cerebral cortex of man - A clinical study of localization of function, NY, Macmillan. [The homunculus]

Penfield, W. (1958) The Excitable Cortex in Conscious Man, Liverpool.

Penfield, W. & Milner B. (1958) Memory deficit produced by bilateral lesions in the hippocampal zone, Arch.Neurol.Psychiat.(Chic.), 79, 475.

Penfield,W. & L.Roberts (1959) Speech and Brain mechanisms, Princeton, N.J., Princeton Univ. Press, .

Penfield W (1959) The interpretive cortex. Science 129: 1719.

Penfield, W. (1961) Activation of the record of human experience. Ann.roy.Coll.Surg.Engl., 29, 77.

Penfield, W. & Perot P., (1963), The brain's record of auditory and visual experience -

A final summary and discussion. Brain, 86, 595.

Penfield,W. (1968) Engrams in the human brain," Proc. Roy.Soc.Med.,61: 831-840.

Penfield, W.(1975) The Mistery of the Mind, Princeton University Press. [Jap]

Penfield, Wilder, 1891-1976.(1977) No man alone: a neurosurgeon's life, Boston, Little, Brown.ü£GK478-30

Pool JL, Ransohoff J (1949) Autonomic effects of stimulating the rostral portion of cingulate gyri in man. J Neurophysiol 12: 385-392.

Pudenz RH et al (1975) Electrical stimulation of the brain. III. The neural damage model. Surgical Neurology 4: 389-400.

Ramey, E.R., & O'Doherty, D.S. ed., Electrical studies on the unanesthetized brain, New York, Hoeber, 1960. [Delgado,1975; ele ---> therapy]

Ranck JB Jr (1975) What elements are excited in electrical stimulation of mammalian central nervous systems: a review. Brain Res 98: 417-440.

Ray ChD, Burton ChV (1980) Deep brain stimulation for severe, chronic pain.

Acta Neurochir (Supple) 30: 289-293.

Ray CD (1981) Electrical and chemical stimulation of the CNS by direct means for pain control: present and future. Clin Neurosurg 28: 564-587.

Rayport M, Ferguson SM (1974) Qualitative modification of sensory responses to amygdaloid stimulation in man by interview content and context. EEG Clin N. 34: 714.

Richardson, D.E. (1967) Thalamotomy for intractable pain,Confin. Neurol. 29, 139-145.

Richardson, D.E. & Akil, H. (1973) Pain relief by electrical stimulation of the brain in human patients, Abstracts for the American Association of Neurosurgeons Meeting,

Los Angeles, CA, Apr.

Richardson, D.E. (1976) Brain stimulation for pain control.IEEE BME, 23 (4), 304-6.

Roland PE et al (1980) Supplementary motor area and other cortical areas in organization of voluntary movements in man. J Neurophysiol 43: 118-136.

Rosene DL, Van Hoesen GW (1977) Hippocampal efferents reach widespread areas of cerebral cortex and amygdala in the rhesus monkey. Science 198: 315-317.

Sano K (1962) Sedative neurosurgery. Neurologica Medico-chirugica 4: 112-142.

Sano K et al (1970) Results of stimulation and destruction of the posterior hypothalamus in man. J Neurosurg 33: 689-707. [Halgren 1982]

Schaeffler L et al. (1993) Comprehension deficits elicited by electrical stimulation of Broca's area. Brain 116: 695-715.

Schaltenbrand, G. (1965) The effects of stereotactic electrical stimulation in the depth of the brain. Brain, 88, 835-40. [-> man =>speech sounds]

Schaltenbrand G, et al (1973) Vegetative and emotional reactions during electrical stimulation of deep structures of the brain during stereotactic procedures. Z Neurol 205: 91-113

Schechter, D.C. (1972) Background of clinical cardiac electrostimulatio. N.Y. State J. Med., 72, 605-619. ["Can you hear me ?"]

Schwarz JR (1977) Results of stimulation and destruction of the posterior hypothalamus: A long-term evaluation. In: Sweet WH, Obrador S, Martin-Rodriquez JG (edw) Neurosurgical treatment in pssychiatry, pain and epilepsy. University Park, Baltimore.

Scoville W.B. & Penfield, W. , (1957), J.Neurol.Neurosurg.Psychiat., 20, 11.

Sem-Jacobsen, C.W., Petersen, M.C., Lazarte, J.A., Dodge, H.W., Jr., Holman, C.B. (1955) Intracerebral electrographic recordings from psychotic patients during hallucinations and agitation. Amer. J. Psychiat. 122, 278-288.ü£îç

Sem-Jacobsen et al (1955) Electroencephalographic rhythms from the depths of the frontal lobe in 60 psycotic patients. EEG clin. N. 7: 193-210.

Sem-Jacobsen, C.W., Petersen, M.C., Dodge, H.W., Lazarte, J.A., & Holman, C.B. (1958) Electroencephalographic rhythms from the depths of the parietal, occipital, and temporal lobes n man. Electroencephalography adn Clinical Neurophysiology, 8, 263-178.

Sem-Jacobsen CW (1959) EEG Clin. N. 11: 379.

Sem-Jacobsen, C.W., & Trkildsen, A. (1960) Depth recording and electrical stimulation in the human barin, In E.R.Ramey & D.s.I'Doherty (Eds), Electrical studies on the unanesthetized brain, New York, Harper & Row, (Hoeber), pp.275-290.

Sem-Jacobsen CW (1964) Electrical stimulation of the human brain. EEG Clin.N.17: 211.

Sem-Jacobsen, C.W. (1968) Depth-electrographic stimulation of the human brain and behavior: From fourteen years of studies and treatment of Parkinson's disease and mental disorders with implanted electordes. Springfield, IL, Thomas.

Shealy, C.N., Mortimer, J.T., & Hagfors, N.R. (1970) J.Neurosurg., 32, 560-564.

[implant ---> chronic pain]

Siegel RK & Jarvik ME (1975) Drug-induced hallucinations in animals and man. In: Hallucinations: Behavior, Experience, and Theory. Edited by RK Siegel & LJ West. NY: Wiley.

Siegfried J et al. (1983) Intracerebral electrode implantation system. J. Neurosurg. 59:356-359.

Spiegel EA & Wycis HT et al. (1947) Stereotactic apparatus for operations on the human brain. Science 106: 349-350.

Spiegel EA & Wycis HT (1953) Mesencephalotomy in treatment of intractable facial pain. Arch Neurol Psychiatr 69: 1-9.

Spiegel EA & Wycis HT (1961) Stimulation of the basal ganglia and brain stem in man. In: Sheer (ed) Electrical Stimulation of the Brain. Texas Press. Austin.

Spiegel EA & Wycis HT (1962) Stereoencephalotomy, Vol II. Grune and Stratton, NY

Spiegel EA & Wycis HT et al. (1964) Stimulation of Forel's field during stereotaxic operations in the human brain. EEG Clin N. 16: 537-548.

Spiegel EA & Wycis HT (1966) Present starus of stereoencephalotomies for pain relief. Conf Neurol 27: 7-12.

Stein L (1975) Norepinephrine reward pathways: role in self-stimulation, memory consolidation, and schizophrenia. Nebraska Syposium on Motivation 22: 113-159.

Stevens JR et al (1969) Deep temporal lobe stimulation in man: long latency, long-lsting psychological changes. Archives of Neurology 21: 157-169.

Strassburg HM, Thoden U, Mundinger F (1979) Mesencephalic chronic electrodes in pain patients. Appl Neurophysiol 42: 284-293

Sweet, W.H., & Wepsic, J.G. (1968) Trans. Am. Neurol. Assn., 93, 103-107.[implant ---> chronic pain]

Talairach J, Bancaus J (1966) The supplementary motor area in man. Int J Neurol 5: 330-347.

Talairach J, et al (973) The cingulate gyrus and human behavior. EEG Clin N. 34: 45-52.

Tasker RR & Organ LW (1972) Mapping of the somatosensory and auditory pathways in the upper midbrain and thalamus of man. Exerpta Medica 253-169-187.

Tasker RR & Organ LW (1973) Stimulation mapping of the upper human auditory pathway. J Neurosurg 38: 320-325.

Tasker RR, Organ LW, Hawrylyshyn P (1980) Visual phenomenon evoked by electrical stimulation o fthe human brainstem. Appl Neurophysiol 43: 89-95.

Tasker RR, Organ LW & Hawrylyshyn P (1982) The Thalamus and Midbrain of Man: A Physiological Atlas using Electrical Stimulation. Springfield, Ill.: Thomas.

Tsubokawa T (1964) The relationship between the human cortical recruiting responses and consciousness. Folia Psychiaatr Neurol Jap 18: 327-336.

Tsubokawa T et al (1993) Chronic motor cortex stimulation in patients with thalamic pain. J. Neurosurg. 78(3): 393-401.

Uematsu et al (1992) Motor and sensory cortex in humans: topography studies with chronic subdural stimulation. Neurosurgery 31(1): 59-72.

Van Buren, J.M. (1961) Sensory, motor and autonomic effects of mesial temporal stimulation in man. J. Neurosurg.18, 273-288.

Van Buren, J.M. (1963) Confustion and disturbance of speech from stimulation in vicinity of the head of the caudate nucleus. J.Neurosurg., 20, 148-157.

Van Buren, J.M. (1963) The abdominal aura: a study of abdominal sensations occurring in epilepsy and produced by depth stimulation. EEG Clin N. 15: 1-19.

Van Buren, J.M., Li, C.L., & Ljemann, G.A. (1966) The fronto-striatal arrest response in man. Electroenceph.clin.Neurophysiol., 21, 114-130.

Van Buren, J.M. (1966) Evidence regarding a more precise localization of the posterior frontal-caudate arrest response in man. J. Neurosurg. Suppl., 2nd Symposium on Parkinson's Disease, 416-17 (Nashold B.S., Huber, W.V., Eds.)

Von Holst E & St.Paul U (1962) Electrically controlled behavior.

Sci. Am. 206(3), March, 1962.

Walker AE, Marshall C (1961) Stimulation and depth recordings in man. In: Sheer DE (ed) Electrical stimulation of the brain. Univ. of Texas, Austin.

Waltregny A, et al (1974) Electrophysiological exploration of the anterior gyrus cinguli (area 24) in man (stereotaxic study). EEG Clin. N. 34: 782.

Wilson CL et al. (1990) Functional connections in the human temporal lobe. I. Analysis of limbic system pathways using neuronal responses evoked by electrical stimulation. Exp. Brain Res. 82: 279-292.

Wilson WP & Nashold BS (1973) Evoked photic responses from the human thalamus and midbrain. Conf Neurol 35: 338-345.

Wilson WP & Nashold BS (1968) Epileptic discharges occuring in the messencephalonand thalamus. Epilepsia 9: 265-273.

Young RF et al. (1985) Electrical ctimulation of the brain in treatment of chronic pain. Experience over 5 years. J. Neurosurg. 62(3): 389-396.

Young RF & Chambi VI (1987) Pain relief by electrical stimulation of the periaqueductal and periventricular gray matter. Evvidence for a non-opioid mechanism. J. Neurosurg. 66: 364-371.

Zimmermann M (1982) Electrical stimulation of the huma brain. Human Neurobiol 1: 227-229.

**Visual prostheses & E.S.B.**

Brindley, G.S. (1962) Beats produced by simultaneous stimulation of the human eye with intermittent light and intermittent or alternating electric curretn, J. Physiol. 164, 157-167.

Brindley, G.S., Lewin, W.S. (1968) The sensations produced by electrical stimulation of the visual cortex. J. Physiol., 196, 479-493.

Brindley, G.S. (1970) Sensations produced by electrical stimulation of the occipital poles of the cerebral hemispheres, and their use in constructing visual prostheses, Ann. Rep. Coll. Surg. 57, 106-108.

Brindley, G.S., Donaldson, P.E.K., Falconer, M.A., & Rushton, D.N. (1972) The extent of the region of occipital cortex that when stimulated gives phosphenes fixed in the visual field. J. Physiol. 225, 57-58.

Brindley, G.S. (1973) Sensory effects of electrical stimulation of the visual and paravisual cortex in man, in JUNG Handbook of Physiology, Vol.III/3B, Springer-Verlag, New York, pp.585-594.

Brindley, G.S.,Rushton, D.N. (1974) Implanted stimulators of the visual cortex as visual prosthetic devices. Trans. Amer. Acad. Ophthalmol. Otolaryngol. , 78, OP742-OP745.

Brindley, G.s., & Rushton, D.N.(1977) Observations on the representation of the visual field on the human occipital cortex, pp.261-276.

Brindley, G.S. (1981) Electroejaculation: its technique, neurological implications and uses. J. Neurology, Neurosurgery and Psychiatry 44: 9-18.

Brindley, G.S. (1982) Effects of electrical stimulation of the visual cortex.

Human Neurobiology 1: 281-283.

Button, J. & Putnam, T.J. (1962) Visual responses in cortical stimulation in the blind.

J. Iowa Med. Soc. 52, 17-21.

Campbell, P.K., Jones, K.E., Huber, R.J., Horch, K.W., & Norman, R.A. (1991)

A silicon-based, three-dimentional neural interface: manufacturing processes for an intracortical electrode array. IEEE Trans. BME, 38, No.8, 758-768.

Collins, C.C.(1977) Electrotactile visual prosthesis, pp.289-301.in Hambrecht & Reswick (Ed.) Functional electricastimulation

Dobelle, W.H., Mladejovsky, M.G. (1974) Phospenes produced by electrical stimulation of human occipital cortex, and their application to the development of a prosthesis for the blind. J. Physiol., 243, 553-576.

Dobelle, W.H. et al (1974) Data processing, LSI will help to braing sight to the blind, Electronics, 47, 81-86.

Dobelle, W.H., Mladejovsky, M.g., Evans, J.E., Roberts, T.S., Girvin, J.P. (1976) 'Braille' reading by a blind volunteer by visual cortex stimulation. Nature, 259, 111-112.

Dobelle, W.H., Mladejovsky, M.G., Girvin, J.P. (1974) Artificial vision for the blind: Electrical stimulation of visual cortex offers hope for a functional prosthesis. Science, 183, 440-444.

Dobelle WH, Mladejovsky MG & Evans JR (1976) "Braille" reading by a blind volunteer by visual cortex stimulation. Nature 259: 111-112.

Donaldson, P.E.K. (1973) Experimental visual prosthesis. IEE Proc., 120, 281-298.

Evans JR, Gordon J, Abramov I, Mladejovsky MG & Dobelle WH (1979) Brightness of phosphenes elicited by electrical stimulation of human visual cortex. Sensory Processes 3: 82-94.

Girvin JP, Evans JR, Dobelle WH, Mladejovsky MG, et al (1979) Electrical stimulation of human cortex: the effect of stimulus parameters on phospene threshold. Sensory Processes 3: 66-81.

Livingstone M & Hubel D (1988) Segregation of form, color, movement and depth: Anatomy, physiology and perception. Science 240: 740-749.

Minsky, M. (1971) Development of a facility for visual prosthesis experiments on humans, in Visual Prostheses : The interdisciplinary dialogue, T.Sterling, Ed. New York: Academic, 315-324.

Pollen, D.A. (1975) Some perceptual effects of electrical stimulation of visual cortex in man, in TOWER The Nervous System, Vol. 2, The Clinical Neurosciences, Raven Press, New York, pp.519-528.

Pollen, D.A. (1976) Responses of single neurons to electrical stimualtion of the surface of the visual cortex. Brain, Behav. Evol.

Pollen, D.A., Andrews, B.W., & Levy, J.C.(1977) Electrical stimulation of the visual cortex in man and cat, pp.277-287.in Hambrecht & Reswick (Ed.)

Rushton, D.N., Brindley, G.S. (1977) Short and long term stability of cortical electrical phosphenes, in Physiological Aspects of Clinical Neurology, Blackwell, Oxford.

Saunders, F.A.(1977) Recommended procedures for electrocutaneous displays, pp.303

in Hambrecht & Reswick (Ed.) Functional electricastimulation

**Auditory prostheses & E.S.B.**

Cochlear Implant () IEEE EMB 6(2)

Dobelle, W.H., Mladejovsky, M.G., Stensaas, S.S., & Smith, J.B. (1973) A prosthesis for the deaf based on cortical stimulation, Ann. Otol. Rhin. Laryngol. 82, 445-563.

Doyle, J.H., Doyle, J.B. & Turnbull, F.M. (1961) Electrical stimulation of eighth cranial nerve. Arch. Otolaryng. 84, 388-391. ü£îç

House, W.F. & Urban, J. (1973) Long term results of electrode implantation and electronic stimulation of the cochlea in man, Ann. Otol. 82, 504-510.

Merzenich, M.M. et al (1973) Neural encoding of sound sensation evoked by electrical stimulation of the acoustic nerve, Ann. Otol. 82, 486-503.

Merzenich, M.M. (1974) In Proceedings of the First International Conference on Electrical Stimulation of the Acoustic Nerve as a Treatment for Profound Sensorineural Deafness in Man, (M.M.Merzenich, R.A.Schindler, F.A. Sooy, eds.), Velo-Bind, Inc., San Francisco, pp.79-92.[ele ---> auditory sensory]

Merzenich, M.M. (1975) Studies on electrical stimulation of the auditory nerve in animals and man; cochlear implants, in The Nervous System, (D.B.Tower, ed.), Raven Press, N.Y.

Merzenich, M.M. & White, M.W. (1977) Cochlear implant; the interface problem.in Hambrecht & Reswick (Ed.) Functional electrical stimulation

Michelson, R.P. (1971) Electrical stimulation of the human cochlea, Arch. Otolaryngol. 93, 317-323. ü£îç

Michelson, R.P. (1971) The results of electrical stimulation of the cochlea in human sensory deafness, Ann. Otol. 80, 914-919.

Mladejovsky, M.G., Eddington, D.K., Dobelle, W.H., & Brackmann, D.E. (1975) Artificial hearing for the deaf by cochlear stimulation: Pitch modulation adn some parametric thresholds, Trans. Amer. Soc. Artif. Int. Organs, 21, 1-6.

Mladejovsky, M.G., Eddington, D.E., Evans, J.J., & Dobelle, W.H. (1976) A computer-based brain stimulation system to investigate sensory protheses for the blind and deaf, IEEE Trans. Biomed. Eng., BME-23, pp.286-296, July, 1976.

Mladejovsky, M.G., Eddington, D.K., Brackman, D.E., & Dobelle, W.H. (1977)

Progress report and future directions of cochlear prostheses. in Hambrecht & Reswick (Ed.) Functional electrical stimulation

Parkins CW et al. (1983) Cochlear implant: a sensory prosthesis frontier.

IEEE EMB 2(2): 18-26.

Simons, F.B. (1966) Electrical stimulation of the auditory nerve in man.

Arch. Otolaryngol. ,84, 24-76. ü£îç

Simons, F.B. (1967) Permanent introcochlear electrodes in cats, tissue tolerance and cochlear microphonics, Laryngscope, 77, 171-186.

**transnasal approach (implant thru nose)**

Barth JT et al (1984) The effects of prefrontal leucotomy: Neuropsychological findings in long term chronic psychiatric patients. Int. J. clin. Neuropsychology 6(2):120-1233. [thru eye's cavity]

Black PM et al (1987) Incidnece and management of complications of transsphenoidal operation for pituitary adenomas. Neurosurgery 20(6): 920-924.

Griffith HB et al. (1987) A direct transnasal approach to the sphenoid sinus. Technical note. J. Neurosurg. 66: 140-142.

Hardy J (1971) Transsphenoidal hypophysectomy. J. Neurosurg. 34: 582-594.

Hardy, Jules (1990) Atlas of Transsphenoidal Microsurgery in Pituitary Tumors Igaku-Shoin, NY, pp.74. [Neurogurgery 29(3): 478, 30(1): 141]

Kandel EI (1989) Functional and Stereotactic Neurosurgery. NY: Plenum Press, pp.492-500. [transnasal -> pituitary gland

Rabadan A et al (1992) Transmaxillary, Transnasal Approach to the Anterior Clivus: A Microsugical Anatomical Model. Neurosurgery 30(4): 473-482.

Rosenfeld JV (1992) Transnasal stereotactic biopsy of a clivus tumor. J. Neurosurg. 76(5): 878-879.

Watson SW et al (1982) Dental considerations in the sublabial trans-shpenoidal surgical approach to the pituitary gland. Neurosurgery 10(2): 236-241.

**BIO-TELEMETRY**

Adey WR (1963) Potential for telemetry in the recording of brain waves from animals and men exposed to the stresses of space flight. In Slater L ed. Bio-Telemetry pp.289-300.

Allen, R.T., Hansomn, M.L., & Dresge, D.J. (1964) Biotelemetry in demdicine, Bio-med. Instru., 1, 15-19, December 1964.

Almond, J.A. (1965) Personal telemetry transmitter system,

Aerospace Med. Res. Labs., Rept. AMRL-TR-65-87, pp.1-23.

Angell, J.B. (1977) Transducers for in vivo measurement of force, strain, and motion. in Physical Sensors for Biomedical Applications, M.R.Neuman et al. Eds., Boca Raton, FL, CRC Press.

Arfel G, et al (1969) Dynamic aspects of electroencephalography. First results of a telemetric study. Revue neurol. 120: 429-430.

Arfel G, et al (1969) Dynamic aspects of the human EEG. First results of a radiotelemetric study. EEG clin. N. 27: 108.

Asaki Y, Iriki M & Kanai H (1980) Design of a two-channel AM-FM transmitter for body temperature measurements in rats. Biotelemetry 7(1): 32.

Atkinson JR, et al (1967) Radio telemetry for the measurement of intracranial pressure. J. Neurosurg. 27: 429-432.

Ax AF (1969) Instrumentation for psychophysiology. Am. Psychol. 24: 229-233.

Barnett GH et al (1990) Epidural peg electrodes for the presurgical evaluation of intractable epilepsy. Neurosurgery 27(1): 113-115.

Barwich, R.E., & Fullagar, P.J. (1967) A bibliography of radio telemetry in biological studies, Proc. ecol. Soc. Aust., 2, 27. [Delgado et al (1970)]

Bement, S.L. et al (1986) Solid-state electrodes for multi-channel multi-plexed intracortical neuronal recording. IEEE Trans. BME, 33, No.2, 230-241.

Bert J, et al (1970) EEG of the mature chimpanzee: 24 hour recordings. EEG clin. N. 28: 368-373.

Bickford RG, et al (1969) Teleprocessing of the EEG from the patient's residence.

EEG clin. N. 26: 117-118.

Blanc C et al (1967) Radiotelemetric recordings of the electroencephalograms of civil aviation pilots during flight. EEG clin. N. 23: 580.

Bojsen JJ & Wallevik K (1972) A radiotelemetrical measuring device, implantable on animals, for long-term measurements of radionuclide-tracers. Int. J. appl. Radiat. Isotopes 23: 505-511.

Bornhausen M & Matthes R (1980) Remote control of electrical brain stimulation reward in rats with pulsed infrared light. Biotelemetry 7(1): 29.

Bowden AN, et al (1975) The place of EEG telemetry and closed-circuit television in diagnosis and management of epileptic patients. Proc R. Soc. Med. 68: 246-248.

Bowman, L. et al (1986) The packing of implantable integrated sensors.

IEEE Trans. BME, 33, No.2, 248-255.

Breakell CC, Parker CS & Christopherson F (1949) Radio transmission of the human EEG and other electrophysiological data. EEG Clin. N. 1: 243-244.

Brown MW, et al (1971) Laboratory note. A miniature transmitter suitable for telemetry of a wide range of biopotentials. EEG clin. N. 31: 274-276.

Bruner JM (1971) Telemetry in a large hospital - a look at the future. IEEE Trans. BME 18: 325-329.

Byford GH (1965) Medical radiotelemetry. Proc. R. Soc. Med. 58: 795-798.

Caceres, C.A. ed. (1965) Biomedical telemetry, New York,Academic Press.

Caceres CA (1968) Telemetry in medicine and biology.

Adv. biomed. Engng med. Phys. 1: 279-316.

Chute FS, et al (1974) Radio tracking of small mammals using a grid of overhead wire antennas. Can. J. Zool. 52: 1481-1488.

Collins, C. (1967) Miniature passive Pressure Transensor for implanting in the eye.

IEEE Trans. BME 14, 74-83.

Collins, C. (1967) Evoked pressure responses in the rabbit eye. Science 155, 106-108.

Currie JC, et al (1967) The measurement of intracranial pressure using thepressure endoradiosonde. J. Physiol. 189:22-23.

Danilevicius Z (1974) Telemetry - best detective in tracing CHD.

J. Am. med. Ass. 299: 1475-1476.

Davies DG & Roberts J (1972) An evaluation of cortical audiometry.

Proc. R. Soc. Med. 65: 367-370.

Erwin CW & Zung WW (1970) Behavioral and EEG criteria of sleep in humans. Comparison using radiootelemetry. Archs gen. Psychiat. 23: 375-377.

Farrar, J.T., Zworykin, V.K. & Baum, J. (1957) Pressure-sensitive telemetering capsule for the study of gastrointestinal motility. Science 126,, 975-976. November 8.

Fonster, F.G., Kupfer, D., Weiss, G., Lipponen, V., McPartland, R., & Delgado, J.M.R. (1972) Mobility recording and cycle research in neuropsychiatry.

J. interdiscipl. Cycle Res. 3, 61-72.

Franklin DL, et al (1966) Technique for radio telemetry blood flow velocity from unrestrained animals. Am. J. med. Electron. 5: 24-28.

Fromm, E. (1983) Athick film hybrid implantable telemeter, IEEE Eng. MBM. 2, 38-41. Mar.1983.

Fryer TB (1974) Power sources for implanted telemetry system. Biotelem., 1, 31-40.

Fryer TB (1974) A multichannel EEG telemetry system utilizing a PCM subcarrier. Biotele. 1: 202-218.

Fryer TB & Sandler H (1974) A review of implant telemetry system. Biotele. 1: 351-374.

Fryer TB et al. (1978) Telemetry of intracranial pressure, Biotelem. 5, 88-112.

Fryer TB (1981) Survey of implantable telemetry. Biotelemetry 8: 125-130.

Galbraith, D.C. et al (1987) A wide-band efficient inductive transdermal power and data link with coupling insensitive gain, IEEE Trans. BME, 34, No.4, 265.

Gschwend, S.J., Knutti, J.W., Allen, H.V. & Meindl, J.D. (1979) A general purpose implantable mutichannel telemetry system. Biotele. 6 (3): 107-117.

Geddes LA (1962) A bibliography of biological telemetry. Am. J. Med. Electronics 1: 294-298.

Geier S (1971) Minor seizures and behavior. EEG clin.N. 31: 499-507.

Geier S (1971) A comparative tele-EEG study of adolescent and adult epeleptics. Epilepsia 12: 215-223.

Geier S, et al (1974) A complete EEG radio-telemetry equipment. EEG clin. N. 37: 89-92.

Geier S, et al (1975) Clinical note: clinical and tele-stereo-EEG findings in apatient with psychomotor seizures. Epilepsia 16: 119-125

Giori FA (1967) Remote physiological monitoring using a microwave inteferometer. Biomed. Sci. Instrum. 3: 291-308.

Gofmann SS (1969) Radioelectroencephalogram recording in humans during work activity under industrial conditions. Biul. eksp. Biol. Med. 68: 13-16

Greatbatch W (1984) Pacemaker power sources. IEEE EMB 3(2): 15.

Greatbatch W (1984) Implantable pacemakers - a twenty five year journey 3(4): 24-26.

Gruenberg EL (1967) Handbook of telemetry and remote control (McGrw-Hill, NY)

Guey J, et al (1969) A study of the rhythm of petit mal absences in children in relation to prevailing situations. The use of EEG telemetry during psychological examinations, school exercisses and periods of inactivity. Epilepsia 10: 441-451.

Hanley J, et al (1969) Combined telephone and radiotelemetry of the EEG.

EEG clin. N. 26: 323-324.

Hanley J, et al (1972) Automatic recognition of EEg correlates of behavior in a chronic schizophrenic patient. Am. J. Psychiat. 128: 1524-1528.

Hiller PK, et al (1974) Proceedings: an automatic wildlife tracking system.

Biomed. Sci. Instrum. 10: 157-159.

Huertas J & Westbrook RC (1970) A system for sensing and transmitting EEG.

EEG clin. N. 28: 102-103.

Hughes JR & Hendrix DE (1968) Telemetered EEG froma football player in action.

EEG clin. N. 24: 183-186.

Hutten H, et al (1971) A new apparatus for the continuous telemetric measurement of intracranial pressure in man. Biomed. Tech., Stuttgart 16: 170-172

Ikeda K, Watanabe A, Saito M (1980) A new biomedical radio telemetry system employing a rotating magnetic field. Biotelemetry 7(1): 24.

Ikeda K, Watanabe A & Saito M (1980) A radio-tracking system for studies of snake movement. Biotelemetry 7(1): 45.

Itoh I, Morizono T, Okada S, Ishimura H, Iijima N, Kanauchi S, Shoji T (1980) Computerized radiotelemetry of gastrointestinal pressure. Biotelemetry 7(1):17.

Ives JR, et al (1973) Acquisition by telemetry and computer analysis of 4-channel long-term EEG recordings from patients subject to 'petit-mal' absence attacks.

EEG clin. N. 34: 665-668.

Jacobson, B. & Mackay, R.S. (1957) A pH endoradiosonde. Lancet 1, 1224. June.

Jeutter, D.C. (1982) A transcutaneous implanted battery recharging and biotelemetry power switching system. IEEE Trans. BME. 29, 314-321.

Jeutter, D.C. (1983) Overview of biomedical telemetry techniques.

IEEE Eng. Med. Biol. 2, 17. Mar.1983.

Jeutter, D.C. (1983) Power sources for biotelemeters, IEEE Eng. Med. Biol. 2, 22-23. Mar.1983.

Jobling, D.T., Smith, J.G. & Wheal, H.V. (1981) Active microelectrode array to record from the mammalian central neural system in vitro. Med. Biol. Eng. Comput. 19, 553-560.

Kado R & Adey WR (1968) Electrode problems in central nervous monitoring in performing subjects. Ann. NY Acad. Sci. 148: 263-278.

Kamp A & Van Leeuwen WS (1961) A two-channel EEG radio elemetering system.

EEG Clin. N. 13: 803-806.

Kimmich HP & Kreuzer F (1974) Trends in biomedical telemetry and patient monitoring . Eurocon 74: 2/7: 1-2.

Knutti JW et al (1979) Chronically implantable instrumentation for medical research animals. IEEE Trans. BME 26: 539.

Knutti, J.W., Allen, H.V. & Meindl, J.D. (1983) Integrated circuit implantable telemetry systems, IEEE Eng. Med. Biol. Mag. 2, 47-50.. Mar.1983.

Ko WH & Neuman MR (1967) Implant biotelemetry and microelectronics: report on developments in implant telemetry, associated problems, and the potential of microelectronics. Science 156: 351-360.

Ko, W.H. & Hyncek, J. (1974) Implant evaluations of nuclear power source - Beta-cell battery. IEEE Trans. BME 21, 238-241.

Ko, W.H. & Spear, T.M. (1983) Packaging materials and techniques for implantable instruments.IEEE Eng. Med. Biol. 2, 24. Mar.1983.

Kofes A (1969) The possibilities of telemetry of physiological data.

EEG clin. N. 27: 628-629.

Kupfer, D.J., Detre, T.P., Fonster, G., Tucker, G.J., & Delgado, J.M.R. (1972) The application of Delgado's telemetric mobility recorder for human stidues.

Behav. Biol. 7, 585-590.

Van Leeuwen WS & Kamp A (1969) Radiotelemetry of EEG and other biological variables in man and dog. Proc. R. Soc. Med. 62: 451-453.

Van Leeuwen WS, et al (1967) EEG of unrestrained animals under stressful conditions. EEG clin. N. suppl. 25: 212ff.?

Legewie H, et al (1969) EEG changes duringperformance of varioius tasks under open- and closed-eye conditions. EEG clin. N. 27: 470-479.

Leung, A.M. et al (1986) Intracranial pressure telemetry system using semicustom integrated circuits, IEEE Trans. BME, 33, No.4, 386-395.

Long, F.M. & Weeks, R.W. (1983) Wildlife biotelemetry. IEEE EMB March 42.

Mackay, R.S. & Jacobson, B. (1957) Endoradiosonde. Nature 179, 1239-1240. June.

Mackay, R.S. (1961) Radio telemetry from within the body.Science 134, 1196.

Mackay, R.S. (1963) Radio telemetry from inside the body. New Sci. 19, 650.

Mackay, R.S. (1964) Galapagos tortoise and marine iguana deep body temperatures measured by radio telemetry. Nature 204, 355-358.

Mackay, R.S. (1964) Deep body temperature of untethered dolphin recorded by ingested radio transmitter. Science 144, 864-866.

Mackay, R.S. (1964) Dolphin telemetry. Science 145, 296.

Mackay, R.S. (1968) Bio-Medical Telemetry, Wiley, New York, 388pp.

MacKay RS (1969) Biomedical telemetry: applications to psychology.

Am. Psychol. 24: 244-248.

Mackay, R.S. (1970) Bio-Medical Telemetry (2nd ed.) John Wylie & Sons., New York.

Mackay, R.S. (1974) Field studies on animals. Biotelemetry 1, 286-312.

Mackay, R.S. & Dolphin, W. (1982) Monitoring feeding of great whales by ingested acoustic temperature trasmitter. Proc. of 7th Int'l. Symp. on Biotelemetry, Stanford University.

Mackay, R.S. (1983) Biomedical telemetry: The formative years.IEEE Eng. MB. 2, 11-17. Mar.1983.

Manson G (1974) EEG radio telemetry. EEG clin. N. 37: 411-413.

Mark VH, Ervin FR, Sweet WH & Delgado J (1969) Remote telemeter stimulation and recording from implanted temporal lobe electrodes. Confinia neurol. 31: 86-93.

Marko, A., Murray, R.H., Kissen, A.T., & McGuire, D.M. (1967) A new versatile miniature multi-channel personal telemetry system for medical research,

Aerospace Med. Res. Labs., Rept. AMRL-TR, pp.152-156.

Marko, A., McLennan, M.A., & Correll, E.C. (1963) Research and development on pulse-modulated personal telemetry systems,

Aerospace Med. Res. Labs., AMRL-TDR-64-96, PP.1-19.

Matumoto Goro (1974) Fundamental design procedures of an inductance coil utilizing thin-film IC technique for biotelemetry. Biotelem. 1, 41.

Matumoto G, Tsuchida Y, Yoshikawa T (1980) Measurement of the cat's EEG and ECG with a telemetry system in high DC electric fields. I: Tow-channel modified PDM/FM telemetry system to obtain from small animals. Biotelemetry 7(1): 34.

McAleenan, R.N. (1976) Computer-aided biotelemetry system applied to free-swimming fish. Biomed. Sci. Instrum. 12, 29-32.

McKean, B. & Gough, D. (1988) A telemetry-instrumentation system for chronically implanted glucose and oxygen sensors, IEEE Trans. BME, 35, No.7, 526.

McNew JJ, et al (1971) The sleep cycle and subcortical-cortical EEG relations to the unrestrained chimpanzee. EEG clin. N. 30: 489-503.

Meindl, J.D. (1980) Biomedical implantable microelectronics, Science, 210, 263-267.

Meindl, J.D. (1984) Implantable telemetry in biomedical Research,

IEEE Trans. BME, 31, No.12, 817.

Michener MC & Walcott C (1967) Homing of pigeons - analysis of tracks.

J. exp. Biol. 47: 99-131.

"mind reading machine by DARPA", National Enquirer, 22 June, 1976. üó

Neukomm PA (1974) A radio-controlled monitoring system for multichannel telemetry. Biotelemetry 1: 251-263.

Nomura T (1984) Telemeter and tele-control. Trans. IEICE (in Japanes) p.208.

Ohata S, Tanji J, Kato M & Matumoto G (1980) Measurement of the cat's EEG and ECG with a telemetry system in high DC electric fields. II. Applications. Biotelemetry 7(1):

Olsem ER, et al (1967) Intracranial pressure measurement with a miniature passive implanted pressure transensor. Am. J. Surg. 113: 727-729.

Pauley JD, et al (1974) An implantable multichannel biotelemetry system.

EEG clin. N. 37: 153-160.

Pauley JD & Reite M (1981) A microminiature hybrid multichannel implantable biotelemetry system. Biotele. 8: 163-172.

Polg P & Wolfgand H (1974) Telemetry of the EEG and EMG in the cat under the influence of psychotropic drugs. Biotelemetry 1: 264-172.

Porter RJ et al (1971) Human electroencephalographic telemetry.

Am. J. EEG Technol. 11: 145-159.

Raloff, Janet (1991) Science News , Nov. 30, 1991. (the rice the implant)

Reid, M.H., Mackay, R.S. & Lantz, B. (1980) Noninvasive blood flow measurements by Doppler ultrasound with applications to renal artery flow determination.

Investigative Radiology 15, 323-331.

Reite M & Walker SD & Pauley JD (1973) Implantation surery in infant monkeys.

Lab. Primate Newl. 41: 1-6.

Reite M, et al (1974) A system approach to studying physiology and behaviors in infant monkeys. J. Appl. Physiol. 37: 417-423.

Rideout CB (1974) Proceedings: radio tracking the Rocky Mountain goat in Western Montana. Biomed. Sci. Instrum. 10: 139-143.

Robinson BW & Warner H (1967) Telestimulation of the primate brain.

Archs phys. Med. Rehabil. 48: 467-473. ü£îç

Robinson BW (1969) Brain telestimulation in primates. Am Psychol. 24: 248-250.

Rokushima, H. (1969) A multi-channel PWM/FM radio-telemetry system for EEG, Proc. 22nd Ann. Conf. on Engineering in Medicine and Biology (Chicago, Ill.)

Roy OZ (1971) Biological energy sources. A review. Biomed. Eng. 6:250-256.

Salcman, M. & Bak, M.J. (1973) Design, Fabrication, and in vivo behavior of chronic recording intracortical microelectrodes, IEEE Trans. BME 20, 253-260.

Seo H & Matsuo T (1989) Manufacture of custom CMOS LSI for an implantable multipurpose biotelemetry system. Frontiers Med. Biolog. Eng. 1(4): 319-329.

Shafer WA (1967) Telemetry on man without attached sensors.

NY St. J. Med. 67: 2832-2837.

Shirer HW & Downhower JF (1968) Radio tracking of dispersing yellow bellied mrmots. Trans. Kans. Aca. Sci. 71: 463-479. ü£îç

Simonova O, et al (1969) Correlation between EEG criteria and attentive behaviour.

EEG clin. N. 26: 447.

Simonova O & Legewie H (1969) EEG changes under different conditions.

EEG clin.N. 27: 627.

Simons DG & Prather W (1964) A personalised radio telemetry system for monitoring central nervous system arousal in aerospace flight. IEEE Trans. Biomed. Engin. 11: 40.

Skutt, H.R., Fell, R.B., & Kertzer, R. (1970) A multichannel telemetry system for use in exercise physiology, IEEE Trans.Bio-Medical Eng., 17, 339-348.

Slater, L. (ed.) (1963) Biotelemetry, New York,Pergamon Press.

Smith EN (1974) Multichannel temperature and heart rate radio telemetry transmitter.

J. appl . Physiol. 36: 252-255.

Sperry CJ (1968) Implantable stimulator and transmitter for telemetry of evoked potentials during defensive behavior. Biomed. Sci. Instru. 4: 119-124.

Stalberg E (1969) Telemetric long-term EEG recording. EEG clin. N. 26: 341.

Stevens JR (1969) Localization of epileptic focus by protracted monitoring of EEG by radio telemetry. Epilepsia 10: 420.

Stevens JR, et al (1969) Prolonged recording of EEG by radiotelemetry: an aid to localization and treatment of epilepsy. EEG clin. N. 27: 544.

Stevens JR, et al (1969) Statistical characteristics of spontaneous seizure discharges recorded by radiotelemetry over 24 hour perioods in man. EEG clin. N. 27: 691.

Stevens JR, et al (1971) Ultradian characteristics of sponataneous seizure discharges recorded by radio telemetry in man. EEG clin. N. 31: 313-325.

Stevens JR, et al (1972) Seizure occurrence and interspike interval. Telemetered eeg studies. Archs. Neurol. (Chicago) 26: 409-419

Stong, C.L. (1968) Amateur scientist. Scien. Am. 218, 128-135.

Sudo M et al. (1987) Low suuply-voltage driving telemetering IC for biological signals. Trans. IEICE (in Jap) J70-D(12): 2754.

Takahashi K & Matsuo T (1984) Integration of multi-microelectrode and interface circuits by silicon planar and three-dimentsional fabrication technology.

Sensors and Actuators 5, 89-99.

Takeuchi Y & Hogaki M (1980) Radiotelemetry of fetal and maternal signals for live fetal monitering. Biotelemetry 7(1): 42.

Towe, C.B. (1986) Passive biotelemetry by frequency keying. IEEE Trans. BME, 33, No.10, 905.

Trotter, Robert J. (1974) A Schocking Story, Science News , April 13, 1974. ü£îç

Updike SJ, et al (1972) Patient monitoring by radiotelemetry.

J. Ass. adv. med. Instrum. 6: 240-244.

Upson RB, et al (1968) An improved remote brain stimulator and EEG transmitter for small animals. Biemed. Sci. Instrum. 4: 164-170.

van Veelen et al (1990) Combined use of subdural and intracerebral electrodes in preoperative evaluation of epilepsy. Neurosurg. 26(1): 93-101.

Vidart L & Geieer S (1968) Telemetric recording sin epileptic subjects while at work. EEG clin. N. 25: 93.

Vidart L & Geier S (1969) Radiotelemetric EEG study of adult epileptics.

Vidart L & Geier S (1970) From epilepsy to the epileptic: a tele-EEG study of adult epileptic subjects. EEG clin. N. 29: 103.

Vreeland R, Collins C, et al (1963) A subminiature radio EEG telemeter for studies of disturbed children. EEG Clin. Neurophysiol. 15: 327-329.

Vreeland RW, et al (1971) A compact sic-channel integrated circuit EEG telemeter.

EEG clin. N. 30: 240-245.

Walker AE & Marshall C (1964) The contribution of depth recording to clinical medicine. EEG Clin. N. 16: 88-99.

Watson NW, et al (1968) Backpack for free-ranging primates. J. appl. Physiol. 24: 252-253.

Yoshii N, et al (1966) Studies on the nerral basis of behavior by continuous frequency analysis of EEG. Prog. Brain Res. 21: 217-250.

Ysenbrandt et al (1976) Biotelemetry, literature survey of the past decade. Biotele. 3: 145-250.

Zweizig JR, et al (1972) EEG monitoring of a free-swimming diver at a working depth of 15 meter. Aerospace Med. 43: 403-407.

Zworykin VK et al (1961) The measurement of internal physiological phenomena using passive-type telemetering capsules. IRE int. Conv. Rec. 9: 141-144

Alexander E & Alexander L (1985) Electronic monitoring of felons: threat or boon to civil liberties. Social Theory and Practive 11: 89-95.

Ball RA & Lilly JR (1986) A theoretical examination of home incarceration.

Fed. Probation March: 17-24.

Beck B (1969) Commentary : Issues in the use of an electronic rehabilitation system with chronic recidivists. Law & Soc R 3: 611-14.

Berry B (1985) Electronic jails: a new criminal justice concern. Justice Quartely 2: 1-22.

Byrne et al (1988) Understanding the limits of technology: an examination of the use of electronic monitoring in the criminal justice system. Perspectives Spring: 30-37.

Badigan TP (1991) Electronic monitoring in federal pretrial release. Fed. Prob. 55(1): 26-30.

Carmen RV (1986) Legal issues in probation. Fed. Prob. 50(2): 60-69.

Casady J (1975) The electronic watchdog we shouldn't use. Psychol Tod January: 84.

Charles MT (1989) The development of a juvenile electronic monitoring program. Fed. Prob.53(2): 3-12.

Conrad JP (1983) News of the future: Research and development. Federal Prob. 47: 54-55.

Electronic monitoring devices (1986) Corrections Today 48: 72.

Ford D & Schmidt AK (1985) Electronically monitored home cconfinement.

NIJ Reports, SNI 194, Nov. 1985, 2-6.

Fried C (1968) Privacy. Yale Law Journal 77: 475. [re. Schwitzgebel machine]

Friel CM & Vaughn JB (1986) A consumer's guide to the electronic monitoring of probationers. Fed. Prob. 50(3): 3-14.

Gablle RK (1986) Application of personal telemonitoring to current problems in corrections. J. Criminal Justice 14: 167-176.

Ingraham BL & Smith GW (1972) The use of electronics in the observation and control of human behavior and its possible use in rehabilitation and control.

Crime and Justice 1971-1972, p.363-377.

King DB (1964) Electronic surveillance and constitutional rights: some current developments and observations. George Washington Law Review 33: 240.

Krajick K (1983) Electronic surveillance makes a comback. Police Maganine March.

Krech D (1966) Controlling the mind-controllers. Think 32(July-August): 2.

Los Angeles Free Press (1972) Wiretapping your body. July: 7-13.

Man, Daniel (1987) Beepers in kids' heads could stop abductors,

Las Vegan Sun, October 27, 1987. üó

Marx GT (1985) The new surveillance. Technology Review May-June 45: 43-48.?

Marx GT (1985) I'll be watching you. Dissent Winter: 26-34.

McCarthy BR ed. (1987) Intermediate Punishments: Intensive Supervision, Home Confinement and Electronic Surveillance. Monsey, NY: Willow Tree Press.

Meyer, J.A. Crime Deterrent Transponder System, IEEE Trans. AES ,7, No.1.

Miller AS (1964) Technology, social change and the constitution.

George WAshington Law Review 33: 17.

New York Times (1969) Psychologist tests electronic monitoring to control parolees. September 7, 1969, p.85.

New York Times (1969) Tiny radio monitors prisoner behavior, November 15, p.53.

Notes (1966) Anthropotelemetry: Dr.Schwitzgebel's Machine.

Harvard Law Review 80: 403-421.

Papy JE & Nimer R (1991) Electronic Monitoring in Florida. Fed. Prob. 55(1): 31-33.

Peck K (1988) High-tech house arrest. The Progressive July: 26-28.

Petersilia J (1986) Exploring the option of house arrest. Fed. Prob. 50(2): 50-55.

Renzema M & Skelton DT (1990) The use of electronic monitoring in the United States: 1989 update. NIJ Reports, Nov/Dec. 9-14.

Reubhausen OM & Brim OG (1965) Privacy and behavior research.

Columbia Law Review 65: 1184.

Rogers CR & BF Skinner (1956) Some issues concerning the control of human behavior. Science 124: 1057.

Rorvik D (1974) Behavior control: Big brother comes. Intellectual Digest January: 17-20.

Sanders CW (1994?) The Seven Signs of the Last Days.

Schmidt AK (1986) Electronic monitors. Fed. Prob. 50(2): 56-59.

Schmidt AK (1987) Electronic monitoring : who uses it, how much does it cost, does it work ? Corrections Today 49: 28+.

Schmidt AK (1991) Electronic monitors - realistically, what can be expected ?

Fed. Prob. 55(2): 47-53.

Schwitzgebel RK (1964) A program for research in behavior electronics.

Behav. Sci. 9: 233-238.

Schwitzgebell RK (1967) Electronic innovation in the behavioral sciences: a call to responsibility. Am. Psychologist 22(5): 364.

Schwitzgebel RK (1968) Electronic alternatives to imprisonment. Lex et Scientia 5(3): 99-104.

Schwitzgebel RL (1969) A Belt from Big Brother. Psychology Today 2(11): 45-47, 65.

Schwitzgebel RK (1969) Development of an electronic rehabilitation system for parolees. Law and Computer Technology 2(3): 9-12.

Schwitzgebel RK (1969) Issues in the use of an electronic rehabilitation system with chronic recidivists. Law & Soc R 3: 597-611.

Schwitzgebel RK & Hurd WS (1969) Behavioral supervision system with wrist carried transceriver. Pat. No. 3,478,344. Official Gazette 1969.12 (?)

Schwitzgebel RL and Bird RM (1970) Sociotechnical design factors in remote instrumentation with humans in natural environments. Behaviour Research Methods and Instrumentation 2.

Schwitzgebel, Robert L. & Schwitzgebel, Ralph K., eds. (1973) Psychotechnology. NY, Rinehart , and N.Y. John Wiley & Sons [Monahan, J. (1984) A.J.P.141(1), 10]

Walker JL (1990) Sharing the credit, sharing the blames: managing political risks in electronically monitored house arrest. Fed. Prob. 54(2): 16-20.

Winkler, Max (1993) Walking prisons: the developing technology of electronic controls. Futurist July/August : 34-49.

Navigation satellite

Burgess L & Munro N (1993) Security concerns may hinder GPS expansion.

Defense News Apr 26 - May 2: 4.

Collins Avionics Develops New Hand-Held GPS Unit. (1992)

Defense News Sep 21-27: 18.

Maggs W (1991) Pentagon fears global march of GPS technology.

Defense Week Aug 26: 2.

Navstar system. IDRü@ 7/1981:937, 7/1983:989 [Rockwell contract]

Sundaram GS (1979) NAVSTAR/GPS: a unique US high-precision worldwide navigation system. IDR 7/1979: 1142-1146.

ele -> scalp -> cortex (transcutaneous stimulation)

Amassian VE & Cracco RQ (1987) Human cerebral cortical responses to contralateral transcranial stimulation. Neurosurgery. 20: 148-155.

Amassian VE, Cadwell J, Cracco RQ & Maccabee PJ (1987) Focal cerebral and peripheral nerve stimulation in man withe the magnetic coil. J. Physiol. 390:29P.

Amassian VE, Quirk GJ & Stewart M (1987) Magnetic coil versus electrical stimulation of monkey motor cortex. J. Physiol. 394:119P.

Amassian VE et al (1987) Physiological basis of motor effects of a transient stimulus to cerebral cortex. Neurosurgery 20:74-93.

Amassian VE et al (1988) Suppression of human visual perception with the magnetic coil over occipital cortex. J. Physiol. 398:408P.

Amassian VE et al (1988) Focal magnetic coil activation of human motor cortex elicits a sense of movement in ischemically paralyzed, distal arm. J. Physiol. 403:75P.

Amassian VE et al (1989) Focal stimulation of human cerebral cortex with the magnetic coil: a comparison with electrical stimulation, EEG Clin. N. 74, 401-416.

Amassian VE et al. (1991) Paraesthesias are elicited by simple pulse, magnetic coil stimulation of motor cortex in susceptible humans. Brain 114: 2505-2520.

Ananev MG et al (1960) Anesthesiology 24: 215. [ele --> anesthesia]

Barker AT, Freeston IL, Jalinous R, Merton PA & Morton HB (1985) Magnetic stimulation of the human brain. J. Physiol. 369:3P.

Barker AT et al (1985) Non-invasive magnetic stimulation of the human motor cortex. Lancet i: 1106-1107.

Barker AT et al (1986) Clinical evaluation of conduction time measurements in central motor pathways using magnetic stimulation of the humna brain. Lancet i: 1325-1326.

Barker AT et al (1987) Magnetic stimulation of the human brain and peripheral nervous system: an introduction and the results of an initial clinical evaluation. Neurosurgery 20: 100-109.

Cowan JMA et al (1984) Abnormalities in central motor pathway conduction in multiple sclerosis. LaNcet ii: 304-307.

Cowan JMA et al (1986) The effect of percutaneous motor cortex stimulation on H reflexes in muscles of the arm and leg in intact man. J. Physiol. 377: 333-347.

Cracco RQ et al (1989) Comparison of human transcallosal responses evoked by magnetic coil and electrical stimulation. EEG clin. N. 74:417-424.

Day BL et al (1986) Differences between electrical and magnetic stimulation of the human brain. J. Physiol. 378: 36P.

Day BL et al (1987) A comparison of the effects of cathodal and anodal stimulation of the human motor cortex thru the intact scalp. J. Physiol. 394: 118P.

Day BL et al (1987) Motor cortex stimulation in intact man. 2. Multiple descending volleys. Brain 110: 1191-1209.

Day BL et al (1988) Diffenrential effect of cutaneous stimuli on responses to electrical or magnetic stimulation of the human brain. J. Physiol. 399: 68

Fabian LW et al (1964) Anesth. Analg. Curr. Res. 43: 87. [ele --> anesthesia]

Flach A (1958) Anesthetist 7: 180. [ele --> anesthesia]

Geddes LA (1965) Med. Elec. Biol. Eng. 3: 11. [ele --> anesthesia]

Gedees LA (1987) Optimal stimulus duration for extracranial cortical stimulation. Neurosurgery 20: 97-99.

Hassan NF et al (1985) Unexposed motor cortex sxcitation by low voltage stimuli. In: Morocutti C & Rizzo PA Eds. Evoked Potentials: Neruphysiological and Clinical Aspects. Elsevier, Amsterdam. 107-113.

Hess CW et al (1987) Responses in small hand muscles from magnetic stimulation of the human brain. J. Physiol. 388: 397-419.

Hill DK, McDonnell MJ & Merton PA (1980) Direct stimulation of teh adductor pollicis in man. J. Physiol. 300: 2P-3P. [ele - skin ->

Maccabee PJ, Amassian VE, Cracco RQ & Cadwell JA (1988) An anaysis of peripheral motor nerve stimulation in humans using the magnetic coil. EEG clin.N. 70: 524-533.

Marsden CD, Merton PA & Morton HB (1983) Direct electrical stimulation of corticospinal pathways through the intact scalp in human subjects. Adv. Neruol. 39: 387-391.

Merton PA & Morton HB (1980) Stimulation of the cerebral cortex in the intact human subject. Nature 285: 227.

Merton PA & Morton HB (1980) Electrical stimulation of human motor and visual cortex through the scalp. J. Physiol. 305: 9P-10P.

Mills et al (1987) Magnetic and electrical transcranial brain stimulation: physiological mechanisms and clinical applications. Neurosurgery 20: 164-168.

Rosenthal J et al (1967) An anlysis of the activation of motor cortical neurons by surface stimulation. J. Neurophysiol. 30: 844-858.

Rossini PM et al (1987) Mechanisms of nervous propagation along central motor pathways: non-invasive evaluation in healthy subjects and in patients with neurological disease. Neurosurgery 20: 183-191.

Rothwell JC et al (1987) Some experiences of techniques for stimulation of the human cerebral motor cortex through the scalp. Neurosurgery 20: 156-163.

Rothwell JC et al (1987) Motor cortex stimulation in intact man. 1. General characteristics of EMG responses in different muscles. Brain. 110: 1173-1190.

Stephen V (1959) Med. J. Australia 1: 831. [ele --> anesthesia]

**head -- magnetic field (MEG)**

Brenner D, Williamson SJ & Kaufman L (1975) Visually evoked magnetic fields of the human brain. Science 190: 480. [SQUID <-- mf]

Brenner D, Williamson SJ & Kaufman L (1978) Somaticaly evoked magnetic fields of the brain. Science 199: 81-83.

Cohen D (1968) Science 161: 784. [head --> mf]

Cohen D (1972) Science 175: 664. [head --> mf]

Cohen D (1975) IEEE Trans. Magn. 11: 694. [head --> mf]

Cohen D et al (1980) Proc. Nat. Acad. Sci. 77: 1447. [human hair--> mf]

Farrell, E.E., Tripp, J.H., Norgren, R., Teyler, T.J. (1980) A study of the auditory evoked magnetic field of the human brain, EEG clin. Neurol. 49, 31-37.ü£öjæ¦û{

Goff GD, Matsumiya Y, Allison T & Goff WR (1977) The scalp topography of human somatosensory and auditory evoked potentials. EEG clin. N. 42: 57-76.

Gutman AU & Morgenshtern AM (1977) Possible mechanism of generation of MEG. Biofizika 22(3)< May/June 1977.

Hughes JR et al (1977) Relationship of the MEG to abnormal activity in the EEG. J. Neurol. 217(2), Dec. 13.

Hughes JR et al () Relationship of MEG to the EEG: Normal wake and sleep activity. Clinical Neurophysiology 40(3)

Reite M & Zimmerman JE (1978) The magnetic phenomena of the central nervous sytem. Ann. Rev. Biophys. Bioeng. 7: 167-188.

Reite M, Zimmerman JE, Edrich J & Zimmerman JT (1976) The human magnetoencephalogram: some EEG and related correlations. EEG clin. N. 40: 59-66.

Reite M, Edrich J, Zimmerman JT & Zimmerman JE (1978) Human magnetic auditory evoked fields. EEG clin.N. 45, 114-117.

Silver AH & Zimmerman JE (1967) Phys. Rev. 157: 317. [SQUID]

Teyler TJ, Cuffin BN & Cohen D (1975) The visual evoked magnetoencephalogram. Life Sci. 17: 683-692.

Taz CA & Thakor NV (1986) Monitoring brain electricaland magnetic activity. IEEE Eng. M.B. 5(3): 11-15.

Zimmerman JE et al (1970) J. Appl. Phys. 41: 1572. [SQUID]

Zimmerman JE (1977) SQUID instruments and shielding for low levelmagnetic measurements. J. Appl. Phys. 48: 702-710.

**mind-reading machine**

Caylor, Ron (1976) Government working on machine that can read your mind. The National Enquirer Juen 22, 1976 [Burdick(1981)]

Glenn JC (1989) Conscious Technology: the co-evolution of mind and machine. Futurist Sep/Oct 1989.

Mind-reading computer. Futurist May/June 1992, p.49.

magnetic --- bioeffects

Alerstam, T. (1983) Role of the geomagnetic field in the development of bird's compass sense, Nature 306, 413.?

Baker, R. (1980) Goal orientation in blindfolded humans after long distance displacemnt: possible involvement of a magnetic sense, Science 210, 555.

Baker, R. (1983) Magnetic bones in human sinuses, Nature 301, 78.

Baker R (RüEâìârâôüEâxü[âJü[) üwÉlè+é¦ò_înè¦èoé¦æµÿZè¦-ÄÑïCé_è¦é¦é_ö]üx

Becker, R.O. (1963) The biological effects of magnetic fields - a survey. Med. Electron. Biol. Eng. 1, 293.

Becker, R.O., Bachman, CC.H., & Friedman, H. (1962) N.Y. State J. Med. 62, 1169.

Becker, R.O. (1963) Relationship of geomagnetic environment to human biology. N.Y. State J. Med. 63, 2215.

Bell, G.B. et al (1992) Alterations in brain electrical activity caused by magnetic fields: detecting the detection process. EEG Clin. N. 83(6), 389-397.

Blakemore, R. (1975) Magnetotactic bacteria, Science 190, 377.

Gaffey, C.T. & Tenforde, T.S. (1981) Alterations in the rat electrocardiograph induced by stationary magnetic fields. BEM 2, 357-370.

Gould, J.L., et al (1978) Bees have magnetic remanence, Science 202, 1026.?

Gould, J.L. (1993) Magnetic senses: birds lost in the red. Nature 364(6437) 491.

Hays, J.D. & Opdyla, N.D. (1967) Antarctic radiolaria, magnetic reversals and climatic change, Science 158, 1001.

Jafary-Asl et al (1983) J. Biological Physics 11: 15. [nuclear magnetic resonance --> yeast growth]

Keeton, W. (1971) Magnets interfere with pigeon homing, Proc. Nat. Acad. Sci. US 68, 102.

Semm, P. (1980) Effect of Earth strength magnetic field on electrical activity of pineal cells, Nature 288, 607.

Semm, P. (1983) Neurobiological investigations on the magnetic sensitivity of the pineal gland in rodents and pigeons. J. Comp Physiol B Biochem Sys Environ Physiol 76, 683-689.

Semm, P. et al (1984) Neural basis of the magnetic compass: interactions of visual, magnetic, and vestibular inputs in the pigwons' brain . J Comp Physiol A sens Neural Behav Physiol 155, 183-288.

**MAGNETIC STIMULATION OF THE BRAIN ( MSB)**

Barker AT et al. (1985) Non-invasive magnetic stimulation of human motor cortex. Lancet i: 1106-1107.

Benzel EC et al (1993) Magnetic Source Imaging: a review of the Magnes system of biomagnetic Technologies Incorporated. Neurosurgery 33(2): 252-259.

Biomagnetic Technologies: Magnetic Source Imaging (MSI) Magnes biomagnetometer.

Neurosurgery 33(1): 166-168. [$2,500,000]

Cohen LG et al. (1990) Effects of coil design on delivery of focal magnetic stimulation: Technical considerations. EEG clin. N. 75: 350-357.

Day BL, Kick JPR, Marsden CD & Thompson PD (1986) Differences between electrical and magnetic stimulation of the human brain. J. Physiology 378: 36P.

Day BL et al. (1987) Different sites of action of electrical and magnetic stimulation of the huma brain. Neuroscience Letters 75: 101-106.

Hess CW, Mills KR & Murray NMF (1986) Magnetic stimulation of the human brain: The effects of voluntary muscle activity. J. Physiology. 378: 37P.

Hess CW, Mills KR & Murray NMF (1987) Responses in small hand muscles from magnetic stimulation of the human brain. J. Physiology 388: 397-419.

Kamada K et L (1993) Functional Neurosurgical stimulation with brain surface magnetic resonance Images and magnetoencephalography. Neurosurgery 33(2): 269-273.

Maccabbee PJ, Amassian VE, Cracco RQ et al (1988) Focal magnetic coil sstimulation of human frontal cortex elicits speech related motor activity

Soc. Neuroscience Abstracts. 14: 159.

Pascual-Leone A et al. (1994) Responses to rapid-rate transcranial magnetic stimulation of the human motor cortex. Brain 17(4): 847-858

Seki Y et al (1990) Transcranial magnetic stimulation of the facial nerve: recording technique and estimation of the stimulated site. Neurosurg. 26(2): 286-290.

Tokimura H et al (1993) Transcranial magnetic stimulation excites the root exit zone of the facial nerve. Nerosurgery 32(3): 414-416.

**Moscow signal**

Anderson, Jack (1972) Washington Merry-Go-Round: "Brainwash" attempt by Russians ? Washington Post 1972.5.10

Anderson, J. (1975) Soviets aim rays at U.S. The Paterson News. 1975.5.16.

Berkley C (1976) A new occupational disease? - of diplomats. Editorial. Med. Res. Eng. 12(3) , 3-7.

Gwertzman, B. (1976) Moscow rays linked to U.S. bugging. NYT 1976.2.26. P.1,4

Gwertzman, B. (1976) US radio spying in Sovit suffers: microwaves end usefulness of embassy's listening post in Moscow. NYT 1976.5.2. P.9

Gwertzman, B. (1976) Soviet dims beam at U.S. Embassy, NYT 1976.7.8. P.1,10

Pursglove, S.D. (1966) The eavesdroppers: 'Fallout' from R&D, Electronic Design 14(15):34-49.

Shipler, D.K. (1976) U.S.radiation report worried foreign diplomats in Moscow, NYT 1976.2.11

The microwave furor, Time 1976.3.22,2.23.

Toth, R.C. (1976) Soviet radiation at U.S.Embassy, NYT 1976.2.7 ?

Wren, C.S. (1976) Bugging in Moscow causes Health scare, NYT 1976.2.9 P.4

Microwave & ELF

Adey, W.R., Bell, F.R. & Dennis, B.J. (1962) Effects of LSD, psilocybin and psilocin on tempral lobe EEG patterns and learned behaivor in the cat. Neurology 12, 591-602.

Adey, W.R., Kado, R.T.., & Didio, J. (1962) Impedance measurements in brain tissue of animals using microvolt signals. Exp. Neurol. 5, 47-66.

Adey, W.R., Kado, R.T., Didio, J., & Schindler, W.J. (1963) Impedance changes in cerebral tissue accompanying a learned discriminative performance in the cat. Exp. Neurol. 7, 259-281.

Adey, W.R. & Walter, D.O. (1963) Application of phase detection and averaging techniques in computer analysis of EEG records in the cat. Exp. Neurol. 7, 186-209.

Adey, W.R., Dado, R.T., McIlwain, J.T. & Walter, D.O. (1966) The role of neuronal elements in regional cerebral impedance changes in alerting, orienting and discriminative responses. Exp. Neurol. 15, 490-510.

Adey, W.R., Elul, R., Walter, R.D., & Crandall, P.H. (1966) The cooperative behavior of neuronal population sduring sleep and mental tasks, Proc. Am. Electroenceph. Soc. 86.

Adey, W.R. (1972) Organization of brain tissue: is the brain anoisy processor ?

Int. J. Neuosci. 3, 271-284.

Adey, W.R. (1980) Frequency and power windowing in tissue interactions with weak electromagnetic fields. Proc IEEE 68, 119.

Adey, W.R. (1981) Tissue interactions with non-ionizing electromagnetic fields. Physiol.Rev. 61: 435-514.

Albert, E.N. & De Santis, M. (1975) Do microwaves alter nervous system structure? Ann. NY Acad. Sci 247, 87-108.

Baldwin, M.S., Bach, S.A., & Lewis, S.A. (1960) Effects of radio frequency energy on primate cerebral activity, Neurol. 10, 178-187.

Baranski, S., & Edelwejn, Z. (1968) Studies on the combined effect of microwaves and some drugs on bioelectric activity of the rabbit CNS, Acta Physiol. Pol. 19, 37-50

Baranski, S. & Czerski, P. (1976) Biological Effects of Microwaves. Stroudsburg, PA: Dowden, Hutchinson, and Ross, Inc.

Bassett, C.A.L., Pawluk,R.J. & Becker, R.O. (1964) Effects of electric currents on bone in vivo. Nature 204, 652.

Bassett, C.A.L., et al (1974) Augmentation of bone repair by inductively coupled em fields, Science 184, 575-577.

Bassett, C.A.L. et al (1974) Acceleration of fracture repair by em fields. a surgically non-invasive method. Ann. N.Y. Acad. Sci. 238, 242-249.

Bawin, S.M., Kaczmarek, L.K., & Adey, W.R. (1975) Effects of modulated VHF fields on the central nervous system, Ann. NY ad.Sci. 247. 74-81.

Becker RO, Bachman CH & Slaughter WC (1962) The longitudinal direct current gradients of spinal nerves. Nature 196: 67

Becker RO & Brown RM (1965) Photoelectric effects in human bone. Nature 206: 1325.

Becker, R.O. (1965) The neural semiconduction control system and its interaction with applied electrical current and magnetic fields, presented at the ZIth Int. Cong.Radiology, Sept.1965.

Becker, R.O. (1974) The basic biological data transmission and control system influenced by electrical forces. Ann. N.Y.Acad. Sci. 238, 236-241.

Becker, R.O. (1985) The Body Electric, (NY, William Morrow)

Becker, R.O. (1985) A theory of the interaction between DC and ELF em fields and living organisms. J. Bioelectricity 4, 133-142.

Becker, R.O. (1990) Cross Currens

üó "Biological effects of electric and magnetic fields associated with proposed project seafarer," Rep. of the Committee on Biosphere Effects of Extremely Low-Frequency Radiation, Division of Medical Sciences, Assembly of Life Sciences, National Research Council, National Academy of Sciences, 1977.

üÖ Boffey, P.M. (1976) Project Seafarer: critics attack National Academy's review gourp. Science 192, 1213-1215. [Project Sanguine]

üó Boffey, P.M.(?) (1976) Science 193, 653-656. [Project Sanguine] ü£îç

üÖ Borth, D.E. & Cain, C.A. (1977) Theoretical analysis of acoustic signal generation in materials irradiated with microwave energy, IEEE Trans. MTT 25, 944-954.

üñ Brodeur, Paul (1977) The Zapping Of America, (NY, W.W.Norton & Company)

# Brodeur, Paul (1989) Currents of Death. Simon & Schuster, New York.

üÖ Brownell, W.E. et al (1985) Evoked mechanical responses of isolated cochlear outerhair cells. Science 227, 194-196.

# Bruce-Wolfe, V. & Adair, E.R. (1985) Operant control of convective cooling and microwave irradiation by the squirrel monkey, BEM 6, 365-380.

ü£ Burden, S.J., McKay, R.D. (1990) Quantum mechanics of synapses, Cell 63, 7.É+û{Æâ

üÖ Burr HS & Northrup FSC (1935) The electrodynamic theory of life. Quart. Rev. Biol. 10: 322.

üó Campbell HJ (1971) Smithsonian Oct. 1971. [Sensory input normally stimulates the pleasure center of the brain]

üó Cleary, S.F. (1977) Biological effects of microwave and radiofrequency radiation,

CRC Crit. Rev. Environ. Contr. 7, 121-166.

# Cleary, S.F. (1980) Microwave cataractogenesis. Proc IEEE 68, 49.

üó Compilation of Navy Sponsored ELF Biomedical and Ecological Research Reports, Vols. I and II (Feb.1975). Vol.III(Jan. 1977). Bethesda, MD: Naval Medical Research and Development Command,Feb.1975. [available from the National Technical Information Service, Springfield, VA 22161]

üó Cope, F.W. (1971) Negative temperature coefficients in neurons. Physiol.chemist. phys. 3, 403.

üó Cope, F.W. (1974) Superconductivity of nerves. Physiol. chemistry and physics. 6, 405.

üó Cope, F.W. (1975) A review of the applications of solid state physics ceoncepts to biological systems. J.biological physics. 3, 1.

ü£ Cox CF et al. (1993) A test for teratological effects ofpower frequency magnetic fields on chick embryos. IEEE BME 40(7): 605-610. [10 micT-> negative effects]

üÖ D'Andrea, J.A., Gandhi, O.P., & Lords, J.L. (1977) Behavioral and thermal effects of microwave radiation at resonant and nonresonant wave lengths, Radio Sci. 12(6S), 251-256.

üÖ D'Andrea, J.A., et al (1979) Physiological and biological effects of chronic exposure to 2450 MHz micrewaves. J. microwave Power 14, 351-362.

üÖ D'Andrea, J.A. et al (1980) Physiological and biological effects of prolonged exposure to 915 MHz microwaves, J. microwave Power , 15, 123-136.

üÖ D'Andrea, J.A. et al (1986) Behavioral and physiological effects of chronic 2450 MHz microwave irradiation of the rat at 0.5 mW.cm2. BEM 7, 45-56.

üÖ D'Andrea, J.A. et al (1986) Intermittent exposure of rats to 2450 MHz microwaves at 2.5 mW/cm2: behavioral and physiological effects.. BEM 7, 315-328.

üó de Lorge, J. (1973) Operant behavior of rhesus monkeys in the presence of extremely low frequency - low intensity magnetic and electric fields: Experiment 2, NAMRL-1179, Pensacola, FL: Naval Aerospace Medical Research Laboratory, Mar. 1973.

üó de Lorge, J. (1974) A psychobiological study of rhesus monkeys exposed to extremely low requency low intensity magnetic fields, NAMRL-1203, Pensacola, FL: Naval Aerospace Medical Research Lab. May 1974.

# de Lorge, J.O. (1984) Operant behavior and colonic temperature of Macaca mulatta exposed to radio frequency fields at and above reasonant frequencies. BEM 5 , 233-246.

üó DelGiudice, S., Doglia, S., Milani, M. et al (1989) Magnetic flux quantization and Josephson behavior in living systems. Physica Scripta. 40, 786.?

üó Delgado JMR, Monteagudo JL, Garcia-Garcia M, Leal J (1981) Teratogenic effects of weak magnetic fields. IRCS Med Sci 9:42-48.?

# Delgado, J.M.R. et al (1982) Embryological changes induced by weak, extremely low frequency electromagnetic fields. J. Anat. 134, 533-551.

# Delgado, J.M.R. (1985) Biological effects of extremely low frequency em fields.

J. Bioelectricity 4, 75-92.

üÖ Diebolt, J.R. (1978) The influence of electrostatic and magnetic fields on mutation i drosophila melanogaster spermatozoa. Mutation Res. 57, 169-174.

üÖ Dixey, R., Rein, G. (1982) Noradrenaline release potentiated in a clonal nerve cell line by low-intensity pulsed magnetic fields. Nature 296, 253.

üó Dodge, C.H. & Glaser, Z.R. (1977) Trends in nonionizing electromagnetic research and related occupational health aspects, J. Microwave Power 12 (4), 319-334.

üó Dƒll, T. & Dƒll, B. (1957) Deutsch. med. Wshr. [magnetic storms -> suicides]

üÖ Edelwejn, Z. (1968) An attempt to assess the functional state of the cerebral synapses in rabbits exposed to chronic irradiation with microwaves. Acta. Physiol. Pol. 19, 897-906.

üó Edelwejn, Z., Elder, R.L., Klimkova-Deutschova, E., & Tengroth, B. (1974) Occupational exposure and public health aspects of microwave radiation, in Biologic Effects and Health Hazards of Microwave Radiation, P.Czerski et al.Eds, Warsaw, Poland, Polish Medical Publishers.

ü£ Effects of EM Radiation () IEEE EMB 6(1)

# ELF: smaller still but not dead yet. IDR 11/1981: 1416-1417. [submarine comm. sys.]

üÖ Foley, P.B., el al (1986) Pineal indoles: significance And measurement.

Neurosci Biobehav Rev 10, 273-293.

üÖ Fraser, A. & Frey, A.H. (1968) Electromagnetic emission at micron wavelengths from active nerves, Biophys.J., 8,731-734.

# Foster KR & Guy AW (1986) Sci. Am. 255: 32. (see also Sci. Am. 1986.12)

ü¢ Foster KR (1986) Am. Scientist March/April.

üÖ Fox SW (1965) A theory of macromelecular and cellular origins. Nature 205, 325.

ü£ Fox SW (1968) How did life begin ? Science & Technology Feb. 1968.

Frey, A.H. (1963) Human response to VLF electromagnetic energy, Nav.Res.Rev., 1-8.

Frey, A.H. (1963) Some effects on humans of UHF irradiation, Am.J.Med.Electron., 2, 28-31

Frey, A.H. (1965) Behavioral biophysics, Psychol.Bull., 63, 322-337.

Frey, A.H. (1967) Brain stem evoked responses associated with low intensity pulsed UHF energy," J.Appl.Physiol., 23, 984-988.

Frey, A.H., Fraser, A., Siefert, E., & Brish, T. (1968) A coaxial pathway for recording from the cat brain stem during illumination with UHF energy, Physiol.Behav., 3, 363-365.

Frey, A.H. (1971) Biological function as influenced by low-power modulated RF energy, IEEE Trans. MTT 19, 153-164.

Frey, A.H. & Messenger, Jr., R. (1973) Human perception of illumination with pulsed ultra-high frequency electromagnetic energy, Science 181, 356-358.

Frey, A.H. & Feld, S.R. (1975) Avoidance by rats of illumination with low power nonionizing electromagnetic energy, J. Comp. Phys. Psyhcol. 89, 183-188.

Frey, A.H. & Spector, J. (1976) Irritability and aggression in mammals as affected by exposure to em energy, Program and Abstracts for URSI Ann. meeting, Amherst, MA. 93.1976.

Frey, A.H. & Gendleman, S. (1979) Motor coordination of balance degradation during mw energy exposure. Bull. Psychonomic Soc. 14(6), 442-444.

Frey, A.H. & Wesler, L.S. (1980) Tail pressure behaviors modification associated with microwave energy exposure, BEM 1 , 202.

Frey, A.H. & Wesler, LS. (1982) A test of the dopamine hypothesis of microwave energy effects. JBE 1, 305-312. ü£îç

Frey, A.H. & Wesler, L.S. (1983) Dopamine receptors and microwave energy exposure.

J. Bioelectricity 2, 145-157.

Frey A.H. & Wesler, L.S. (1984) Modification of the conditioned emotioanl response in rats living in a 60 Hz electrical field, Bull. Psychonomic Soc. 22, 477-479.

Frey, A.H. (1985) Data analysis reveals significant microwave-induced eye damage in

Frey, A.H. & Wesler, L.S. (1990) Interaction of Psychoactive drugs with exposure to electromagnetic fields. J. Bioelectricity 9, 187-196.

Friedman, H., Becker, R.O., & Bachman, C.H. (1963) Geomagnetic parameters and psychiatric hospital admissions. Nature 200, 626.

Friedman, H., Becker, R.O., & Bachman, C.H. (1965) Nature 205, 1050.

Friedman, H., Becker, R.O., & Bachman, C.H. (1967) Effect of magnetic fields on reaction time performance. Nature 213, 949.

Froehlich H (1968) Long-range coherence and energy storage in biological systems.

Int. J. Quant. Chem. II: 641-649.

Froehlich H (1975) Evidence for Bose condensation-like excitations of coherent modes in biological systems. Phys. Lett. 51A: 21-22.

Froehlich H (1978) Coherent electric vibrations in biological systems and the cancer problem.

IEEE MTT 26: 613-617.

Frohlich, H., Ed. (1988) Biological coherence and response to externa stimuli. New York, Springer.

Fujita, Y. & Sato, T. 1964) Intracellular records from hippocampal pyramidal cells in rabbit during theta rhythms activity. J. Neurophysiol. 27, 1101-1025.

Fukida Eiichi () Ed. BBoard of J. Beioelectricity The Inst. Chemical and Physical Res., Wako-shi Saitama 351, JAPAN

Gandhi OP (1974) Plolarization and frequency effects on whole animal absorption of RF energy. Proc. IEEE 62: 1171-1175.

Gandhi OP (1975) Conditions of strongest em power deposition in man and animals. IEEE Trans. MTT 23: 1021-1029.

Gandhi OP (1990) Biological Effects and Medical Applications of Electromagnetic Fields (Prentice-Hall)

Gaston S. & Manaker M (1968) Pineal function: the biological clock in the sparrow. Science 160, 1125-1127.

Gavalas-Medici, R. & Day-Magdaleno, S.R. (1976) Extremely low frequency, weak electric fields affext schedule-controlled behavior of monkeys, Nature 261, 256-258.

Glaser, Z.R. & Dodge, C.H. (1976) Biomedical aspects of radiofrequency radiation: A review of selected Soviet, East European, and Western references, Selected Papers of the USNC/URSI Annual Meeting (Boulder, CO, Oct.1975), HEW Publication (FDA) 77-8010/8011,pp.2-34.

Gold M (1979) The radiowave syndrome. Science 80(1): 78-84.

Goodman, E.M., Greenebaum, B., & Marron, M.T. (1980-) Bio-effects of extremely low frequency electromagnetic fields: variation with intensity, waveform and indivudual or combined electric and magnetic fields, Rad. Res. in press.

Graf ER & Cole FE (1967) Radiant em energy and life, Recent Adv. Eng. Sci. 4 ,67.

Grissett, J.D. (1980) Biological effects of electric and magnetic fields associated with ELF communications systems. Proc IEEE 68, 98.

Greene, L.A., Rein, G. (1977) Release, storage and uptake of catecholamines by a clonal cell line of NGF responsive phaeochromocytoma cells. Brain Res. 129, 247.

Greene, L.A., Rein, G. (1977) Synthesis, storage and release of acetylcholine by a noradrenergic phaeochromocytoma cell line. Nature 268, 349.

Grundler W & Keilman F (1978) Nonthermal effects of millimeter waves on yeast growth. Z. Naturforsch 33cm 15-22.

Guy, E. et al (1975) Effect of 2450 MHz radiation on the rabbit eye, IEEE Trans. MTT 23, June, 495.

Guy, A.W., Chou, C., Honson, R.B. & Kunz, L.L. (1980) Study of effects of long-term low-level RF exposure on rats: a plan. Proc IEEE 68, 92. Guy, A.W. (1988) The bioelectromagnetics Research Laboratory, University of Washington: reflection on twenty-five years of Reaearch, BEM 9, 113-128.

Halberg, F., Cutkomp, L., Nelson, W., & Sothern, R. (1975) Circadian rhythms in plants, insects and mammals exposed to ELF magnetic and/or electric fields and currents, University of Minnesota, Aug. 1975.

Hamer, J. (1968) Effects of low level, low frequency electric fields on human reaction time. Commun. Behav. Biol. 2 (A), 217-222.

Hathaway, J.A. (1979) reply to Dr.Zaret (letter to Ed.), J. Occup. Med. 20, 316-317.

Hinton HE & Blum MS (1965) Suspended animation and the origin of life. New Sci.Oct. 28:270.

Holland JG (1957) Technique for behavioral analysis of human observing. Science 125: 348-350.

Hosmer H (1928) Science 68: 327. [the first report of mw --> heat => bioeffects]

Huai, C. et al (1985) Experimental research in China on the biological effects of microwaves. J. Bioelectricity 4, 103-120.

Huang, A.T., Engle, M.E., Elder, J.A., Kinn, J.B., & Ward, T.R. (1977) The effect of microwave radiation (2450 MHz) on the morphology and chromosomes of lymphocytes, Rad. Sci. 12(6S), 173-177.

Hunt, E.L., King, N.W., Phillips, R.D. (1975) Behavioral effects of pulsed microwave radiation, Ann. NY Acad. Sci. 247, 440-453.

Hutchison, Michael (1986) Mega Brain, (Ballantine)

IEEE Transactions on Microwave Theory and Techniques, MTT-19, No.2, Februay 1971. Special issue on biological effects of microwaves ü£11(1):1963.1- (Z53-N415)

Karel Marha,"Microwave Radiation Safety Standards in Eastern Europe,"

Jaffe, R.A. et al (1980) Chronic exposure to 60-Hz electric fields: effects on synaptic trasmission and peripheral nerve function in the rat. BEM 1, 113-118.

Jaffe, R.A. et al (1981) Chronic exposure to a 60-Hz electric field: effects on neuromuscular functio in the rat. BEM 2, 227-239.

Jaggard, D.L. & Lords, J.L.(1980) Celular effects: millimeter waves and Raman spectra - report of a panel discusstion. Proc IEEE 68, 114.

Janchem, J. (1991) Alleged health effects of em fields: misconceptions in the scientific literature. J. m.wave Power 26, 189-195. [Current Death]

Jasper, H. & Stefanis, C. (1965) Intracellular and oscillatory rhythms in pyramidal tract neurons in the cat. EEG Clin. Neurophysiol. 18, 541-553.

Johnson, C.C., & Guy, A.W. (1972) Non-ionizing electromagnetic wave effects in biological materials and systems. Proc IEEE 60, 692-718.

Johnson, C.C. (1973) Research needs for establishing a radio frequency electromagnetic radiation safety standard, J. Microwave Power, 8, 367-388.

Johnson, C.C. (1975) Recommendations for specifying EM wave irradiation conditions in bioeffects research, J. Microwave Power 10, 249-250.

Josephson, B.D. (1965) Advanced physics. 14, 419.

Justesen, D.R., & King, N.W. (1970) Behavioral effects of low level microwave irradiation in the closed space situation, in Biological Effects and Health Implications of Microwave Radiation, S.F.Cleary, Ed., pp.154-179.

Justesen, D.R. (1977) Diathermy versus the microwaves and other radio-frequency radiations: A rose by another name is a cabbage, Radio Sci. 12, 355-364.

Justesen, D.R., & Baird, R.C. Eds. (1979) Biological Effects of Electromagnetic Waves, special issue of Radio Sci. 14, no.65.

Justesen DR, Adair ER, Stevens C & Bruce-Wolfe V (1982) A comparative study of huma sensory thresholds: 2450 MHz microwaves vs. far i nfrared radiation. BEM 3:117-125.

Kaiser F (1978) Coherent oscillations in biological systems. Z. Naturforsh. 33a: 294-304.

Kalmijin, Ad. J. (1982) Electric and magnetic field detection in Elasmobranch fishes, Science 218, 916.

Kaune, W.T. & Gillis, M.F. (1981) General properties of the interaction between animals and ELF fields, BEM 2, 1-11.

Kaune, W.T. (1981) Interactive effects in 60 Hz electric-field exposure systems, BEM 2, 33-50.

Kholodov, Y.A. (1966) The Effect of Electromagnetic and Magnetic Fields on the Central Nervous System Moscow, USSR, Nauka, p.283.

Kim, Y.S. (1976) Some possible effects of static magnetic fields on cancer.

Tower int. Technomed. Inst. J. Life Sci. 6, 11-28.

Kinouchi, Y. et al (1984) Design of a magnetic field generator for experiments on magnetic effects in cell cultures. BEM 5, 399-410.

Kinouchi, Y. et al (1988) Effects of static magnetic fields on diffusion in solutions, BEM 9,159-166.

Korbel, S.F. & Fine, J.L. (1967) Effects of low intensity UHF radio fields as a function of frequency. Psychonom. Sci 9, 527.

Konig, H. (1959) Atmospherics peringster Frequenzen.

Z. Angew. Physik.. 11, 264-274. [earth rhythms]

Konig, H.H. & Ankermuller, F. (1960) Uber den Einfluss besonders niederfrequenter elektrischer Vorgange in der Atmosphare auf den Menschen, Naturwissenschaften, 47, 486-490.

Konig, H.H. (1974) Behavioral changes in human subjects associated with ELF electric fields, in ELF and VLF Electromagnetic Field Effects, M.A. Persinger, Ed. ,New York: Plenum, 81-133.

Korbel, S. & Thompson, W.D. (1965) Behavior effects of stimulation by UHF radio fields, Psychological Reports, 17, 595-602.

Korbel, s. & Fine, H.L. (1967) Effects of low intensity UHF radio fields as a funciton of frequency, Psychonomic Sci., 9, 527-528.

Kritikos HN & Schwan HP (1972) Hot spots generated in conducting spheres by em waves and biological implications. IEEE Tran. BME 19: 53-58. [resonant --> head]

Lai, H. et al (1983) Psychoactive drug response is affected by acute low-level microwave irradiation. BEM 4, 205-214.

Larsen LE et al (1974) A microwave decoupled brain temperature transducer.

IEEE Trans. MTT 22: 438-444.

Lawrence L. George (1973) Electronics and Brain Control. Popular Electronics July.

Leal J, Ubeda A, Trillo A, Monteagudo JL, Delgado JMR (1982) Modification of embryogenesis by magnetic fields.. Neuroscience 7(Suppl.):S77.

Lerner, E. (1984) Biological effects of electromagnetic fields, IEEE Spectrum Mar, 63.

Lerner, E. (1984) Biological effects of electromagnetic fields, IEEE Spectrum May, 57.

Lebovitz, R.M. (1981) Prolonged microwave irradiation of rats: effects on concurrent operant behavior. BEM 2, 169-185.

Lewy, A.J. et al (1980) Light suppresses melatonin secretion in humans. Science 210, 1267-1269.

Lewy, A.J. et al (1982) Bright artificial light treatment of a manic depressive patient with a seasonal mood cycle. Am J Psychiatry 139, 1496-1497.

Liboff A et al (1984) Science 223: 818. [ELF/VLF --> DNA systesis]

Liboff AR (1985) Cell-field interactions at extremely low frequencies.

Bull Am Physical Soc 30: 548a. [cylotron resonace]

Liboff A (1985) J. Biological Physics 13: 99. [cyclotron resonance]

Lilienfeld, A.M., Tonascia, J., Tonascia, S. et al. (1978) Foreign service health status study evaluation of health status of foreign service and other employee from selected Eastern European posts, Final rep. (Contract No. 6025-619073) to U.S. Dep. of State, July 31, 1978.

Lin, J.C. (1975) Biomedical effects of microwave radiation - a review,

Proc. Nat. Electron.Conf. 30 , 224-232.

Lin, J.C., Guy, A.W., & Caldwell, L.T. (1977) Thermographic and behavioral studies of rats in the near field of 918-MHz radiations, IEEE Trans. MTT. 25, 833-836.

Lin, J.C., Meltzer, R.J., & Redding, F.K. (1979) Microwave-evoked brainstem potentials in cats, J. Microwave Power 14, 291-296.

Lisk RD & Kannwischer LR (1964) Light: evidence for its direct effect on the hypothalamic neurons. Science 146 272-273.

Lott, J.R. & McCain, H.B. (1973) Some effects of continuous and pulsating electric fields on brain wave activity in rats, Int. J. Biometeorol. 17, 221-225

Lu, S, Lotz, W.G. & Michaelson, S.M. (1980) Advances in microwave-induced neuroendocrine effects: the concept of stress. Proc IEEE 68, 73.

Lyle DB et al (1988) BEM 9: 303. [60Hz -->! T-cell]

Lyskov, E.B. et al (1993) Effects of 45 Hz magnetic fields on the functional state of the human brain. BEM 14, 87-96.

Mantle, E.R. & Persinger, M.A. (1983) Alterations in subjective evaluations during acute exposures to 5 Hz but not 9 Hz magnetic field devices. J. Bioelectricity 2, 5-14.

Marino, A.A. & Becker, R.O. (1977) Hazard at a distance: effects of exposure to the electric and magnetic fields of high volatge transmission lines. Med. Res. Eng. 12(5)

Marino, A.A. (1985) We need a science court. J. Bioelectricity 4 , vii-viii.

Martin, A.H. (1992) Development of chicken embryos following exposure to 60 Hz magnetic fields with differing wave forms. BEM 13, 223-230.

Mather, J.G. (1981) Magnetic sense of direction in woodmice for route based navigation, Nature 291, 152

McAfee RD (1962) Physiological effects of thermode and mw stimulation of peripheral nerves. Am. J. Physiol. 203: 374-378.

McAfee RD (1971) Analeptic effect of mw irradiation on experimental animals. IEEE Tran. MTT 19: 251-253.

McAuliffe, Kathleen (1985) The Mind Fields, Omni Magazine, February, 1985.

McGeer, P.L., McGeer, E.G. (1980) Chemistry of mood and emotion. Annual Rev. Psychology 31, 273-307.

McLaughlin J (1957) Tissue destruciton and death from microwave radiation (radar). California Medicine 86: 336-339. [the first mw victim]

McRee, D.I. (1980) Soviet and Eastern European research on biological effects of microwave radiation. Proc IEEE 68, 84.

Medici, R.G. (1980) Methods of assaying behavioral changes during exposure to weak electric fields, Proceedings of Conference XI: abnormal animal behavior prior to earthquakes (II), US Geological Survey Open File Report 80-453, Menlo Park, CA, 114-140.

Medici, R. (1985) Behavioral studies with em fields: implications for psychobiology. J. Bioelectricity 4, 527-552.

Merritt, J.G. et al (1985) Science and Standards = another viewpoint. J. microwave Power 20, 55-56.

Michaelson, S.M. (1971) The Tri-Service Program, IEEE Trans. MTT 19 (2)

Michaelson, S.M., Houk,W.M.., Lebda, J.A., Lu, S.-T., & Magin, R. (1975) Biochemical and neuroendocrine aspects of exposure to microwaves. Ann. NY Acad. Sci. 247, 21-45.

Michaelson, S.M. (1980) Microwave biological effects: an overview. Proc IEEE 68, 40.

Miller SL (1953) The production of amino acids under possible primitive Earth conditions. Science 117, 528.

Mitchell, C.L. et al (1988) Some behavioral effects of short-term exposure of rats to 2.45 -üÖ Modak, A.T. et al (1981) Effect of short electromagnetic pulses on brain acetylcholine content and spontaneous motor activity of mice. BEM 2, 89-92.

Moisescu, D. & Margineanu, D. (1970) Electromagnetic emission sources in the active nerve, Biophys.J., 10, 482-484.

Monteagudo, J.l., Ramirez, E. & Delgado, J.M.R. (1984) Magnetic inhibition of bacterial growth. Abstr. in Proc. XXI Gen. Assembly Union Radio Science International, Florence, Italy, August 27-30, 1984.

NORDIC SCIENCE(1992) Nature 360(6404), 1992.12.10.

O'connor, M.E. (1980) Mammalian teratogenesis and radio-frequency fields.

Proc. IEEE 68, 56.

O'leary JL & Goldring S (1964) DC potentials of the brain. Physiol. Rev. 44: 91.

Oscar, K.J., et al (1981) Local cerebral blood flow after mw exposure. Brain Rex. 204, 220-225.

Parker LN (1973) Thyroid suppression and adrenomedullary activation by low-intensity mw radiation. Am. J. Physiol. 224: 1388-1390.

Perry, F.S., Reichmanis, M., Marino, A.A., & Becker, R.O. (1981) Environmentalpower-frequency magnetic fields and suicide. Health Phys 41, 267-277.

Persinger, M.A. ed. (1974) ELF and VLF Electromagnetic Field Effects, NewYork: Plenum, 81-133.

Persinger, M.A. & Nolan, M. (1985) Partial amnesia for a narrative following application of theta frequency em fields. J. Bioelectricity 4, 481-494.

Pethig, R. (1983) The Physical characteristics and control of air ions for biological studies. J. Bioelectricity 2, 15-36.

Pittendrigh CS & Minis DH (1964) The entrainment of circadian ossilations by light and their role as photoperiodic clocks. Am. Nat. 98, 261-264.

Pittendrigh CS (1972) Circadian cycles and the diversity of possible roles of circadian organization in photoperiodic induction . Proc. Nat. Acad. Sci. USA 69, 2734-2737.

Polorny, A.D., Mefferd, R.B., Jr. (1966) Geomagnetic fluctuations and disturbed behavior. Ner Mental Dis 143, 140-151.

Presman, A.S. (1964) The role of electromagnetic fields in physiological processes, Biofizika 1, 131-134.

Proc. Ad Hoc Committe for the Review of Biomedical and Ecological Effects of ELF Radiation, Washington, DC: Navy Bureau of Medicine and Surgery, Dec. 1973.

Purpura, D.P. & Cohen, B. (1962) Intracellular recording from thalamic neurons during recruiting responses, J. Neurophysiol. 25, 621.

Ramirez, E., Monteagudo, J.L. Garcia-Gracia, M. & Delgado, J.M.R. (1983) Ovipositoion and development of drosophila modified by magnetic fields. BEM 4, 315-326.

Ramirez, E., Monteagudo, J.L., Medrano, J.C. & Delgado, J.M.R. (1984) Drosophila mutation induced by a pulsed magnetic field. Abstr. in Proc. XXI Gen. Assembly Union Radio Science International Florence, Italy, August 27-30, 1984.

Pandal, W. & Randall, s. (1991) The solar wind and hallucinations - a possible relation due to magnetic disturbances. BEM 12, 67-70.

Reichmanis, M., Perry, F.S., Marino, A.A., Becker, R.O. (1979) Relation between suicide and em field of overheal power lines. Physiol Chem Phys 11, 395-403.

Rein, G., Korins, K., Pilla, A. (1987) Inhibition of neurotransmitter uptake in a neuronalcell line by pulsed electromagnetic fields. Proceedings of the 9th Bioelectromagnetic Society. June 1987.

Rein, G. (1993) Modulation of neurotransmitter function by quantum fields. PACE 6(4) 19.

Reiter R (1960) Meteoribiologie - Und Electrizitat der Atmosphare. (Akademische Verlabsgesellschaft Geest and Potig, Leipzig)

Reiter RJ, et al (1976) New horizons of pineal research. Am. Zool 16: 93-101.

Richardson, A. et al (1951) Experimental cataract produced by three centimeter pulsed microwave irradiations, Arch. Ophth. 45, 382.

Roberti, B., Heebels, G.H., Hendrics, J.C.M., de Greef, A.H.A.M., & Wolthuis, O.L. (1975) Preliminary investigations of the effects of low-level microwave radiation in spontaneous motor activity in rats. Ann. NY Acad. Sci. 247, 417-423.

Rockwell, D.A., et al (1976) Psychologic and psychophysiologic response to 105 days of social isolation. Aviat Space Environ Med i47, 1087-1093.

Rockwell, S. (1977) Influence of a 14,000 Gauss magnetic field on the radiosensitivity and recovery of EMT6 cells in vitro. Int. J. radiat. Biol. 31, 153-160.

Rommel SA & McCleave JD (1972) Ocean electric fields: perception by American eels? Science 176: 1233.

Sadchikova, M.N. & Orlova, A.A. (1958) Clinical picture of the chronic effects of electromagnetic microwaves, Ind. Hyg. Occupat. Dis. (USSR), 2, 16-22.

Sagan, P.M. & Medici, R.G. (1979) Behavior of chicks exposed to low-power 450 MHz fields sinusoidally modulated at EEG frequency, Rad. Sci 14 (6S), 239-245.

Sanza, J.N., & de Lorge, J. (1977) Fixed interval behavior of rats exposed to microwaves at low power densities, Radio Sci. 12(6S), 273-277.

Schmidt,D.E., Speth, R.C., Welsch, F. & Schmidt, M.J. (1972) The use of microwave radiation in the determination of Acetylcholine in the rat brain," Brain Research, 38, 377-389.

Schwan, H.P. (1971) Interaction of Microwave and Radio Frequency Radiation with Biological systems, IEEE Trans. MTT 19 (2)

Schwan, H.P. & Foster, K.R. (1980) RF-field interactions with biological systems: electrical properties and biophysical. Proc IEEE 68, 104

Schwan, H.P. (1982) Microwave and RF hazard standard considerations. J. microwave Power 17, 1-10.

Schwan, H.P. (1984) RF-hazards and standards: an historical perspective, J. microwave Power 19, 225-232.

Scott AC, et al (1973) The soliton: a new concept in applied science. Proc IEEE 61, 1443-1483.

Shamos, M.H. & Lavine, L.S. (1967) Piezoelectricity as a fundamental property of biological tissues. Nature 213, 267-269.

Shapiro AR et al (1970) Induced fields and heating within a cranial structure irradiated by an em plane wave. IEEE Trans. MTT 19: 187-196. [resonant --> head]

Shigematsu et al (1993) 50 Hz magnetic field exposure system for small animals. BEM 14, 107-116.

Silverman, C. (1968) The Epidemiology of Depression, Baltimore, MD: Johns Hopkins Press. [SB251-1]

Silverman, C. (1973) Nervous and behavioral effects of microwave radiation in humans, Am J. Epidemiol. 97, 219-224.

Silverman, C. (1980) Epidemiologic studies of mivrowave effects. Proc IEEE 68, 78.

Smialowicz, R.J. et al (1981) Biological effects of long-term exposure of rats to 970 MHz radio frequency radiation. BEM 2, 279-284.

Stenek NH, et al (1980) The origins of US safety standards for microwave radiation. Science 208:1230-1237.

Stenek NH (1983) Values in standards: The case of ANSI C95.1-1982. Microwaves and RF May 1983: 137,141-42,164-67.

Stenek N (1984) Science and Standards - the case of ANSI C95.1-1982.J. mw Power 19, 153-158.

Stenek N (1984) Microwave Debate. MIT Press, Cambridge, MA.

Stern SS et al (1979) Microwaves: Effect on thermoregulatory behavior in rats. Science 206: 1198-1201.

Stern S (1980) Behavioral effects of microwaves. Neruobehav Toxicol 2: 49-58.

Subbota, A.G. (1958) The effect of a pulsed super-high frequency SHF electromagnetic field on the higher nervous activity of dogs. Bull. Exp. Med. 46, 1206-1211.

Szmigielski, S. et al (1982) Accelerated development of spontaneous and benzopyrene-induced skin cancer in mice exposed to 2450 MHz microwave radiation. BEM 3, 179-192.

Takuma et al (1990) A three-dimensional method for calculating curretns induced in bodies by ELF electric fields, BEM 11, 71-89.

Tanner, J.A. (1962) Reversible blocking of nerve conduction by alternating-current excitation. Nature 195, 712. [a.c. --> nerve]

Tanner, J.A. (1966) Effect of microwave radiation on birds. Nature 210, 636.

Tanner, J.A., Romero-Sierra, C., & Davie, S.J. (1967) Nonthermal effects of microwave radiation on birds. Nature 216, 1139.

Taylor, L.S. (1981) The mechanisms of athermal microwave biological effects. BEM 2, 259-267.

Tell, R. (1972) Broadcast radiation: how safe is safe ? IEEE Spectrum, Aug., 43-51.

Tell, R.A. & Mantiply, E.D. (1980) Population exposure to VHF and UHF broadcast radiation in the United States. Proc. IEEE 68(1)Jan. 6.

Tenforde, T.S. Gaffey, C.T. et al (1983) Cardiovascular alterations in Macaca monkeys exposed to stationary magnetic fields: experimental observations and theoretical analysis. BEM 4, 1-9.

Tesla, N. (1904) Transmission of energy without wires. Scientific American Supplement 57, 23760.

Thomas, J.R., Finch, E.D., Fulk, D.W., & Burch, L.S. (1975) Effects of low level microwave radiation on behavioral baselines, Ann. NY Acad. Sci. 247, 425-432.

Thomas, J.R., & Maitlqand, G. (1977) Combined effects on behavior of low-level microwave radiation and dextroamphetamine, in Abstracts of Scientific Papers p.121 URSI 1977 Int. Symp. Biological Effects Electromagnetic Waves, Airlie, VA.

Thomas JR, Burch L & Yeandle SS (1979) Microwave radiation and chlordiazepoxide: synergistic effects on fixed-interval behavior. Science 203, 1357-1358.

Thomas, J.R. et al (1982) Comparative effects of pulsed and continuous wave 2.8 GHz microwaves on temporally defined behavior. BEM 3, 227-236.

Thomas, J.R. et al (1985) Weak low frequency magnetic fields alter operant bewhaivor in rats, Abstracts of papers presented at the Seventh Ann. Meeting of Bioelectromagnetics Society.

Thomas JR, Schrot J & Liboff A (1986) Low-intensity magnetic fields alter operant behavior in rats. BEM 7: 349.

Trillo, M.A., Jimenez, M.A., Leal, J., Ubeda, A. & Delgado, J.M.R. (1983) Alterations and fractional recovery of chick embryos exposed to em fields. Trans. 3rd Ann. Meeting Bioelectrical Repair & Growth Society, San Francisco, CA, October 2-5, 1983, III, 49.

Tyazhelov, V.V., Tigranian, R.E., & Khizhniak, E.P. (1977) New artifact-free electrodes for recording of biological potentials in strong electromagnetic fields, Radio Sci. 12(6S), 121-123.

Ubeda, A., Leal, J., Trillo, M.A., Jimenez, M.A. & Delgado, J.M.R. (1983) Pulse shape of magnetic fields influences chick embryogenesis. J. Anat. 137, 513-536.

Walcott, C. (1979) Pigeons have magnets, Science 205, 1027.

Walker, N.M., et al (1984) A candidate magnetic sense organ in the yellowfin tuna, Thunnus albacares Science 224, 751.

Wallace, R.K. (1970) Physiological effects of transcendental mediatation, Science 167, 1751-1754.

Webb SJ & Dodds DD (1968) Inhibition of bacterial cell growth by 136 Gc microwave. Nature 218: 374-375.

Webb SJ & Booth AD (1969) Absorption of microwaves by micro-organisms.

Nature 222:1199-1200.

Webb SJ & Booth AD (1971) Microwave absorption by normal and tumor cells.

Science 174: 72-74.

Webb SJ & Stoneham ME (1977) Resonances between 1011 and 1012 Hz in active bacterial cells as seen by laser raman spectroscopy. Phys Lett 63A:267-268.

Webb SJ, Stoneham ME & Froehlich H (1977) Evidence for nonthermal excitation of energy levels in active biological systems. Phys Lett 63A:407-408.

Wehr, T.A. et al (1979) Phase-advance of circadian sleep-wake cycles as an anti- depressant. Science 206, 710-713.

Welker, H.A. et al (1983) Effects of an artificial magnetic field on serotonin N-acetyltransferase activity and melatonin content of the rat pineal gland, Exp. Brain Res. 53. 7.

Wellborn SN (1987) An electrifying new hazard.U.S.News & World Report March 30: 72

Wertheimer N & Leeper E (1979) Am. J. Epidemiology 109: 273.

Wike, E.L. & Martin, E.J. (1985) Comments on Freys' "Data ..." J. m.wave Power 20, 181.

Wilson, B.S. (1988) Chronic exposure to ELF fields may induce depression . BEM 9, 195-205.

Wurtman, R.J. et al (1959) Effects of penealectomy and bovine pineal extracts in rats.

Am J Physiol 197, 108-110.

Zaret, M.M., Cleary, S.F., Pasternack, B., et al. (1963) A study of Lenticular imperfections in the eyes of a sample of microwave workers and a control population, Final Contract Rep. for Rome Air Development Center, RADC-TDR-6310125, Mar.15,1963.

Zaret, M.M. (1974) Selected cases of microwave cataract in man associated with concomitant annotated pathologies, in: Biologic Effects and health Hazards of Microwave Radiation, P.Czerski, et al. Eds. Warsaw, Poland: Polish Medical Publishers, pp.294-301.

Zaret, M.M. (1976) Electronic smog as a potentiating factor in cardiovascular disease: A hypothesis of microwaves as an etiology for sudden death from heart attack in North Karelia, Med. Res. Eng. 12(3), 13-16.

Zaret, M. (1978) Human Injury Relatable to Non-Ionizing Radiation. IEEE-ERDA Symposium, The Biological Effects on Electro Magnetic Radiation.

Zoeger, J. (1981) Magnetic material in the head of the common pacific dolphin, Science 213, 892.

mw -- auditory

Adrian, D.J. (1977) Auditory and visual sensation stimulated by low-frequency dectric currents. Rad. Sci. 12, 243S-250S.

Airborne Instruments Lab. (1956) Proc. IRE 44. [the first RF sound report]

Borth DE & Cain CC (1977) Theoretical analysis of acoustic signal generation in materils irradiated with microwave energy. IEEE MTT 5: 944-954.

Bourgeois, Jr.,A.E. (1967) The effects of microwave exposure upon the auditory threshold of humans, Ph.D.Dissertation, Baylor Univ., Waco, Tex., Univ.Microfilms 67-2927, [A.Frey (1971)]

Bourgeois,Jr., A.E."The effects of microwave exposure upon the auditory threshold of humans," NASA Sci. and Tech. Info. Svc. N68-23132, 1967. [A.Frey (1971)]

Cain, C.A. & Rissman, W.J. (1978) Mammalian auditory responses to 3.0 GHz microwave pulses, IEEE Trans. BME 25: 288-293.

Cain, C.A. (1981) Biological effects of oscillating electric fields, BEM 2, 23-32.

Chou, C.K., Galambos, R., Guy, A.W., & Lovely, R.H. (1975) Cochlear microphonics generated by microwave pulses, J. Microwave Power 10, 361-367.

Chou, D.K., Guy, A.W., & Galambos, R. (1976) Microwave induced cochlear microphonics in cats, J. Microwave Power 11 (2), 171-173.

Chou, C.K., Guy, A.W., & Galambos, R. (1976) Microwave-induced auditory response: cochlear microphonics, Biological Effects of Electromagnetic Waves, C.C. Johnson et al Eds., HEW publication (FDA) 77-8010,89-103.

Chou, C.K., Guy, A.W., & Galambos, R. (1977) Characteristics of microwave-induced cochlear microphonics, Rad.Sci. 12, 221S-228S.

Chou CK & Galambos R (1979) Middle ear structures contribute little to auditory perception of microwaves. JMP 14(4): 321-326.

Chou CK & Guy AW (1979) Microwave-induced auditory responses in guinea pigs: relationship of threshold and microwave-pulse duration. Radio Sci. 14(6S): 193-197.

Chou, C-K, Guy, A.W., Foster, K.R., Galambos, R., & Justesen, D.R. (1980) Holographic assessment of microwave hearing. Science 209, 1143-1144.

Chou, C.K., Guy, A.W. & Galambos, R. (1982) Auditory perception of RF em fields.

J. Acoust. Soc. Am. 71(6), 1321-1334.

Chou, C.K. et al (1985) Auditory response in rats exposed to 2450 MHz electromagnetic fields in a circulary polarized waveguide, BEM 6, 323-326.

Flottorp, O.(1953) Effect of different types of electrodes in electrophonic hearing," J. Acousi.Soc. Amer. 25, 236-243. [A.Frey (1971)]

oster, K.R. & Finch, E.D. (1974) Microwave hearing: evidence for thermoacoustical auditory stimulation by pulsed microwaves, Science 185, 256-258.

Foster KR & Wiederhold ML (1978) Auditory responses in cats produced by pulsed ultrasound, J. Acoust. Soc. Am. 63, 1199-1205.

Frey, A.H. (1961) Auditory system response to radio frequency energy. Aerosp.Med., 32, , 1140-1142.

Frey, A.H. (1962) Human auditory system response to modulated electromagnetic energy, J.Appl.Physiol., 17, 689-692.

Frey, A.H. & Coren, E. (1979) Holographic assessment of a hypothesized microwave hearing mechanism. Science 206, 232-234.

Frey, A.H. & Coren, E. (1980) Holographic assessment of microwave hearing.

Science 209, 1144-1145.

Frey, A.H. & Eichert (1985) Psychophysical analysis of microwave sound perception, J. Bioelectricity 4, 1-14.

Gournay, L.S. (1966) Conversion of electromagnetic to acoustic energy by surface heating, J.Acous. Soc.Amer. 40, 1322-1330.

Guy, A.W., Taylor, E.M., Ashleman, B., & Lin, J.C. (1973) Microwave interaction with the auditory systems of humans and cats, presented at 1973 IEEE Microwave Symp., (Boulder, CO, June 1973).

Guy, A.W., Chou, C.K., Lin, J.C., & Christensen, D. (1975) Microwave-induced acoustic effects in mammalian auditory systems and physical materials, Ann. NY Acad. Sci. 247, 194-218.

Ingalls CE (1967) Sensation of hearing in electromagnetic fields. NY State J. Med. 67: 2992-2997.

Jaramillo, F. & Markin, V.S (1993) Auditory illusions and single hair cell. Nature 364(6437), 527.

Johnson RB, Lovely RH & Guy AW (1976) Microwave control of behavior: an auditory phenomenon. USNC/URSI Meeting, Amherst, MA.

Joines WT & Spiegel RJ (1974) Resonance absorption of microwaves by the human skull. IEEE BME 21: 46-48.

Joines WT (1976) Reception of microwaves by the brain. Med. Res. Engng. 12: 8-12.

Joines WT & Wilson BS (1981) Field-induced forces at delectric interfaces as a possible mechanism of RF hearing effects. Bull. Math. Biol. 43: 401-413.

Justesen DR (1975) Microwaves and Behavior. Am. Psychologist 30: 391-401. [Dr.Sharp's "voice transmission"]

King. N.W., Justesen, D.R., & Clarke, R.L. (1971) Behavioral sensitivity to microwave irradiation. Science 172, 398-401.

Lebovitz RM (1975) Detection of weak em radiation by the mammalian vestibulocochlear apparatus. Ann. N.Y. Acad. Sci. 247: 182-193.

Lebovitz, R.M. & Seaman, R.L. (1977) Microwave hearing: The response of single auditory neurons in the cat to pulsed microwave radiation, Rad. Sci. 12, 229S-236S.

Lebovitz, R.M. & Seaman, R.L. (1977) Single auditory unit responses to weak, pulsed microwave radiation, Brain Res. 126, 370-375.

Lin, J.C. (1975) Microwave auditory effect - a comparison of some possible transduction mechanisms, J. Microwave Power, 11, 77-81.

Lin, J.C. (1976) Microwave-induced hearing : some preliminary theoretical observations, J. Microwave Power vol. II, 295-298.

Lin, J.C. (1977) On microwave-induced hearing sensation, IEEE Trans. MTT 25, 605-613.

Lin, J.C. (1977) Further studies on the microwave auditory effect, IEEE Trans. MTT 25, 938-943.

Lin, J.C. (1977) Theoretical calculations of frequencies and thresholds of microwave-induced auditory signals, Rad. Sci. 12, 237S-242S.

Lin, J.C. (1978) Microwave Auditory Effects and Applications. Springfield, IL, C.C.Thomas.

Lin, J.C., Meltzer, R.J..., & Redding, F.K. (1978) Microwave-evoked brainstem auditory responses, Proc. San Diego Biomed. Symp. 17, 461-465.

Lin, J.C., Meltzer, R.J. & Redding, F.K. (1978) Characteristics of microwave auditory effects : Theory and experiment. URSI Open Symp. Biol. Effects Electromagnetic Waves (Finland, Aug. 1978)

Lin, J.C. (1980) The Microwave Auditory Phenomena. Proc. IEEE 68, 67.

Moeser W (1962) Whiz Kid, Hands Down, Life 1962.9.14

Olsen, R.G. & Lin, J.C. (1981) Microwave pulse-induced acoustic reasoannces in spherical head models, IEEE TRans. MTT 29, 1114-1117.

Olsen, R.G. & Hammer, W.C. (1981) Evidence for microwave-induced acoustical resonances in biological material , J. microwave Power 16, 263-270.

Olsen, R.G. & Lin, J.C. (1983) Microwave-induced pressure waves in mammalian brain, IEEE Trans. BME, 30, No.5, 289-294.

Rissman, W.J. & Cain, C.A. (1975) Microwave hearing in mammals, Proc. Nat. Electron. Conf. 30, 239-244.

Sharp, J.C., Grove, H.M., & Gandhi, O.P. (1974) Generation of acoustic signals by pulsed microwave energy. IEEE Trans. MTT 22, 583-584.

Sharp, J.C. (1979) Some perspectives on research into biological resopnse to non-ionizing electromagnetic radiation. Rad. Sci. 14 (1) 5-10.

Sommer, H.G.& VonGierke, H.E. (1964) Hearing sensations in electric fields.Aerosp.Med.,35, 834.

Taylor, E.M. & Ashleman, B.T. (1974) Analysis of the central nervous involvement in the microwave auditory effect, Brain Res. 74, 201-208.

Tyazhelov, V.V. et al (1979) Some peculiarities of auditory sensations evoked by pulsed microwave fields. Rad. Sci. 14(6S), 259-263.

Los Angeles Herald-Examiner, Nov. 22, 1976. ( m.wave --> sounds/voice )

White, R.M. (1963) Generation of elastic waves by transient surface heating,

J. Appl. Phys. 34, 3559-3569.

White, R.M. (1963) Elastic wave generation by electron bombardment or electromagnetic wave absorption, J. Appl. Phys. 34, 2123-2124.

Wilson BS, Joines WT & Casseday JH (1976) Responses of auditory nerve fibers to pulses of microwave irradiation: evidence of a direct effect of microwave radiation at hair cells of the cochlear. 1976 USNC/URSI Meeting, Amherst, MA.

Wilson, B.S., Joines, W.T., et al (1980) Responses in the auditory nerve to pulsed, CW, and sinusoidally-modulated microwave radiation. BEM 1, 237.

Wilson BS, Zook JM, Joines WT & Casseday JH (1980) Alterations in activity at auditory nuclei of the rat induced by exposure to mw radiation: autoradiographic evidence using [14C]-2-deoxy-D-glucose. Brain Res. 187: 291-306.

Wilson BS, Kobler JB, Casseday JH & Joines WT (1983) Spectral content of mw-indduced auditory stimuli as demonstrated by [14C]-2-deoxy-D-glucose uptake at theinferior colliculus. Bioelectromagnetics Abstracts 5:46.

Wilson, B.S. & Joines, W.T. (1985) Mechanisms and physiologic significance of m.w. action on auditory system. J. Bioelectricity 4, 495-526.

Acoustics

Anderson AB & Munson WA (1951) Electrical excitation of nerves in the skin at audio frequencies.

J. Acoust. Soc. Am. 23, 155.

von Bekesy G (1948) Vibrations of the head in a sound field and its role in hearing by bone conduction. J. Acoust. Soc. Am. 20, 749.

Bilsen FA & Ritsma RJ (1969/1970) Repetition pitch and its implication for hearing theory. Acustica 22: 63-73. [review]

Bilsen, F.A. & Ritsma, R.J. (1970) Some parameters influencing the perceptibility of pitch. J. Acoust. Soc. Ame. 47, 469-475.

Dallos, R. et al (1972) Cochlear inner and outer hair cells: functional differences. Science 177, 356-358.

Davis H (1935) The electrical phenomena of the cochlea and the auditory nerve.

J. Acoust. Soc. Am. 6: 205-215. [sound wave --> cochlea potential]

Flottorp G (1953) Effects of different types of electrodes in electrophonic hearing.

J. Acoust. Soc. Am. 25, 236.

Jones RC et al (1940) Three mechanisms of hearing by electrical stimulation.

J. Acoust. Soc. Am. 12, 281.

Naftalin, I. (1977) The peripheral hearing mechanism: new biophysical concepts for transduction of the acoustic signal to an electrochemical event. Physiol. Chemi. Physics 9, 337-382.

Ritsma, R.J. (1962) Existence region of the tonal residue I.

J. Acoust. Soc. Amer. 34, 1223-1229.

Schouten, J.F.., Ritsma, R.J.. & Cardozo, B.L. (1962) Pitch of the residue.

J. Acoust. Soc. Am. 34, 1418-1424.

Stevens SS (1937) On hearing by electrical stimulation. J. Acoust. Soc. Am. 8, 191.

Titinen, H. et al (1993) Selective attention enhances the auditory 40 Hz transient response in humans. Nature 360(6404)

Zwislock J (1957) In search of the bone-conduction threshold in a free-field sound field.

J. Acoust. Soc. Am. 29, 795.

em --> heart

Birenbaum L, Kaplan IT, Metlay W, Rosenthal SE & Zaret MM (1975) Microwave and infrared effects on heart rate. JMP 10(1): 3-18.

Blanchi, C., Cedrini, L., et al (1973) Exposure of mammalians to strong 50-Hz electric fields: effect on heart's and brain's electrical activity. Arch Fisiol 70, 33-34.

Chou, C.K. et al (1980) Microwave radiation and heart-beat rate of rabbits,

J. microwave Power 15, 87.

Clapman RM & Cain CA (1975) Absence of heart rage effects in isolated frog heart irradiated with pulse modulated mw energy. JMP 10(4): 411-419.

Frey, A.H., & Siefert, E. (1968) Pulse modulated UHF energy illumination of the heart associated with change in heart rate, Life Sci., 7, 505-512.

Frey, A.H. & Eichert (1986) Modification of heart function with low intensity electromagnetic energy, J. Bioelectricity 5, 201-210.

Kaplan IT, Metlay W, Zaret M, Birenbaum L, & Rosenthal SW (1971) Absence of heart rage effects in rabbit during low level mw irradiation. IEEE Tran. MTT 19(2): 168-173.

Liu LM, Rosenbaum FJ & Pickard WF (1976) The insensitivity of frog heart rate to pulse modulated mw enrgy. JMP 11(3): 225-232.

Lords JL, Durney CH, Borg AM & Tinney CE (1973) Rate effects in isolated hearts induced by mw irradiation. IEEE Trans. MTT 21: 834-836.

Olson RG, Durney CH, Lords JL & Johnson CC (1975) Low level mw interaction with isolated mammalian hearts, Symposium Proceedings, Microwave Power, Waterloo, Ontario, IMPI Canada,pp. 76-78.

Sutton CH & Nunnally RL (1973) Exogenous peroxidase activity in the selectively hyperthermic rat brain. Proc. Fed. Am. Soc. Exp. Biol. 32: 859.

Tinney, C.E., Lords, J.L., & Durney, C.H. (1976) Rate effects in isolated turtle hearts induced by microwave radiation, IEEE Trans. MTT 24, 18-24.

**mw -- EEG**

Adey, W.R. (1974) The influences of impressed electrical fields at EEG frequencies on brain and behavior. In Behavior and Brain Electrical Activity. H.Eltshuler & N.Burch, Eds. Plenum Publishing Co. , NY.

Baranski S & Edelwejn Z (1967) EEG and morphological investigations upon influence of microwaves on central nervous system. Acta Physiol. Pol. 18: 423.

Baranski S & Edelwjn Z (1975) Experimental morphologic and EEG studies of mw effects on the nervous system. Ann. N.Y. Acad. Sci. 247: 109.

Bawin, S.M., Gavalas-Medici, R.J., & Adey, W.R. (1973) Effects of modulated very high frequency fields on specific brain rhythms in cats. Brain Res. 58, 365-384.

Caccia M & Castelpiertra R (1985) Electroencephalogram sysnchronization induced by em low frequency field administration in normal humans )preliminary observations).Bioelectrochem Bioenerget 14, 215-218.ü@ü£îç

Direnfeld, L.K. (1983) The genesis of the EEG and its relation to em radiation, J. Bioelectricity 2, 111-121.

Gavalas, R.J., Watter, D.O., Hamer, J. & W.R. Adey (1970) Effect of low-level, low-frequency electric fields on EEG and Behavior in MACACA NEMESTRINA , Brain Res. , 18, No.3, 491-501.

Servantie, B., Servantie, A.M., & Etienne, J. (1975) Synchronization of crotical neurons by a pulsed microwave fild as evidenced by spectral analysis of EEG from the white rat. Ann. NY Acad. Sci. 247, 82-86.

Takashima S, Oronal B & Schwan HP (1979) Effects of modulated RF energy on the EEG of mammalian brains. Rad. Environ. Biophys. 16: 15-27.

**mw -- Blood brain barriers**

Albert, E.N. (1979) Current status of microwave effects on the blood-brain-barriers, J. microwave Power 14, 281-285.

Frey, A.H., Feld, S.R., & Frey, B. (1975) Neural function and behavior: defining the relationship, Ann. NY Acad. Sci. 247,, 433-439.

Frey AH (1980) On microwave effects at the blood-brain barrier. Bioelectromagnetics Society Newsletter 18 (November 1980): 4-5.

Frey, A.H. (1983) Comments on "Microwaves and the BBB" J. Bioelectricity 2(1), 83-88.

Justesen, D.R. (1980) Microwave irradiation and the blood-brain barrier. Proc IEEE 68, 60.

Merritt, H.H., Chamness, A.F., & Allen, S.J. (1978) Studies on blood-brain barrier permeability after microwave-radiation, Rad. Environ. Biophys. 15, 367-377.

Oscar, K.J. & Hawkins, T.D. (1977) Microwave alterations of the blood-brain barrier system of rats, Brain Res. 126, 281-293.

**MW -- Ca2+**

Adey, W.R. & Bawin, S.M. (1977) Efflux of calcium and amino acids from cerebral tissues with weak, low frequency electric fields, Fed. Proc. 36, 589.

Adey, W.R. & Bawin SM (1982) Binding and release of brain calcium by low level electromagnetic fields, Rad. Sci. 17(5s) 149.

Bawin, S.M. & Adey, W.R. (1976) Sensitivity of calcium binding in cerebral tissue to weak environmental electric fields oscillating at low frequency, Proc. Nat. Acad. Sci. USA 73, 1999-2003.

Bawin, S.M., Sheppard, A.R. & Adey, W.R. (1978) Bioelectro-chem. Bioenergetics. 5, 67-76. [0.1 - 1.0 mW/cm2 -> 45Ca2+]

Bawin, S.M., Adey, W.R. & Sabbot, I.M. (1978) Ionic factors in release of 45Ca2 from chicken cerebral tissues by electromagnetic fields, Proc. of the Nat. Acad. Sci., USA 75, 6314-6318.

Blackman, C.F., Elder, J.A., Weil, C.M., Benane, S.G. & Eichinger, D.C. (1977) Two parameters affecting radiation-induced Ca++ efflux from brain tissue, in Abstrancts 1977 Int. Symp. Biol. Effects Electromagentic Waves (Oct. 30-Nov.4, 1977, Airlie, VA), p.101.

Blackman, C.F., Elder, J.A., Wil, C.M., Benane, S.G., & Eichinger, D.C. (1979) Modulation-requency and field-strength dependent induction of calcium-ion efflux from brain tissue by radio-frequency radiation, Radi Sci. 14, 93-98.

Blackman, C.F., et al (1980) Calcium-ion efflux from brain tissue: powr-density vs internal field-intensity dependencies at 50-MHz RF radiation, BEM 1,277-283.

Blackman, C.F. et al (1985) Effects of ELF (1-120 Hz) and modulated (50 Hz) RF fields on the efflux of calcium ions from brain tissue in vitro. BEM 6, 1-11.

Blackman CF et al (1985) BEM 6: 327. [Earth --> Ca++]

Blackman,C.F. et al (1988) Influence of electromagnetic fields on the efflux of calcium ions from brain tissue in vitro: a three model analysis consistent with the frequency reaponse up to 510 Hz.. BEM 9, 215-227.

Kaczmarek, L.K. & Adey, W.R. (1973) The efflux of 45Ca2+ and 3H-gamma aminobutyric acid from cat cerebral cortex. Brain Res. 63, 331-342.

Kaczmarek, L.K. & Adey, W.R. (1974) Weak electric gradients change ionic and transmitter fluxes in cortex. Brain Res. 66, 537-540.

Rasmussen, H. (1970) Cell communication, calcium ion, and cyclic adenosine monophosphate, Science 170, 404-412.

**Biorhythms**

Aschoff J (1965) Circadian rhythms in man. Science 148, 1427-1432.

Blackman S & Catalina D (1973) The moon and the emergency room. Percept Mot Skills 37: 624-626.

Brown FA (1959) Living clocks. Science 130, 1535.

Brown FA (1971) Some orientational influence of non-visual terrestrial em fields. Ann. N.Y. Acad. Scie. 188: 224-41.

Brown FA (1972) The "Clocks" timing biological rhythm, Am. Scientist 60, 756.

Lanzerotti LJ (1988) The Earth's magnetic environment. Sky and Telescope Oct. 1988.

Lerner EJ (1988) The Big Bang never happened. Discover June 1988. [magnetic --> universe]

Lieber AL (1978) Human aggression and the lunar synodic cycle. J. Clin. Psychiatry 39: 385-391.

Newell ND (1963) Crises in the history of life. Sci. Am. 205:77. [species extinctions]

Schumann (1952) Z. Naturforsch. 7A, 150

Thiemann W & Jarzak U (1981) Origins of Life 11: 85. [magnetic --> life]

Weller G et al (1987) Science 238: 1361. [present knowledge of the magnetosphere]

Wever R (1973) Human circadian rhythms under the influence of weak electric fields and the different aspects of these studies, Int. J. Biometeorol. 17, 227-232.

Wever R (1975) The circadian multi-oscillatory system of man, Int. J. Chronobiol. 31, 19-55.

Winstead K. et al (1981) Biorhythms: fact or superstition. A. J. Psychiat 138(9), 1188.

**em weapons (&non-lethal weapons)**

NBC News Magazine by David Brinkleyü@1981.3.13

Alexander, J.B., Lt.Col.,US Army (1980) The new mental battlefield, Military Rev. December 47-54.

Alexander, J.B. US Army, Ret. (1989) Antimaterial technology, Military Rev. Oct.

Bearden, T. (1978) Soviet Psychotronic Weapons: A condensed background, Specula, March-June, pp.20,27.

Byrd EA (1979) Technology Tommorrow June 1979.

de Caro, Chuck (1987) The zap gap.The Atlantic March 1987. [David fratus(1988)]

Cooper P (1994) ARPA office takes on crime.Defense News 1994.6.27/7.3, p.16

DOD (1988) Soviet Military Power. pp.146.

Electromagnetic-gun competition IDR 12/1982:1748 [not an EM radiation weapon]

Giovanni de Briganti (1994) Lasers, viruses, may rule no-fly zone sky. Defense News Feb.7-13: 1,45.

Holzer R & Munron (1992) Microwave weapons stun Iraqis. Defense News April 13-19: 1,52.

Holzer R (1992) US Navy to study use of laser weapons aboard combat ships. Defense News April 27-May 3

International Herald Tribune 1993.12.23 [Zhirinovsky's secret weapon]

Kiernan V (1993) War over weapons that can't kill. New Scientist 140(1903): 14.

LaMothe JD (1972) Controlled Offensive Behavior - USSR (Unclassified), Defense Intelligence Agency, Washington, D.C.

Lovece J (1994) CIA asked to review 'Buck Rogers' Weapon. Defense Week Jan.18: 6. [sound resonance weapon]

Maire III, L.F. & LaMothe, J.D. (1975) Soviet and Czechoslovakian Parapsycholody Research (Unclassified), Defense Intelligence Agency, Washington, D.C.

Mar, R.K. (1986) Bnad-less tank killer. U.S.Naval Institute Proc. September

Martinez, Thomas and Guinther, John (1988) The Brotherhood of Murder. NY, McGraw-Hill. [The Order -- $.1m -> scientists]

Michrowski A (1980) Covert ELF Warfare, Specula , January-March, p.27.

Morrison, D. (1989) Tactical laser weapons, Lasers Optronics May

Newell, C.R. Lt.Col. US Army (1989) The technological future of war, Military Rev. Oct. 22-28.

One to One: Edward Teller (1992) Defense News May 25-31: 30.

Opall B (1992) Pentagon forges strategy on non-lethal warfare. Defence News Feb.17:1,50.

Opall B (1992) Pentagon units jostle over non-lethal initiative.Defence News March 2: 6.

Opall, Barbara (1993) US explores Russian mind-control technology. Defense News Jan.11-17: 4, 29. [Stonehill,1994]

Opall B (1994) DoD to boost nonlethal options. Defense News March 28-Apr 3: 46.

Opall B (1994) Sound waves may target N. Korean tunnels. DN June 13-19: 1,37.

Polsky D (1992) Livermore plans tiny laser weapons Defense News June 1-7: 22-23.

Slayton, B.F., Mj. US Army (1980) War in the Ether: Soviet radio-electronic warfare. Military Rev. Jan. 1980, 56-68.

Starr B (1993) Non-lethal weapon puzzle for US Army, Int. Defense Rev. Apr. 319.

Starr B (1994) Pentagon maps non-lethal options. IDR 30-39.

Stonehill, Paul (1994) Fate Feb.1994.

Stonehill, Paul (1994) Russians still bent on mind control, UFO 9(3): 16-17.

Tapscott, M. (1993) DOD, Intel agencies look at Russian mind control technology, Defense Electronics July, 17.

Tennenbaum AN & Moore AM (1993) Non-lethal weapons. Futurist Sep/Oct: 20-23.

Tyler PE (1986) The electromagnetic spectrum in low-intensity conflict. In Low-Intensity Conflict and Modern Technology. edited by Lt.Col.David J.Dean, USAF Center for Aerospace Doctrine, Research, and Education, Maxwell Air Force Base, Ala.: Air University Press. ü¢Walter Reed's microwave research Department: its history and mission [Part 1 of two parts]. (1989) in Bioelectromagnetics Society Newsletter Jan/Feb 1989.

Weinschenk A (1993) Non-lethal weaopns group set to form in March.Defense Week Nov.22: 1,14.

Younger SM (1993) AGEX II, the high-energy-density regime of weapons physics.Los Alamos Science No.21: 63.

Zigunenko, Stanislav (1992) Tekhnika Molodezhi Magazine Sept.1992 [Stonehill,1994]

**Internal Security equipment**

Hogg IV (1989) Keeping them out : solutions to perimeter protection. IDR 10/1989:33-37.[mw sensor, etc]

Internal Security Equipment Survey (1980) IDR 8/1980: 1261-1265. [mw sensor, &c]

Internal Security Equipment Survey (1981) IDR 10/1981: 1347-1348. [strobe gun, &c]

Internal Security Equipment Survey (1984) IDR 6/1984: 804. [perimeter protection sys]

Internal Security Equipment Survey (1985) IDR 6/1985: 925-927.[mw sensor,&c]

Israel stun grenade IDR 10/1987: 1386.

Lovece J (1993) FBI used military robots in Waco: standoff but got mixed results.Defence Week May 17: 16.

**em -- victims**

mediaecco Stockholm

(1993) NZ Herald 1993.1.30, 1.31 [Mr. Larry Hammond]

Besly, Kimm (1984) Electro Magnetic Pollution : A Little Known Health Hazard, A New Means of Control ?, Preliminary Report Greenham Common Women's Peace Camp, Inlands House, Southbourned, Ensworthy, Hants, England PO10 8JH, 1984.

Chamberlain P (1993) Frequency assault : the case of the Verneys. OPEN Eye 2: 28.

Farkas K (1991) Psychiatrist testifies at mom's hearing. The Plain Dealer 1991.6.28

Koski M (1981) My life depends on you !

Neal RM (1991) Paralysis by microwaves. MUFON 283: 14.

Rex Niles !<---, Los Angeles Times March 28, 1988.Part II p.1&8 (Z92-176)

Slesin L (1987) Zapped ? The Nation March 14 [the Greeham Common]

SovData DiaLine - Soviet Press Digest, February 15, 1992.

(DELOVOI MIR) (see 1985/Voronezh)

Wade N (1972) Fischer-Spassky charges: What did the Russians have in mind?

Science 177: 778.

Friday, February 20, 1998

Ultrasonics

Ben-Hur, E. & Green, M. (1982) Temperature dependence of ultrasound-induced cell killing: the role of membrane fluidity, BEM 3, 247-251.

Carstensen, E.L. (1982) Biological effects of low-temporal, average-intensity, pulsed ultrasound, BEM 3, 147-156.

Henry GE (1954) Ultrasonics. Sci. Am. 190(5), May.

Young, R. & Henneman, E. (1961) Reversible block of nerve conduction by ultrasound. Archives of Neurology (Chicago), 4, 83-89.[Swett,1981] u.sonic --> frog nerve.

**Subliminal**

Bevan W (1964) Subliminal stimulation: a pervasive problem for psychology. Psychol. Bull. 61: 81-99.

Bryce, Susan (1992) Television: Drug of the nation. Nexus 2(10): 11-14.

Clark E (1988) The Want Makers Hodder & Stoughton.

Dixon NF () Subliminal Perception.

Eagle (1959) The effects of subliminal stimuli of aggressive content upon conscious cognition. J. Pers. 27: 578-600.

House of Representatives, Committee on Science and Technology, Subcommittee on Transportation, Aviation and Materials (1984) Subliminal Communication Technology.

Key WB (1974) Subliminal Seductions. Signet Books, NY.

Key WB () Media Sexploitation.

Key WB (1980) The Clam Plate Orgy. Prentice Hall, Sydney.

Spence DP (1967) Subliminal perception and perceptual defence: two sides of a single problem. Behav. Sci. 12: 183-193.

U.S. Patent # 3773049 Nov. 20th 1973

**Psychiatry and mind control ... psychosis or mind-control**

**Tinnitus** [RN 1994.4.26]

Shulman A (1991) Tinnitus Diagnosis/Treatment. Lea and Febiger, Philadelphia, pp.547, $ 99.50 [Neurosurgery 32(4): 688]

unknown diseases [RN 1994.4.26]

dental filling material [RN 1994.4.26]

computer society [RN 1994.4.26]

[key words: man-machine interaction, man-computer interaction, dataregister, data integrity, data law, information society, cyberculture, future research, artificial intelligence]

Burnham D (1983) The Rise of the Computer State. NY:Rnadom House.

Eden PF (1994) Privacy on parade. Futurist 28(4):1994.7/8, p.38.

Huxley, Aldous () Brave New World.

Marx G & Reichman N (1984) Routinizing the discovery of secret: computers as informants. Am. Behav. Scientist March

Masuda () The Information society. [see letter of RN 1994.1.26]

Orwell, George () 1984.

Rosnak, Theodore (1986) The Cult of Information [Akwei vs NSA]

Warwick DR (1992) The cash-free society. Futurist Nov/Dec. p.19.

Wiener, Norbert () Cybernetics. 2nd ed. The MIT Press.

Zamytian () We.

National Diet Library Code #

Acta Neurochir Suppl. 30:1980- Z54-H260

Acta Physiologica Scandinavica ü£3:1942- Z53-D17

Acta psychol. (Amst.) ü£1(1):1935- Z52-A27

Acta Physiol. Pol. ü£ 19:1968.1- Z53-N390

Acustica 1:1951- Z53-A438

Adv. Neurol. NIL

Adv. physics. ü£ NIL

Aerosp.Med. ü£31:1960- (Z53-G120)

Aerospace Med. Res. Labs. ü£NIL

Am. J. Epidemiol. ü£ 81:1965- Z53-D75

Am. J. Med. 34:1963- Z53-C384

Am. J. Med. Electron. .ü£2:1963- (Z53-D301)

Am. J. Physical Anthropology ü£1:1943- (Z53-B358)

Am. J. Physiol. ü£1(1):1898- Z53-D19

Am. J. Psychiat. ü£ 107(2):1950- Z53-D588 îç117-136.scan. 137:1980- 1982.12 (147,8 É+û{Æâ)

Am. J. Surg. 139: 1980- Z54-A679

Am. Nat.. 1:1967: Z53-B374

Am. Psychologist ü£4(4):1949.4- (Z52-A28)

Am. Scientist ü£ 30(2):1942- Z53-A7

Am. Zool. ü£ 2:1962- Z53-C145

Anesthesia & Analgesia ü£59(1):1980.1-

Anesthesiology 52: 1980- Z53-X394

Animal Behav. ü£6:1958- Z53-C197

Ann. N. Y. Acad. of Sciences ü£23:1913- (Z53-A134)

Ann. Neurology Z53-X98

Ann. Otol. ü£NIL

Ann. Otol. Rhin. Laryngol. ü£89(2):1980- Z54-B54

Ann. Rep. Coll. Surg. ü£NIL

Ann. roy. Coll. Surg. Engl. ü£1(1):1947- Z54-A675

Ann. Surgery ü£191(1):1980- Z54-A570

Annual Review of Psychology ü£48:1986- Z63-A174 æOè¬SB21-15,150,158-A615

Appl.Neurophysiology ü£38(1):1975- Z53-D68

Arch. Anat. Pshysiol., Lpz.ü@ü@ü£NIL

Arch. Italiennes de Biologie ü£100:1962- Z53-B426

Arch. General Psychiatry ü£Z53-D587

Arch. Neurology (Chicago) ü£37(1):1980- Z53-D586

Arch. Neurol. Psychiat.(Chic.) ü£61(1):1949.1- 81: 1959 Z53-D585 scan. 75: 1956 - 81: 1959

Arch Opththalmology ü£4:1949- Z53-D615

Arch. Otolaryngol. ü£ 49:1949- Z53-D622

Arch. Phys. Med. Rehabil. 34: 1953- Z53-D558

Arch. Psychiat. Nervenkr ü£ 227:1979.7- Z53-W395

Atlantic Z55-A173

Aviat. Space Environ. Med. 46:1975- Z53-G120

Behav. Biol. ü£ 7(1):1972- Z53R80

Behavioral and Brain Sciences ( BBS ) Z53-W364 scan. 1(1):1978-1994.6 (ex.1991)

Behav. Sci. ü£1(1):1956- Z51-A8 scan. 1964-1982.

Berichte Gesamte weber die Physiol.Exp.Pharmakologie ü£1(1):1920- Z53-D22

Bioelectro-chem. Beioenergetics ü£ 1:1974- Z53-T414

Bio-electromagnetics ü£ 2(1):1981- Z54-C507 scan. - 15(5): 1994 (1987NILüA1989out. )

Biolog. Psychiat. ü£ 1:1969- Z53-S61

Biomed. Eng. 4: 1970- Z53-W478

Bio-med. Instru. ü£ NIL

Bio-med. Instru. Technology ü£23:1989- Z54-A106 (Med. Instru.é¦ënæ_)

Biomed. Sci. Instrum. ü£ NIL

Biophys. J. ü£1:1960.9- Z53-B461

Biophys. Soc. Abstracts ü£NIL

Biotelemetry and Patient Monitoring ü£ 1(1):1974- 9(4):1982. Z53-W267. scanned all.

Biul. eksp. Biol. Med. nil

Brain ü£1938- Z53-R18 scan. 103:1980 - 117(4):1994.8

Brain, Behav. Evol. ü£1:1968- Z54-C321

Brain Research ü£1(1):1966.1- (Z53-L382)

Brain Res. Bull. 1: 1976- Z53-V263

Bull. Am. Physical Soc. 1:1956- Z53-A409

Bull. Exp. Med. ü£ 51:1961- Z53-B390

Bull. Math. Biol. ü£ 35:1973- Z53-B447

Bull. Psychonomic Soc. 13:1979- Z53-V384

Can. J. Zool. 32: 1954- Z53-C148

Cand. M.A. J. ü£ 88:1963- Z53-C460

Cell ü£ 1:1974- Z53-V215

Clin. Neurol. Neurosurg 82(1):1980- Z54-A686

Clin. Neuropsychol. 3:1981-5:1983 Z54-C436

Commun. Behav. Biol. ü£ 1:1968-6:1971 Z53-R80 [see Behav. Biol.]

Confin. neruol. (Basel), ü£23(3):1963- Z53-D68

Corrections Today 41:1979- Z51-G214

CRC Rev. Environ. Contr. ü£ 10:1980- 19:1990 Z54-A101

Crime and Deliquency in California 1984- (-1983 books) Z61-A216-B

Crime and Justice 1987- (-1986 books) Z61-C225-B

Crime Prevention and Criminaal Justice Newsletter 7:1982-1986 Z51-P290-KO

Crime Prevention Review 1:1973-6:1979 Z51-K258

Defense Electronics ü£ 12:1980.3- Z54-A492

Defense News 7(1): 1992- Z92-505 scan. 1992.1.6 - 10.4, 1993.1-4, 1994.1.10 - 12.5/11

Defense Week 9:1988- Z51-P271 scan. 1988.1-1991.12, 1993.1-1994.8.29

Dissent 1:1954- Z51-B15

EEG Clin. Neurophysiol ü£ 14(1):1962- (Z53-N226) scan. 48(1):1980.1 - 83(6):1993.12 (75-81É+û{Æå)

Electro-and magnetobiologyü@ü@ü£ü@Z54-E816 1992- 1993:12(1)

Electronic Design 2:1954- Z53-E464

Electronics ü£ü@ü@(NY) 1:1936- Z53-E462 scan. 1991.6 - 1994.7.25

Endocr. 68:1961- Z53-D61

Endocrine Rev. 2:1981- Z54-B831

Epilepsia 3: 1962- Z53-D357

Exerpta Medica 22:1969-57:1990 Z53-P418

Exp. Brain Research ü£1(1):1965- Z53-M198 scan. 1980 - 43: 1981

Exp. Neurology ü£5(1):1962- Z53-D69 scan..1993.10 --> 1992.11:118(2)

Fate

Fed. Probation 12:1948-46:1982 (1983- Int'l Organ. Data House) Z51-D48-M scan.'70-77,80-91.3.

Fed. Proc. ü£1:1942- Z53-B428

Folia Primatologica ü£1:1936- Z53-P207

Folia Psychiat. et Neurol. Japon. ü£1:1935-39:1985 Z53-D351 (ê+ì~JJPN)

Frontiers Med. Biol. Eng. (Japan) 1: 1988 - Z54-G799 scan. 1:1988- 6(1): 1994

Futurist 5(1):1971 - Z55-B295 scan.25(3):1991.5/6 - 29(1):1994.6

Health Phys. 1:1958- Z53-B470

Helvetic Physiol. Pharmacol. Accta ü£1:1943- Z53-D27

Human Neurobiology 1: 1982- Z54-D561 scan. 1982 - 1988

IEEE Eng. Med. Biol. Mag. ü£ 1:1982.3- Z54-D705 scan. 1:1982 - 13(3):1994.6/7 (ex1990-1991)

IEEE Spectrum ü£ 1:1964- Z53-L389

IEEE Int. Conv. Rec. 8:1961- Z53-P160

IEEE Trans. AES (Aerospace and Electronic Systems) ü£ (Z53-M119)

IEEE Trans. BME (Bio-Medical Engineering) ü£11(1):1964.1- Z53-M457

scan. 27(1):1980.1- 41(7):1994.7; îç1985.7-12, 1987.7-12; É+û{Æâ 1990.1-12.

IEEE Trans. Magn. 1:1965- Z53-L156

IEEE Trans. MTT (Microwave) ü£ 11:1963- Z53-N415.

Ind. Hyg. Occupat. Dis. (USSR) ü£ NIL

Indian J. Med. Res. ü£51:1963, 71:1980- Z53-C569

Indian J. of Physiology and Pharmacology ü£28(1):1979- Z56-A156

Int. Defense Rev. ü£ 4:1971.2- Z51-J146ü@ü@ü@scan. 1980 - (1994.1-4 NIL) 1994.10

Int. J. appl. Radiat. Isotopes 1: 1956- Z53-B90

Int. J. Biometeorol. ü£ 5:1961- Z53-B493

Int. J. Chronobiol. ü£ 1:1973- 8:1983 Z53-V20

Int. J. clin. exp. Hypnosis 28:1980- Z54-A799

Int. J. clin. Neuropsychol. 6:1984- Z54-C436 scan. 6:1984-12(4):1990

Int. J. Neurol. 13: 1979- Z54-C471

Int. J. Neuropsychiat. ü£NIL

Int. J. Neuosci. ü£ 1:1970- Z53-W446

Int. J. Psychobiol. ü£NIL

Int. J. Quant. Chem. 1:1967- Z53-N92

Int. J. radiat. Biol. 54:1988- Z53-B471

Int. Review of Neurobiology ü¢27:1985- Z63-A100 (æOè¬É}Åæê¦éó) scan. 1985-1993

Investigative Radiology ü@ü£ 14:1979- Z53-X88

IRCS Med. Sci. 9: 1981- Z54-B794

J. Acousi.Soc. Amer. ü£1:1929- (Z53-P26)

J. Am. Geriatr. Soc. ü£1:1953- Z54-Z332

J. Am. med. Ass. 173: 1960- Z53-N157

J. Appl. Phys. 8:1937- Z53-A376

J. Appl. Physiol. ü£1(1):1948- Z53-D28

J. Bioelectricity ü£ 1:1982-10:1991 scan.all Z54-E816 1992- Electro-and magnetobiology

J. biological physics ü£ 9:1981- Z54-D254

J. Cellular and Comparative Physiology ü£1(1):1932- Z53-D30

J. Clin. Psychiatry 41:1980- Z54-B211

J. comp. Physiol. A 154:1984- Z53-C185

J. comp. Physiol. B 154:1984- Z53-Y175

J. comp. Physiol. Psychol. ü£1947- Z52-A55

J. comp. Psychol. ü£ü@1:1921- Z52-A55

J. Criminal Justice 1:1973- Z51-K35

J. Exp. Anal. Behav. ü£ 1(1):1958- (Z53-V324)

J. Exp. Biol. 1: 1923- Z53-B396

J. Genet. Psychol. ü£84:1954- Z53-M295

J. Hist. Med. allied Sci. 1:19496- Z53-C499

J. interdiscipl. Cycle Res. ü£1:1970.5- Z53-S32

J. Iowa Med. Soc. ü£70:1980- Z53-B128

J. Ment. Sc. ü£ => British J. Psychiatry 97:1951- Z53-D353

J. Microwave Power ü£ 14:1979.3- Z53-X292 scan. - 28(2):1993 (excl.24,25)

J. Nervous and Mental Disease ü£ 169:1981- (Z54-B767) scan.-1993.1 (excl.1989.1-1991.6)

J. Neural Transm. 44:1979- Z53-V391

J. Neurol. Sci. 40:1979- Z53-V226

J. Neurophysiology ü£1(1):1938.1- Z53-D71

J. Neuropsychiat. ü£NIL

J. Neurosurgery ü£52(1):1980- Z54-A778 scan. 52(1):1980 - 80(6):1994.6 (ex1991.4-1991.12)

J. Neurol. Neurosurg. Psychiat. ü£1(1):1938- Z53-D352 scan. 1980-48(6):1985.6

J. Occup. Med. ü£ 21:1979.8- Z53-X91

J. Physiol. (Lond.) ü£140:1958- Z53-D32

J. Psychol. ü£1:1935/1936- Z52-A36

Laboratory Animal Science 21(1): 1971 - 42(6):1992.12 Z53-P334

Lancet ü£ 222(5672): 1932.5- ü£Z53-C416 scan 1984 (June & Dec. INDEX)

Laryngscope ü£90:1980- Z54-A412

Life Sci. ü£ 1963- Z53-B399

Los Alamos Science 9:1983- Z54-F230 scan. 1983-1993 (excl. 1991)

Mal.Cardiovas. ü£NIL

Mayo Clinic Proceedings ü£55:1980.1- Z54-A509

Med. biol. Eng. ü£4(1):1966- Z53-D304ü@

Med. biol. Eng. Comput. ü£15:1977- Z53-D304ü@

Med. Electron. Biol Eng. ü£ 1:1963-3:1965 Z53-D304

Med. Instru. ü£ 14:1980- Z54-A106

Med. Progress through Technology ü£1(1):1972- Z53-W401

Med. Res. Eng. ü£5(2):1966- Z53-D301

Metabolism 11:1962- Z53-D50

Microwave News ü£ NIL

Microwaves and RF 21:1982- Z53-F6

Military Electronics Countermeasures 6(6):1980.6-9(4):1983.4 E54-A821

Military Rev. ü£ 36(9):1956.12- Z51-D3 scan.1980-1989.11, 1990.1-12, 1992.5-1994.5

Military Sci. & Technology 2(2):1982.1-2(3):1982.6 Z54-E398

Mutation Res. ü£ 1:1964- Z53-L479

The Nation Z55-A180

Nature ü£1:1869- (Z53-A28) scan.366(6452): 1993.11 --> 360:1992 (6444-6450 ë{ùùÆå)

Naturwissenschaften ü£7:1919- (Z53-A31)

Nav.Res.Rev. ü£(Z53-A119)

Neurobehav. Toxicol. 1:1979- Z54-C108

Neurochirurgie ü£ 26:1980- Z54-A650

Neurologica Medicochirurgica (Tokyo) 1:1959-18:1978 Z53-M401

Neurology ü£31(1):1981.1- Z54-C89

Neuroophthalmol. NIL

Neuropsychobiology (Basel) 1:1975- Z54-A288

Neuropsychologia 1:1963- Z53-D355

Neuroscience 1:1976- Z53-V202

Neurosci. Biobehav. Rev. 3:1979- Z53-X60

Neurosurgery ü£ 6 (1): 1980.1- (Z54-A464) scan. 1980-1994.6

N. Engl. J. Med. ü£244:1951- Z53-N131 scan.1981.1-8 (6,12 Index)

N. Scientist 52(772): 1971.12- Z53-A35 scan. 1993.12.4-1994.2.12, 1994.5.14-7.16

N.Y. State J. Med. ü£ 42:1942- Z53-C432

N. Y. T. Int. Ed. Z92-442 (City Ed. Z92-2)

N. Y. T. Magazine 1925.1- Z55-A183

Official J. Internat. Soc. Biotelemetry ü£

Origins of Life 5:1974- Z53-P272

Percept Mot Skills 1:1949- Z53-V473

Perspectives 13: 1986- Z51-P230 & others

Philosophical Transactions Ser.B ü£Z53-B445

Phys. Lett. 24:1967- Z53-A387

Physica Scripta ü£ 1:1982- Z54-H114

Physiologist ü£ 4:1961.2- Z53-D36

Physiology and Behvior ü£1(1):1966- Z53-M343

Physiol. chemistry and physics ü£ 11:1979- Z53-W127

Physiol. Rev. ü£ 1:1921- Z53-D34

Planetary Association for Clean Energy (PACE ) #

Popular Electronics 6:1957- Z53-F12

Proc. ecol. Soc. Aust. ü£NIL

Proc. IEEE ü£ü@51:1963- Z53-F56ü@

Proc. Int. Union Physiol. Sci. ü£NILü@

Proc. Nat. Acad. Sci. USA ü£ 1:1915- Z53-A78

Proc. R. Soc. Med. 55: 1962- Z53-C484

Proc. Soc. Exp.Biol.and Med. ü£28(1):1930- Z53-B438

Progressive 21:1957- 31:1967 Z52-B273

Progr. Brain Res. ü£NIL

Progr. Neurol. Surg. NIL

Psychiatr. Neurol. Jap. ü¢

Psychological Bulletin ü£1(1):1904.1- Z52-A41

Psychological Reports ü£ 10:1962- Z52-A43

Psychol. Rev. ü£1:1894- Z52-A39

Psychol. Today 6:1973-23:1989 Z53-S376

Psychonomic Sci.ü@ü@ü£NIL

Psychosom. Med. ü£ 11:1949- (excl. 22-41) Z53-D591

Quart. Rev. Biol. 1:1926- Z53-P394

Rad. Environ. Biophys. 11:1974- Z53-L144

Radio Sci. ü£ 1:1966- Z53-L8ü@scan 1980-1981.10ü@

Res. Publ. Ass. nerv. ment. Dis. ü£ NIL

Revue neurol. 135: 1979- Z53-V467

Science ü£1:1883- ü£Z53-A48

Science News ü£92(22):1967.11- (Z53-A53)

Scientific American ü£1(1):1859.7.2- Z53-A54

Sensors and Actuators 2:1981- Z54-C646

Smithsonian 6:1976- Z55-C258

Social Theory and Practice 2: 1973- Z51-K140

Surgery ü£ (St Louis) 87:1980- Z54-A596

Surgical Neurology ü£ 13(2):1980.2- (Z54-A694)

Technology Review 59:1957- Z53-C305

Tekhnika Moledezhi 22(2): 1954- Z53-C311

Time 23(1): 1934- Z55-A401

Tohoku J. exp. Med. 1:1920- Z53-C486

Trans. Am. Acad. Ophthalmol. Otolaryngol. ü£NIL

Trans. Am. Neurol. Assn. ü£NIL

Trans. Am. Soc. Artif. Int. Organs ü£NIL

Trans. Kans. Aca. Sci. 64: 1961- Z53-A96

US News & World Report Z55-A188

Yale J.of Biology and Medicine ü£ 22:1949- (Z53-B349)


Appel P: Performance enhancement in physical medicine and rehabilitation. Am J Clin Hypn 35(1):13-24, 1992

Balthazard C: The hypnosis scales at their centenary: Some fundamental issues still unresolved. Int J Clin Exp Hypn 41:47-73. 1973

Banyai El, Meszaros I, Greguss AC: Alteration of activity level: The essence of hypnosis or a byproduct of the type of induction? In Adam G, Meszaros I, Banyai EI (eds): Advances in Physiological Sciences, vol 17. Brain and Behavior. New York, Pergamon, pp 457-465, 1981

Barber TX: Hypnosis: A scientific approach. Northvale. New Jersey. Jason Aronson, 1995

Beahrs J: Unity and multiplicity: Multilevel consciousness of self in hypnosis. In Psychiatric Disorder and Mental Health. New York, Brunner Mazel, 1982

Bernheim H: Suggestive therapeutics. New York. Putnam, 1897

Bishay EG, Lee C: Studies of the effects of hypnoanesthesia on regional blood flow by transcutaneous oxygen monitoring. Am J Clin Hypn 27(1):64-69, 1984

Blakely T: Orientation in time: Implications for psychopathology and psychotherapy. Am J Clin Hypn 34(2):100-110, 1991

Boucsein W: Electrodermal Activity. New York, Plenum Press, 1992

Bowers KS: Dissociation in hypnosis and multiple personality disorder. Int J Clin Exp Hypn 39(3):155-176, 1991

Bowers KS, LeBaron S: Hypnosis and hypnotizability: Applications for clinical intervention. Int J Clin Exp Hypn 37:457-467, 1986

Bryant R, McConkey K: Hypnotic emotions and physical sensations: A real-simulating analysis. Tnt J Clin Exp Hypn 37:305-319, 1989

Burgess P: The use or hypnosis with dermatological conditions. Australian Journal of Clinical and Experimental Hypnosis 24:110-119, 1996

Chaves J: Hypnosis: The struggle for a definition. Contemporary Hypnosis 11:145-146, 1994

Cheek DB: Why did the fathers of psychoanalysis abandon hypnosis? Hypnos 22(4):211-215, 1995

Counts R: The concept of dissociation. J Am Acad Psychoanal 18:460-479, 1990

Crabtree A: From Mesmer to Freud: Magnetic Sleep and the Roots of Psychological Healing. New Haven. Yale University Press, 1993

Crawford H: Brain dynamics and hypnosis: Attentional and disattentional processes. Int J Clin Exp Hypn 42(3):204-232, 1994

Crile GW: Autobiography. Philadelphia, Lippincott, 1947

Darnton R: Mesmerism and the end of the Enlightenment in France. New York, Schocken, 1970

Davic-Jefdic M, Barnes G: Event-related potentials during cognitive processing in hypnotic and nonhypnotic conditions. Psychitria Danubina 5(1-2):47-61, 1993

Deabler H, Fidel E, Dillenkoffer R: The use of relaxation and hypnosis in lowering high blood pressure. Am Clin Hypn 16:75-83, 1973

DeBenedittis G, Cigada M, Bianchi A: Autonomic chances during hypnosis: A heart rate variability power spectrum analysis as a marker of sympatho-vagal balance. Int J Clin Exp Hypn 42(2):140-152, 1994

De Pascalis V: EEG spectral analysis during hypnotic induction. hypnotic dream and age regression. International Journal of Psychopathology 15(2):153-166, 1993

Diamond MJ: It takes two to tango--Some thoughts on the neglected importance of the hypnotist in an interactive hypnotherapeutic relationship. Am J Clin Hypn 27(1):3-13, 1984

Diehl B,Meyer H, Ulrich P: Mean hemispheric blood perfusion during autogenic training and hypnosis. Psychiatry Res 29(3):317-318. 1989

Dinges D, Whitehouse W, Orne E: Evaluating hypnotic memory enhancement (hyperamnesia and reminiscence) using multitrial forced recall. Journal of Experimental Psychology 18:1139-1147, 1992

Drabovich W: Fragilité de la liberté et séduction des dictatures. Essai de Psychologie Sociale. France. Mercure de France. 1934

Dudley DL. Holmes TH. Maitin CJ: Changes in respiration association with hypnotically induced emotion. pain and exercise. Psychosom Med 26:46-57, l964

Edmonston W: Neutral hypnosis as relaxation. Am J Clin Hypn 20:69-75, 1977

Edwin D: Hypnotic technique for recall of sounds heard under general anaesthesia. In Bonke B, Fitch W, Millar K (eds): Memory and Awareness in Anaesthesia. Amsterdam, Swets Zeitlinger, 1990, pp 226-232

Ellenberg H: The Discovery of the Unconscious. New York, Basic Books, 1970
Erickson JC: The use of hypnosis in anesthesia. Int J Clin Exp Hypn 42(1):8-12, 1994
Erickson MH: Further clinical techniques of hypnosis: Utilization techniques. Am J Clin Hypn 2:3-21, 1959
Esdaile J: Mesmerism in India and its practical application in surgery and medicine. London, longmans Green, 1850
Fellows BJ, Richardson J: Relaxed and alert hypnosis: An experimental comparison. Contemporary Hypnosis 10:49-54, 1993
Ferenczi S: Introjecktion und Vebertragung. JB Psychoanalyse 1:422, 1909
Field PB: An inventory scale of hypnotic depth. Int J Clin Exp Hypn 13:238-249, 1965
Frankel FH: Hypnotizability and dissociation. Am J Psychiatry 147:823-829,1990
Freundlich B, Fisher S: The role of body experience in hypnotic behavior. Int J Clin Exp Hypn 22:68-83, 1974
Friedman H, Taub H: The use of hypnosis and biofeedback procedures for essential hypertension. Int J Clin Exp Hypn 25:335-347, 1977
Fromm E: Quo vadis hypnosis: Predictions of future trends in hypnosis research. In Fromm E, Shor R (eds): Hypnosis: Research in Developments and Perspectives. New York, Aldine AthertoII, 1972
Fromm E, Kahn S: Self Hypnosis. The Chicago Paradigm. New York, Guilford, 1990
Frurnkin L, Ripley H, Cox G: Changes in cerebral hemispheric lateralization with hypnosis. Biol Psychiatry 13:741-750, 1978
Gabel S: The right hemisphere in imagery, hypnosis, rapid eye movement sleep and dreaming: Empirical and tentative conclusions. J Nerv Ment Dis 176:323-331, 1988
Gardner E: Fundamentals of Neurology: A Psychophysiological Approach. Philadelphia, W.B. Saunders Co., 1975
Garver R: Eight steps to self hypnosis. Am J Clin Hypn 26(4):232-235, 1984
Gill M. Brenman M: Hypnosis and related states: Psychoanalytic studies in regression. New York, International Universities Press, 1954
Graffin N. Ray W, Lundy R: EEG concomitants of hypnosis and hypnotic susceptibility. J Pers Soc Psychol 50:1004-1012, 1995
Graham KR: Hypnosis: A case study in science. Hypnos 17:78-84, 1991
Gravitz MA: Early theories of hypnosis: A clinical perspective In Lynn S, Khue J (eds): Theories of Hypnosis: Current Models and Perspectives. New York, Guilfoid, 1991, pp 19-42
Greenleaf E: What to do when a patient falls asleep in hypnosis. In Zilbergeld B, Edelstein MG, Araoz DL (eds): Hypnosis: Questions and Answers. New York, Norton, 1986, pp 160-169
Gruenwald D: A psychoanalytic view of hypnosis. Am J Clin Hypn 24(3):185-190, 1982
Gruzelier J, Warren K: Neuropsychological evidence of reductions on left frontal tests with hypnosis. Psychol 23(1):93-101, 1993
Guillain G: JM Charcot (1835-1893). Sa vie et son oeuvre. Masonson, Paris.
Hammond DC: Age-progression. In Hammond DC (ed): Handbook of Suggestions and Metaphors. New York, Norton, 1990, pp 515-516
Harris R, Proges S. Clemenson-Carpenter M: Hypnotic susceptibility, mood slate and cardiovascular reactivity. Am J Clin Hypn 36(1):15-25,1993
Haule J: The perceptual alteration scale: A scale measuring dissociation. Am J Clin Hypn 29(2):86-94, 1986
Hilgard ER: Hypnotic Susceptibility. New York, Harcourt Brace, 1965
James W: The Varieties of Religious Experience. New York, Longmans Green, 1935
Jutai J, Gruzeilier J, Golds J: Bilateral auditory evoked potentials in conditions of hypnosis and focused attention. Int J Psychophysiol 15(2):167-176, 1993
Kinnunen T, Zamansky H: Hypnotic amnesia and learning: A dissociation interpretation. Am J Clin Hypn 38(4):247-253, 1996
Kirsh I, Lynn SJ: The altered state of hypnosis: Changes in the theoretical landscape, Am Psycho 50:846-858, 1995
Klein K, Spiegel D: Modulation of gastric acid secretion by hypnosis. Gastroenterology 96(6):1383-1387, 1989
Kraines SH: Hypnosis: Physiologic inhibition and excitation. Psychosomatic 10:36-41, 1969
Kroger WS: Hypnosis and behavior modification: Imagery conditioning. Philadelphia, Lippincott, 1976
Levitt E, Brady J: Psychophysiology of hypnosis. In Schneck JM (ed): Psychophysiology of Hypnosis. Indianapolis, Bobbs-Merrill, 1963. pp 314-362
Liggett D, Hamada S: Enhancing the visualization of gymnasts. Am J Clin Hypn 35(3):190-197, 1993
Lovett-Doust JW: Studies in the physiology of awareness: Oximetric analysis of emotion and the differential planes of consciousness seen in hypnosis. Journal of Clinical and Experimental Psychopathology 14:113-126, 1953
Ludwig A: Altered states of consciousness. In Tart C (ed): Altered States of Consciousness. Garden City Doubleday & Co.. 1972. pp 11-24
Lynn S, Rhue J: Theories of Hypnosis: Current Models and Perspectives, New York, Guilford, 1991
Maiolo AT, Porro GB, Granone F: Cerebral hemodynamics and metabolism in hypnosis. Br Med J 1:314-320, 1969
Malort JM: Active-alert hypnosis: Replication and extension of previous research, J Abnorm Psychol 93:246-249, 1984
Margolis CG, Domangue BB, Ehleben MS: Hypnosis in the early treatment of burns: A pilot study. Am J Clin Hypn 26:9-15, 1983
Martin D, Lynn SJ:The hypnotic simulation index: Successful discrimination of real versus simulating participants. Int J Clin Exp Hypn 44(4):338-353, 1996
Meares A: A System of Medical Hypnosis. New York, Julien Press, 1972
Megas JC, Coe W: Hypnosis as role-enactment:The effect of positive information about hypnosis on self role congruence. Am J Clin Hypn 15(2):132-137, 1975
Melzack R, Perry C: Self-regulation of pain: The uses of alpha-feedback and hypnotic training for the control of chronic pain. Exp Neurol 46:452-469, 1975

Morgan J, Darby B, Heath B: The future of hypnosis through the remainder of the decade: A Delphipoll. Am J Clin Hypn 34(3):149-157, 1992
Mott T: Hypnotizability testing and clinical hypnosis. Am J Clin Hypn 32:2-3, 1995
Naranjo C, Orenstein R: On the Psychology of Meditation. New York, Viking, 1971
Nash M, Spindler D: Hypnosis and transference: A measure of archaic involvement with the hypnotist. J Clin Exp Hypn 37:129-144. 1989
Nathan RG, Morris DA, Goebel RA: Preoperative and intraopcrative rehearsal in hypnoanaesthesia for major surgery. Am J Clin Hypn 29(4):238-241, 1987
Orne M: The nature of hypnosis: Artifact and essence. J Abnorm Psychol 58:277-299, 1959
Orne MT: The mechanisms of hypnotic age regression: An experimental study. Journal of Abnormal and Social Psychology 46:213-225, 1951
Papez JW: A proposed mechanism of motion. Archives of Neurology and Psychiatry 38:725, 1937
Pavlov IP: Conditioned Reflexes. London, Oxford University Press, 1927
Pavlov IP: The identity of inhibition with sleep and hypnosis. Scientific Monthly 17:603-608, 1923
Penfield W, Rasmussen R: The cerebral cortex of man: A clinical study of localization of function, New York, Macmillan, 1950
Perry C: Theorizing about hypnosis in either/or terms. Int J Clin Exp Hypn 40:238-252, 1992
Porter J: Suggestions and success imagery for study problems. In J Clin Exp Hypn 26(2):63-75, 1978
Raikov V: Hypnoticage regression to the neonatal period: Comparison with role playing. Int J Clin Exp Hypn 30:108-116, 1982
Rossi A, Cavatton G, Marotti A: Hemodynamics following real and hypnosis-simulated phlebotomy. Am J Clin Hype 40(11):368-375, 1997
Rossi EL, Check DB: Mind-Body Therapy. New York, Norton, 1958
Rouget G: La Musique et la Trance. Paris, Gallimard, 1980
Sacerdote P: Teaching self-hypnosis to adults. Int J Clin Exp Hypn 29(3):282-299, 1981
Sachar EJ. Fishman JR. Mason JW: The influence of the trance on Plasma 17-dydrcorticosterod concentration. Psychosom Med 26:635-636, 1964
Sanders S: Clinical Self-hypnosis: The Power of Words and Images. New York, Guilford, 1991
Sanders S: The perceptual alteration scale: A scale measuring dissociation. Am J Clin Hypn 29(2):95-102.1986
Saletu B: Brain function during hypnosis, acupuncture and transcendental meditation. In Taneli B. Perris C, Kemali D (eds): Advances in Biological Psychiatry: Neurophysiological Correlates of Relaxation and Psychopathology, vol 16. Basel, Karger. 1987, pp 18-40
Sarbin TR: Physiological effects of hypnotic stimulation. In Dorcus R-M (ed): Hypnosis and its Therapeutic Applications. New York, McGraw-Hill, 1956, pp 1-57
Sarbin TR, Coe WC: Hypnosis: A Social-Psychological Analysis of Influential Communication. New York. Holt Reinhart Winston, 1972
Sarbin T, Slagle R: Hypnosis and psychophysiological outcomes. In Fromm E, Shore (eds): Hypnosis: Research Developments and Perspectives. Chicago, Aldine Atherton, 1972, pp 185-214
Schacter DL: Searching for memory: The brain, the mind and the past. New York, Basic Books, 1996
Schilder P. Kanders O: The Nature of Hypnosis, part II. New York, International Universities Press, 1956, pp 45-184
Schilder PF: Regression in the service of the ego. New York, International Press, 1958
Shapiro D: Overview: Clinical and psychological comparison of meditation with other self-control strategies. Am J Psychiatry 139(3):267-274, 1982
Sheikh A: Eidetic psychotherapy. In Singer J, Pope K (eds): The Power of Human Imagination. New York, Plenum Publishing Corp., 1978
Shrikh AA. Sheikh KS: Eastern and Western Approaches to Healing: Ancient Wisdom and Modern Knowledge. New York, John Wiley & Sons, 1981
Shor RE: Three dimensions of hypnotic depth. Int J Clin Exp Hypn 10:23-38, 1962
Silverman J: A paradigm for the study of altered states of consciousness. Br J Psychiatry 114:1201-1218, 1968
Spiegel D, King R: Hypnotizability and CSF HVA levels among psychiatric patients. Biol Psychiatry 31:95-98, 1992
Spiegel H. Spiegel D: Trance and Treatment: Clinical Uses of Hypnosis. New York, Basic Books. 1978
Stanton H: Sports imagery and hypnosis. A potent mix. Australian Journal of Clinical and Experimental Hypnosis 22(2):119-124, 1994
St Jean R: Hypnotic underestimation of time: Fact or artifact? British Journal of Experimental and Clinical Hypnosis 5(2):82-86, 1988
Sturgis L, Coe W: Physiological responsiveness during hypnosis. Int J Clin Exp Hypn 38(3):196-207, 1990
Tart CT: From spontaneous event to lucidity: A review of attempts to consciously control nocturnal dreaming. In Wolman B (ed): Handbook of Dreams: Research, Theories and Applications. New York, Van Nostrand Reinhold, 1979, pp 226-268
Tart CT: Quick and convenient assessment of hypnotic depth: Self report scales. Am J Clin Exp Hypn 21:186-207, 1979
Tart CT: States of Consciousness. New York, Dutton, 1975
Tebecis AK, Provins KA, Farnbach RW: Hypnosis and EEG. J Nerv Ment Dis 161:1-17, 1975
Twenlow SW, Gabbard G, Jones F: The out-of-body experience: A applied phenomenological typology based on questionnaire responses. Am J Psychiatry 139:450-455, 1982
Vishwanath R: The psychoneuroimmunology system: A recently evolved networking organ system. Med Hypotheses 47(4):265-268, 1996

Von Kirchenheim C Persinger M: Time distortion: A comparison of hypnotic induction and progressive relaxation procedures. Int J Clin Exp Hypn 39(2):63-66, 1991
Warner L, McNeil ME: Mental imagery and its potential for physical therapy. Phys Ther 68:516-521, 1988
Watkins J, Watkins H: Hypnosis and ego-state therapy. In Keller P, Heyman S (eds): Innovations in Clinical Practice: A Source Book. Sarasota, Professional Resource Exchange. 1991, pp 23-37
Williamsen JA, Johnson HJ, Ericksen CW: Some characteristics of hypnotic anaesthesia. J Abnorm Psychol 70:123-131, 1965
Wilson J. Turner D: Awareness during caesarean section under general anaesthesia. Br Med J 1:280-283, 1969
Wolberg LR: Hypnoanalysis. New York, Grune & Stratton, 1964
Zilborg G: A History of Medical Psychology. New York, Norton, 1941
Norry: *Metologia Hipnotica, La Semana Medica ( Buenos Aire ) Mar 1956 pages 312-318*
Wakin : *Ultrasonic energy as applied to medicine- from the American Journal of Physical Medicine - Feb 1953 Vol 32 No 1 pages 32-45*
*George A. Miller The Magical Number Seven, plus or minus Two: Some limits on our capacity for processing information*

**Sergey A. Miroshnikov / THEORETICAL AND COMPUTER MODELLING OF THE NEUROPSYCHOLOGICAL SYSTEM: FROM REFLEX - TO CONSCIOUSNESS - Materials of the report at the XXVII International Congress of Psychology Stockholm 23-28 July 2000 Saint-Petersburg State University 2000**

Alfred Tarski: LOGIC, SEMANTICS, METAMATHEMATICS (Clarendon, 1956)

Taylor Charles: THE EXPLANATION OF BEHAVIOR (Routledge & Kegan,1964)

Thagard Paul: MIND (MIT Press, 1996)

Thelen Esther & Smith Linda: A DYNAMIC SYSTEMS APPROACH TO THE DEVELOPMENT OF COGNITION AND ACTION (MIT Press, 1994)

Thom Rene': STRUCTURAL STABILITY AND MORPHOGENESIS (Benjamin, 1975)

Tipler Frank: THE PHYSICS OF IMMORTALITY (Doubleday, 1995)

Toffoli Tom: CELLULAR AUTOMATA MACHINES (MIT PRess, 1987)

Touretzky David: THE MATHEMATICS OF INHERITANCE SYSTEMS (Morgan Kaufman, 1986)

Trehub Arnold: THE COGNITIVE BRAIN (MIT Press, 1991)

Tulving Endel: ORGANIZATION OF MEMORY (Academic Press, 1972)

Turbayne Colin Murray: THE MYTH OF METAPHOR (Yale Univ Press,1962)

Turing Alan Mathison: MORPHOGENESIS (North-Holland, 1992)

Turing Alan: PURE MATHEMATICS (Elsevier Science, 1992)

Turing Alan: MECHANICAL INTELLIGENCE (Elsevier Science, 1992)

Turner Raymond: LOGICS FOR ARTIFICIAL INTELLIGENCE (Ellis Horwood, 1985)

Turner Scott: THE CREATIVE PROCESS (Lawrence Erlbaum, 1994)

Turvey Michael: PERCEIVING, ACTION AND KNOWING (Lawrence Erlbaum, 1977)
Tversky Amos, Kahnemann Daniel & Slovic Paul: JUDGMENT UNDER UNCERTAINTY (Cambridge University Press, 1982)

Tye Michael: THE METAPHYSICS OF MIND (Cambridge University Press, 1989)

Tye Michael: TEN PROBLEMS OF CONSCIOUSNESS (MIT Press, 1995)

Ulanowicz Robert: GROWTH AND DEVELOPMENT (Springer-Verlag, 1986)

Underwood Geoffrey: ASPECTS OF CONSCIOUSNESS (Academic Press, 1982)

Unger Peter: IDENTITY, CONSCIOUSNESS AND VALUE (Oxford UnivPress, 1991)

Valiant Leslie: CIRCUITS OF THE MIND (Oxford University Press, 1994)

Van Benthem Johan: THE LOGIC OF TIME (Kluwer, 1991)

Van Benthem Johan: A MANUAL OF INTENSIONAL LOGIC (Univ Of Chicago Press, 1988)

Van Benthem Johan: LANGUAGE IN ACTION (MIT Press, 1995)

Wilson mellows down his original stand on the mind as a mere
Winograd Terry: LANGUAGE AS A COGNITIVE PROCESS (Addison Wesley, 1983)
Winograd Terry: UNDERSTANDING NATURAL LANGUAGE (Academic Press, 1972)

Winograd Terry & Flores Fernando: UNDERSTANDING COMPUTERS AND COGNITION (Ablex, 1986)

Winson Jonathan: BRAIN AND PSYCHE (Anchor Press, 1985)

Winston Patrick: ARTIFICIAL INTELLIGENCE (Addison Wesley, 1993)

Wittgenstein Ludwig: PHILOSOPHICAL INVESTIGATIONS (Macmillan, 1953)
Wolfram Stephen: CELLULAR AUTOMATA AND COMPLEXITY (Addison-Wesley, 1994)
Wood Mary McGee: CATEGORIAL GRAMMARS (Routledge, 1993)
Woods William: SEMANTICS FOR A QUESTION-ANSWERING SYSTEM (Garland, 1967)
Wright Larry: TELEOLOGICAL EXPLANATIONS (Univ of California Press, 1976)
Yager Ronald & Zadeh Lotfi: AN INTRODUCTION TO FUZZY LOGIC APPLICATIONS (Kluwier Academic,1992)

Zadeh Lotfi: FUZZY LOGIC APPLICATIONS (Kluwer Academics, 1992)

Zeki Semir: A VISION OF THE BRAIN (Blackwell, 1993)

Zimmermann Hans: FUZZY SET THEORY (Kluwer Academics, 1985)

Wiener N. Cybernetics or Control and Communication in Animal and the Machine. New York, Wiley. 1948.

Borisyuk R.M., Borisyuk G.N., Kazanovich Y.B. The Synchronization Principle in Modelling of Binding and Attention // Membr. Cell Biol., 1998, Vol. 11 (6), pp. 753-761.

Crick F., Koch C. Are we aware of neuronal activity in primary visual cortex? // Nature. 1995. V. 375. # 625. P. 121-123.

Desmedt J., Tomberg C. Neurophysiology of preconscious and conscious mechanisms of the human brain // Abstracts of the Xth International Congress of Electromyography and Clinical Neurophysiology. Kyoto, Japan, October 15-19, 1995. P 4.

Dorrer M.G., Gorban A.N., Kopytov A.G., Zenkin V.I. Psychological Intuition of Neural Networks. Proceedings of the WCNN'95 (World Congress on Neural Networks'95, Washington DC, July 1995). PP. 193-196.

Edelman G.M. The remembered present. A biological theory of consciousness. New York. Basics Books, 1989. 346 pp.

Edelman G.M., Mountcastle V.B. The mindful brain. Cortical Organization and the Group-Selective Theory of Higher Brain Function. Cambridge and London, 1978.

Ermentrout B., Kopell N. Learning of phase lags in coupled neural oscillators. Neural Computation, v. 6, 1994, pp. 225-241.

Frick F.C. Information Theory. Psychology: Study of a Science. Study 1, vol. 2. New York - Toronto - London, 1959.

Gray J.A. The contents of consciousness: A neuropsychological conjecture // Behav. Brain Sci. 1995. Vol. 18 # 4. P. 659-676.

Mead G.H. Mind, Self and Society. Chicago, 1934.

Minsky M. The Society of Mind. New York, 1985.

Miroshnikov S.A. Psychophysiology of the computer model - the approach to research of organization of information in the biosystem // Mechanisms of adaptive behavior. Abstracts of International symposium dedicated to Academician Ivan Pavlov's 150-anniversary. Russian Academy of Sciences, St. Petersburg, Russia, December 7-9, 1999. P. 129-130.

Schuster H.G., Wagner P. A model for neuronal oscillations in the visual cortex. 2. Phase description of the feature dependent synchronization. Biol. Cybern., v.64, 1990, pp.83-85.

Shen B., Nadkarni M., Zappulla R.A. Spectral modulation of cortical connections measured by EEG coherence in humans // Clin. Neurophysiol. 1999. V. 110. P. 115.

Sompolinsky H., Golomb D., Kleinfeld D. Global processing of visual stimuli in a neural network of coupled oscillators. Proc. Natl. Acad. Sci., v. 87, 1990, pp. 7200-7204.

Stoerig P., Brandt S. The visual system and levels of perception: properties of neuromental organization. // Theoretical Medicine. 1993. V. 14. No 2. P. 117-135.
Wiener N. Cybernetics or Control and Communication in Animal and the Machine. New York, Wiley. 1948.
бММБИЧЕТДПЧ ч.н. уПЪОБОЙЕ ЛБЛ РБТБДПЛУ. ф. 1. ю. 2. урВ, 1999. 422 У. Allahverdov V.M. Consciousness as a paradox. V. 1. Part. 2. Saint-Petersburg, 1999. 422 p. (in Russian)

чЕЛЛЕТ м.н. чПУРТЙСФЙЕ Й ПУОПЧЩ ЕЗП НПДЕМЙТПЧБОЙС, йЪД-ЧП мзх, 1964. Vekker L.M. Perception and fundamentals of its simulation, Leningrad, 1964. P. 38-56. (in Russian)

зПРРБ ч.д. чЧЕДЕОЙЕ Ч БМЗЕВТБЙЮЕУЛХА ФЕПТЙА ЙОЖПТНБГЙЙ. н. оБХЛБ. 1995. Goppa V.D. Introduction in algebraic theory of information. Moscow, 1995. (in Russian)

йЧБОЙГЛЙК б.н. зМБЧОБС ЪБЗБДЛБ РТЙТПДЩ: ЛБЛ ОБ ПУОПЧЕ ТБВПФЩ НПЪЗБ ЧПЪОЙЛБАФ УХВЯЕЛФЙЧОЩЕ РЕТЕЦЙЧБОЙС // рУЙИПМПЗЙЮЕУЛЙК ЦХТОБМ, 1999, ФПН 20, # 3. у. 93-104. Ivanitsky A.M. The main riddle of the nature: the mental events origin out of the brain processing // Psychological journal, 1999, Vol. 20, # 3, P. 93-104. (in Russian)

йЧБОЙГЛЙК б.н., йМШАЮЕОПЛ й.т. лБТФЙТПЧБОЙЕ ВЙПРПФЕОГЙБМПЧ НПЪЗБ РТЙ ТЕЫЕОЙЙ ЧЕТВБМШОПК ЪБДБЮЙ // цХТО. ЧЩУЫ. ОЕТЧО. ДЕСФ. 1992. ф. 42. # 4. у. 627. Ivanitsky A.M., Iljuchenok I.R. Mapping of biological potentials of a brain at solution of the verbal task // Journ. high. nerv. act. 1992. V. 42. # 4. P. 627. (in Russian)

йЧБОЙГЛЙК б.н., уФТЕМЕГ ч.в. чЩЪЧБООЩЕ РПФЕОГЙБМЩ Й РУЙИПЖЙЪЙЮЕУЛЙЕ ИБТБЛФЕТЙУФЙЛЙ ЧПУРТЙСФЙС // цХТО. ЧЩУЫ. ОЕТЧ. ДЕСФ. 1976. ф. 26. # 4. у. 793-801. Ivanitsky A.M., Streletc V.B. The evoked potentials and psychophysical characteristics of perception // Journ. high. nerv. act. 1976. ф. 26. # 4. P. 793-801. (in Russian)

мЕПОФШЕЧ б.о. рТПВМЕНЩ ТБЪЧЙФЙС РУЙИЙЛЙ. н., йЪД-ЧП нзх, 1981. у.219-344. Leontiev A.N. Problems of development of the psyche. Moscow, 1981. P. 28, 62, 219-344. (in Russian)

нБФАЫЛЙО д.р. п ЧЕТПСФОПН УХВУФТБФЕ УХВЯЕЛФЙЧОЩИ УПУФПСОЙК ЮЕМПЧЕЛБ Й П УФБОПЧМЕОЙЙ ЬФПЗП УХВУФТБФБ Ч ЬЧПМАГЙЙ // цХТОБМ ЬЧПМАГЙПООПК ВЙПИЙНЙЙ Й ЖЙЪЙПМПЗЙЙ, 1997, Ф. 33, # 1. у. 99-108. Matyushkin D.P. The probable substratum of subjective states of the man and about development of this substratum in the evolution // Journal of evolutionary biochemistry and physiology, 1997, Vol. 33, # 1. P. 99-108. (in Russian)

нБФАЫЛЙО д.р. гЙФП-ЬФПМПЗЙЮЕУЛЙК РПДИПД Й РУЙИП-ЖЙЪЙЮЕУЛБС РТПВМЕНБ урВ, оБХЛБ 1991. Matyushkin D.P. The Cyto-etological approach and psychophysical problem, St.-Petersburg, Science, 1991. 33 p. (in Russian)

нЙТПЫОЙЛПЧ у.б. лПНРШАФЕТОПЕ НПДЕМЙТПЧБОЙЕ РУЙИПЖЙЪЙПМПЗЙЮЕУЛПК РТПВМЕНЩ // вЙПМПЗЙС Й РУЙИПМПЗЙС: ОПЧЩК УЙОФЕЪ. нБФЕТЙБМЩ НЕЦЧХЪПЧУЛПК ЛПОЖЕТЕОГЙЙ 3 ЖЕЧТБМС 1999 З. уБОЛФ-рЕФЕТВХТЗ, 1999. у. 46-49. Miroshnikov S.A. Computer simulation of a psychophysiological problem // Biology and psychology: new synthesis. Materials of the interuniversity conference of February 3, 1999. St.-Petersburg, 1999. P. 46-49. (in Russian)

нЙТПЫОЙЛПЧ у.б. лПНРШАФЕТОПЕ НПДЕМЙТПЧБОЙЕ ЖХОЛГЙПОБМШОЩИ ОЕКТПРУЙИПМПЗЙЮЕУЛЙИ УЙУФЕН // фЕПТЕФЙЮЕУЛЙЕ Й РТЙЛМБДОЩЕ ЧПРТПУЩ РУЙИПМПЗЙЙ. чЩРХУЛ 3, юБУФШ 1. у.-рЕФЕТВХТЗ, 1997. у. 114-120. Miroshnikov S.A. Computer simulation of functional neuropsychological systems // Theoretical and applied problems of psychology. Vol. 3, Part 1. St.-Petersburg, 1997. P. 114-120. (in Russian)

нЙТПЫОЙЛПЧ у.б. хТПЧОЕЧБС ПТЗБОЙЪБГЙС НПДЕМЙ ОЕКТПРУЙИПМПЗЙЮЕУЛПК УЙУФЕНЩ // бОБОШЕЧУЛЙЕ ЮФЕОЙС - 98. фЕЪЙУЩ ОБХЮОП-РТБЛФЙЮЕУЛПК ЛПОЖЕТЕОГЙЙ 27-29 ПЛФСВТС 1998 ЗПДБ. йЪДБФЕМШУФЧП у.-рЕФЕТВХТЗУЛПЗП ХОЙЧЕТУЙФЕФБ, 1998. у.45-47. Miroshnikov S.A. The level organization of the model of the neuropsychological system // Ananyev reading - 98. Theses of scientific-practical conference of October 27-29, 1998. St.-Petersburg, 1998. P. 45-47. (in Russian)

нЙТПЫОЙЛПЧ у.б. уЙУФЕНОП-ЙОЖПТНБГЙПООЩК РПДИПД Л РУЙИПЖЙЪЙПМПЗЙЮЕУЛПК РТПВМЕНЕ // иии чУЕТПУУЙКУЛПЕ УПЧЕЭБОЙЕ РП РТПВМЕНБН ЧЩУЫЕК ОЕТЧОПК ДЕСФЕМШОПУФЙ, РПУЧСЭЕООПЕ 150-МЕФЙА УП ДОС ТПЦДЕОЙС й.р.рБЧМПЧБ. уБОЛФ-рЕФЕТВХТЗ, 15-18 НБС 2000 З. фЕЪЙУЩ ДПЛМБДПЧ. фПН 2. уБОЛФ-рЕФЕТВХТЗ, 2000. у. 685-688. Miroshnikov S.A. The system-information approach to the psychophysiological problem // иии All-Russia conference on problems of higher nervous activity dedicated. St.-Petersburg, May 15-18, 2000. Theses of the reports. V. 2. St.-Petersburg, 2000. PP. 685-688. (in Russian)

ABORN, M. and RUBENSTEIN, H. (1952). Information theory and immediate recall. J. exp. Psychol. 44, 260-266.

ADELSON, M. (1955). Some observations on a delayed-feedback self-tracking task. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

ADELSON, M., MUCKLER, F.A. and WILLIAMS, A.C., Jr. (1955). Verbal learning and message variables related to amount of information. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

AHRENDT, W.R. and TAPLIN, J.F. (1947). Automatic regulation - a discussion of fundamentals. (Preliminary edition.) Washington: U.S. Library of Congress.

AHRENDT, W.R. and TAPLIN, J.F. (1951). Automatic feedback control. New York: McGraw-Hill.

ALEXANDER, L.T. and GARNER, W.R. (1952). Information transmission in a tracking task. Amer. Psychologist, 7, 276.

ALLANSON, J.T. (1955). Some properties of a randomly connected neural network. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

ALLANSON, J.T. and WHITFIELD, I.C. (1955). The cochlear nucleus and its relation to theories of hearing. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

ALLUISI, E.A., MULLER, P.F. and FITTS, P.M. (1955). Rate of handling information and the rate of information presentation. USAF WADC Tech. Note No. 55-745, iv

ASHBY, W.R. (1946a). The behavioural properties of systems in equilibrium. Amer. J. Psychol. 59, 682-686.

ASHBY, W.R. (1946b) Principles for the quantitative whole system; with some applications to the nervous system. J. ment. Sci. 92, 319-323.

ASHBY, W.R. (1947a). Dynamics of the cerebral cortex - automatic development of equilibrium in self-organization systems. Psychomet. 12, 135.

ASHBY, W.R. (1947b). Dynamics of the cerebral cortex. XIII - Inter-relations between stabilities of parts within a whole dynamic system. J. comp. physiol. Psychol. 40, 1.

ASHBY, W.R. (1947c). The nervous system as a physical machine, with special reference to the origin of adaptive behaviour. Mind, 56, 44.

ASHBY, W.R. (1947d). Principles of the self-organizing dynamic system. J. gen. Psychol. 37, 125-128.

ASHBY, W.R. (1948). The homeostat. Electron. 20, 380.

ASHBY, W.R. (1950a) The cerebral mechanism of intelligent action. In D. Richter (Ed.), Perspectives in neuropsychiatry .London: H.K. Lewis.

ASHBY, W.R. (1950b). Cybernetics. In G.W.T.H. Fleming (Ed. ), Recent progress in psychiatry-2. J. ment. Sci. Suppl.

ASHBY, W.R. (1950c). The stabilityof a randomly assembled nerve-network. EEG clin. Neurophysiol. 2, 471-482.

ASHBY, W.R. (1952a). Can a mechanical chess-player outplay its designer? Brit. J. Phil. Sci. 3, 44

ASHBY, W.R. (1952b). Design for a brain. London: Chapman and Hall.

ASHBY, W.R. (1953a.). Homeostasis. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

ASHBY, W.R. (1953b). Mechanical chess player. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

ASHBY, W.R. (1954). The application of cybernetics to psychiatry. J. ment. Sci. 100, 114-124.

ASHBY, W.R. (1956a). Design for an intelligence-amplifier. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, NJ.: Princeton Univer. Press.

ASHBY, W.R. (1956b). The effect of experience on a determinate dynamic system. Behav. Sci. 1, 35-42.

ASHBY, W.R. (1956c). An introduction to cybernetics. London: Chapman and Hall.

ATTNEAVE, F. (1954). Some informational aspects of visual perception. Psychol. Rev. 61, 183-193. Also (1954) USAF Pers. Train. Res. Cent. Bull. No.54-59.

ATTNEAVE, F. (1955a). The estimation of transmitted information when conditional probabilities are interdependent. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

ATTNEAVE, F. (1955b). Symmetry, information and memory for patterns. U.S.A.F. Personn. Train. Res. Cent. Rep. No. TN-55-29. Also (1955) Amer. J. Psychol. 68, 209-222.

AUGENSTINE, L. (1953a). Information and thermodynamic entropy. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

AUGENSTINE, L. (1953b). Remarks on Pauling's protein models. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

AUGENSTINE, L. (1953c). Structural interpretations of denaturation data. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

AUGENSTINE, L. (1955a). Evidence of periodicities in human task performance. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

AUGENSTINE, L. (1955b). The use of ILLIAC in determining distributions for information functionals. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

AUGENSTINE, L., BLANK, A.A. and WAYNER, M. (1955). Human performance in information transmission. Technical report No. 69, Control Systems Laboratory, Univer. of Illinois, Urbana.

AUGENSTINE, L., BRANSON, H.R. and CARVER, E.B. (1953). A search for inter- symbol influences in protein structure. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

B

BABBAGE, H.P. (1889). Babbage's calculating engines. London: Spon.

BAER, R.M. (1953a). Biological systems and information dynamics. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

BAER, R.M. (1953b). Some general remarks on information theory and entropy. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

BAKAN, D. (1953). Learning and the principle of inverse probability. Psychol. Rev. 60, 360-370.

BAR-HILLEL, Y. (1952). The present state of research on mechanical translation. Amer. Doc. 2, 4.

BAR-HILLEL, Y. (1953). Some linguistic problems connected with machine translation. Phil. Sci. 20, 217-225.

BAR-HILLEL, Y. (1954). Can translation be mechanized? Amer. Scientist. 42, 248-260.

BAR-HILLEL, Y. (1955a). An examination of information theory. Phil. Sci. 22, 86-105.

BAR-HILLEL, Y. (1955b). Semantic information and its measures. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the tenth conference. New York: Josiah Macy, Jr. Foundation.

BAR-HILLEL, Y. and CARNAP, R. (1953) Semantic information. Technical report No. 247, Research Laboratory of Electronics. M.I.T. Also (1953) Brit. J. Phil. Sci. 4, 147-157. Also (1953) in W. Jackson (Ed), Communication theory, second London symposium. London: Butterworths.

BARNARD, C.I. (1948). Functions of the executive. Cambridge, Mass: Harvard Univer. Press.

BARNARD, G.A. (1951). The theory of information. J. roy. statist. Soc. B 13, 46.

BARNARD, G.A. (1955). Simple proofs of simple cases of the coding theorem. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

BARRETT, E. (1950). Cybernetics as applied to a study of normal and abnormal adjustment mechanisms. J. Psychol. 30, 11-31.

BARRETT, E. and POST, G. (1950). Introduction to some principles of applied cybernetics. J. Psychol. 30, 3-10.

BARRETT, F.D. and SHEPARD, H.A. (1953). A bib1iography of cybernetics. Proc. Amer. Acad. Arts and Sci., 80, 3, 204-222.

BARTLETT, M.S. (1949). Probability in logic, mathematics and science. Dialectica, 3, 104-112.

BARTLETT, M.S. (1950). The statistical approach to the analysis of time-series. In Information theory, first London symposium. London: Ministry of Supply, Mimeographed. 81-102.

BATES, J.A.V. (1950). Significance of information theory to neurophysiology. In Information theory, first London symposium London: Ministry of Supply, mimeographed, 137-143.

BATESON, G. (1949). Bali - the value system of a steady state. In Meyer Fortes (Ed.), Social structure - studies presented to A.R. Radcliffe-Brown. Oxford: Clarendon Press.

BATESON, G. (1953). The position of humor in human communication. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

BAVEIAS, A. (1948). .A. mathematical model for group structures. Appl. Anthrop. 7, 3, 16.

BAVELAS, A. (1950). Communication patterns in task-orientated groups. J. acoust. Soc. Amer. 22, 6, 725-730.

BAVELAS, A. (1952). Communication patterns in problem-solving groups. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

BAVELAS, A. and BARRET, D. (1951). An experimental approach to organizational communication. Personnel (April).

BAVELAS, A. et al. (1950). Human communications systems. Quarterly progress report, Research Laboratory of Electronics, M I T., July, 81-86.

BELL, D.A. (1950). The relevance of entropy to information. Read at U.R.S.I. meeting, Zurich, Sept.

BELL, D.A. (1953a). Information theory and its engineering applications. London: Pitman.

BELL, D.A. (1953b). The 'internal information' of English words. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

BELL, D.A. and ROSS, S.C. (1955). Negative entropy of Welsh words. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

BENDIG, A.W. (1953). Twenty questions - an information analysis. J. exp. Psychol. 46, 345-348.

BENDIG, A.W. (1954). Transmitted information and the length of rating scales. J. exp. Psychol. 47, 303-308.

BENDIG, A.W. and HUGHES, J.B. (1953) Effect of amount of verbal anchoring and number of rating scale categories upon transmitted information. J. Exp. Psychol. 46, 87-90.

BERKELEY, E.C. (1949). Giant brains. New York: Wiley.

BERKELEY, E.C. (1950a). The relations between symbolic logic and large-scale calculating machines. Science, 112, 395-399.

BERKELEY, E.C. (1950b). Simple Simon. Sci. Amer. 183, 5.

BERNE, E. (1953). Concerning the nature of communication. Psychiat. Quart. 27, 185-198.

BERRY, J. (1953). Some statistical aspects of conversational speech. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

BIRCH, H.G. (1952). Communication between animals. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

BIRDSALL, T.G. (1955). The theory of signal detectability. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

BIRMINGHAM, H.P. and TAYLOR, F.V. (1954). A design philosophy for man-machine control systems. Proc. I.R.E 42, 1748-1758.

BLACK, H.S. (1934). Stabilised feedback amplifiers. Elec.Engng, 53, 114.

BLACK, J.W. (1954). The information of sounds and phonetic digrams of one- and two- syllable words. US Naval Sch. Aviat. Med. Res. Rep., Project No. NM 001 064.01.22. Also (1954) J. Speech Hearing Disorders, 19, 397-411.

BLANC-LAPIERRE, A. (1953). Application to optics of certain results and methods of information theory .In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

BLANK, A.A. and QUASTLER, H. (1954). Notes on the estimation of information measures. Technical report No. R-56, Control Systems Laboratory, Univer. of Illinois, Urbana.

BLUNDELL, P.H. (1953). The definition. of rate of information in the presence of noise. In W. Jackson (Ed.), Communication theory, second. London symposium. London: Butterworths.

BODE, H.W. (1945). Network analysis and feedback amplifier design. New York: Van Nostrand.

BODE, H.W. and SHANNON, C.E. (1950). A simplified derivation of linear least square smoothing and prediction theory. Proc. I.RE. 38, 4l7-425.

BODMER, F. (1943). The loom of language. London: Allen and Unwin.

BONNELL, K.E. (1950). 'Feed-back' and 'hunting' as human behaviour. Etc. Rev. gen. Semant. 7, 210-212.

BOOTH, A.D. (1954). Calculating machines and mechanical translation. Discovery, 15, 280-285.

BOOTH, A.D. (1955). Influence of context on translation. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

BOOTH, A.D. and BOOTH, K.H.V. (1953). Automatic digital computers. London: Butterworths.

BOWMAN, J.R. (1953). Reduction of the number of possible Boolean functions. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

BRAGDON, D.E., NAIBANDOV, O. and OSBORNE, J.W. (1953). The control of the blood sugar level. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

BRANSON, H.R. (1953a). A definition of information from the thermodynamics of irreversible processes. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

BRANSON, H.R. (1953b). Information theory and the structure of proteins. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

BRAZIER, M.A.B. (1950a). Neural nets and the integration of behaviour. In D. Richter (Ed.), Perspectives in neuropsychiatry. London: H.K. Lewis.

BRAZIER, M.A.B. (1950b). A neuronal basis for ideas. Dialectica, 4, 237-241.

BRICKER, P.D. (1955). Information measurement and reaction time. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

BRIDGMAN, P.W. (1950-51). The operational aspect of meaning. Synthese, 8, 251-259.

BRILLOUIN, L. (1949). Life, thermodynamics and cybernetics. Amer. Scientist, 37, 554-568.

BRILLOUIN, L. (1950). Thermodynamics and information theory. Amer. Scientist, 38, 594-599.

BRILLOUIN, L. (1951a). Information theory and most efficient codings for communication or memory devices. J. appl. Physics, 22, 9, 1108-1111.

BRILLOUIN, L. (1951b). Maxwell's demon cannot operate - information and entropy. I. J. appl. Physics, 22, 3, 334-337.

BRILLOUIN, L. (1951c). Physical entropy and information. II. J. appl. Physics, 22, 3, 338-343.

BRILLOUIN, L. (1956). Science and information theory. New York: Academic Press.

BROADBENT, D.E. (1955). The concept of capacity and the theory of behaviour. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

BROSIN, H.W. (1953). Information theory and clinical medicine (psychiatry). In R.A. Patton (Ed.), Current trends in information theory, 140-188. Pittsburgh, Pa.: Univer.of Pittsburgh Press.

BROWN, G.S. (1955). Chance and control - some implications of randomization. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

BROWN, G.S. and CAMPBELL, D.P. (1948). Principles of servomechanisms - dynamics and synthesis of closed loop control systems. New York: Wiley.

BROWNLEE, K.A. (1955). Comments on McGill's paper (1955a). In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

BRUCE, D.J. (1955). Effects of context upon intelligibility of heard speech. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

BURKS, A.W. and WRIGHT, J.B. (1953). Theory of logical nets. Proc. I.R.E. 41, 10, 157-1365.

BURTON, A.C. (1939). The properties of. the steady state as compared to those of equilibrium as shown in characteristic biological behavior. J. cell. comp. Physiol. 14, 327.

BURTON, N.G. and LICKLIDER, J.C.R. (1955). Long-range constraints in the statistical structure of printed English. Amer. J. Psychol. 68, 650-655.

BUSH, R.R. and MOSTELLER, F. (1951). A mathematical model for simple learning. Psychol. Rev. 58, 313.

BUSH, R.R. and MOSTELLER, F. (1955). Stochastic models for learning. New York: Wiley. Also London: Chapman and Hall.

### *C*

CANNON, W. (1923). The wisdom of the body. New York: Norton.

CECCATO, S. and MARETTI, E. (1955). Suggestions for mechanical translation. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

CECCATO, S. and MARETTI, E. (1956). Construction of a. translating machine. Methodos, 8.

CHAO, Y.R. (1955). Meaning in language and how it is acquired. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and socia.l systems. Transactions of the tenth conference. New York: Josiah Macy, Jr. Foundation.

CHAPANIS, A. (1954). The reconstruction of abbreviated printed messages. J. exp. Psychol. 48, 496-510.

CHAPPLE, E.D. (1940). Measuring human relations - an introduction to the study of the interaction of individuals. Genet. Psychol. Monogr. 22, 1-147

CHERRY, E.C. (1950). The.history of the theory of information. In Information theory, first London symposium. London: Ministry of Supply, 22-24. Also (1951), Proc. I.E.E. 98, 383. Also as Cherry (1952).

CHERRY, E.C. (1952) The communication of information - an historical review. Amer. Scientist, 4), 641-664; 724-725.

CHERRY, E.C. (1954a). On the mathematics of social communication. Int. soc. Sci. Bull. 6, 591-609.

CHERRY, E.C. (1954b). Organisms and mechanisms. Advancement of Sci. 40, 393.

CHERRY, E.C. (1955). 'Communicatian theory' - and human behaviour. In University College London, Communication research centre, Studies in communication. London: Secker and Warburg.

CHERRY, E.C. (1957a). On human communication - a review, a survey, and a criticism. New York: Wiley.

CHERRY, E.C. (1957b) Minds and machines. II - The present state of brain models. B.B.C. Third programme talk, reported in The Listener, Jan 3.

CHERRY, E.C. and GOURIET, G.G. (1953). Some possibilities for the compression of television signals by recoding. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

CHERRY, E.C., HALLE, M. and JAKOBSON, R. (1953). Toward the logical description of languages in their phonemic aspect. Language, 29, 34.-36.

CHURCH, A. (1936). An unsolvable problem of elementary number theory. Amer. J. Math. 58, 345-363.

CHURCHMAN, C.W. and ACKOFF, R.L. (1947). An experimental definition of personality. Phil. Sci. 14, 304-332.

CHURCHMAN, C.W. and ACKOFF, R.L. (1950). Purposive behaviour and cybernetics. Soc. Forces, 29, 1, 32- 39.

CLAVIER, A.G. (1948). Evaluation of transmission efficiency according to Hartley's expression of information content. Elec. Comm. 25, 414.

CLEAVE, J.P. (1955). A programme for Braille transcription. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

COBURN, H.E. (1951). The brain analogy. Psychol. Rev. 58, 155-178.

COBURN, H.E. (1952). The brain analogy - a discussion. Psychol. Rev. 59, 6, 453.

COHEN, F. ( ). Some analytical and practical aspects of Wiener's theory of prediction. Technical Report No.69. Research Laboratory of Electronics, M.I.T.

COHN, S.H. (1953). The role of cybernetics in physiology. Sci. Mon., N.Y., 76, 85-89.

COSSA, P. (1950). La cybernetique ou l'art de tenir le mecanisme pour demontre. (Cybernetics or the art of holding mechanism for demonstration.) Ann. med.-psychol. 2,1-10.

COSSA, P. (1955). La cybernetique - "Du cerveau humain aux cerveaux artificiels". (Cybernetics - "From human brain to artificial brains.") Paris: Masson.

COYLE, G.L. (1930). The social process in organised groups. New York: Smith.

CRAIK, K.J.W. (1947). Theory of the human operator in control systems. I - The operator as an engineering system. Brit. J. Psychol. 38, 56-61.

CRAIK, K.J.W. (1948). Theory of the human operator in control systems. II - Man as an element in a control system. Brit. J. Psychol. 38, 142-148.

CRONBACH, L.J. (1953). A consideration of information theory and utility theory as tools for psychometric problems. Bureau of Educational Research, Univer. of Illinois.

CRONBACH, L.J. (1955). On the non-rational application of information measures in psychology. In H. Quastler (Ed.) Information theory in psychology. Glencoe, Ill.: Free Press.

CROSSMAN, E.R.F.W. ( ). The measurement of discrimination.

CROSSMAN, E.R.F.W. (1953). Entropy and choice time - the effect of frequency unbalance on choice-response. Quart. J. exp. Psychol. 5, 41-51.

CROZIER, W.J. (1951). Physiology and computation devices. In Proceedings of a second symposium on large-scale digital calculating machinery. Cambridge, Mass.: Harvard Univer. Press.

CULBERTSON, J.T. (1950). Consciousness and behaviour - a neural analysis of behaviour and of consciousness. Dubuque, Ia: Brown

CULBERTSON, J.T. (1952). Hypothetical robots. RAND Project P-296.

***CULBERTSON, J.T. (1956). Some uneconomical robots In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton: Princeton Univer. Press. D***

DANCOFF, S.M. and QUASTLER, H. (1953). The information content and error rate of living things. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

DAVID, H.T. et al. ( ). Sampling distributions for information functions. Report of Control Systems Laboratory, Univer. of Illinois, Urbana.

DAVIS, H. (1952). Information theory, 3 - Applications of information theory to research in hearing. J. Speech Hearing Disorders. 17, 189-197.

DAVIS, H.M. (1948). Mathematical machines. Sci. Amer. 180, 4, 29-40.

DAVIS, K.H., BIDDULPH, R. and BALASHEK, S. (1953). Automatic recognition of spoken digits. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

DAVIS, M.D. (1956). A note on universal Turing machines. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton: Princeton Univer. Press.

de LATIL, P. (1953). La Pensee artificielle -Introduction a la cybernetique. (Artificial thought - Introduction to cybernetics.) Paris: Gallimard.

de LEEUW, K., MOORE, E.F., SHANNON, C.E. and SHAPIRO, N. (1956). Computability of probabilistic machines. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J: Princeton Univer. Press.

DEININGER, R.I. and FITTS, P.M. (1955). Stimulus-response compatibility, information theory and perceptual-motor performance. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

DELORAINE, E. (1949). Pulse modulation. Proc. I.R.E. 37, 702-705.

DELPECH, L. (1953). Psychanalyse et cybernetique. (Psychoanalysis and cybernetics). Prox. XIth Int. Congr. Phil. 7, 155-161.

DEMPSEY, E.W. (1951). Homeostasis. In S.S. Stevens (Ed.), Handbook of experimental psychology. New York: Wiley.

DENBIGH, K.G. (1948). The kinetics of open reaction systems. Trans. Faraday Soc. 44, 158-163.

DEUTSCH, J.A. (1953). A new type of behaviour theory. Brit. J. Psychol, 44, 304-317.

DEUTSCH, J.A. (1954). A machine with insight. Quart. J. exp. Psychol. 6, 6-11

DEUTSCH, K. W. (1953a). Nationalism and social communication. Cambridge, Mass: Technology Press.

DEUTSCH, K.W. (1948/9). Some notes on research on the role of models in the natural and social sciences. Synthese, 7, 506-533.

DEUTSCH, K.W. (1949a). Innovation, entrepreneurship, and the learning process. In Change and the entrepreneur. Cambridg, Mass: Harvard Univer. Press.

DEUTSCH, K.W. (1949b). Some notes on research on the history of entrepreneurship, innovation and decision-making. In Explorations in entrepreneurial research, 8-16.

DEUTSCH, K.W. (1950a). Higher education and the unity of knowledge. In Goals for American education, ninth conference symposium on science, philosophy and religion. New York: Harper.

DEUTSCH, K.W. (1950b). Nationalism, communication and community. In Perspectives on a troubled decade, tenth conference syrnposium on science, philosophy and religion. New York: Harper.

DEUTSCH, K.W. (195la). Mechanism, organism, and society - some models in natural and social science. Phil. Sci. 18, 230-252.

DEUTSCH, K.W. (1951b). Mechanism, teleology, and mind - the theory of communications and some problems in philosophy and social science. Phil. phenomenol. Res. 12, 185-223.

DEUTSCH, K.W. (1952a). Communication theory and social science. Amer. J. Orthopsychiat. 22, 469-483.

DEUTSCH, K.W. (1952b). On communication models in the social sciences. Publ. Opin. Quart. 16, 356-380.

DEUTSCH, K.W. (1953b). Nationalism and the social scientists. In Lyman Bryson et al. (Eds.), Foundations of world organization. Eleventh conference symposium on science, philosophy and religion. New York: Harper.

DIEBOLD, J. (1952). Automation. New York: Van Nostrand.

DINEEN, G.P. (1955). Programming pattern recognition. In Proc. Western Joint Computer Conf., I.R.E., A.I.E.E., A.C.M.

DUBARLE, D. (1950). Existe-t-il des machines a penser? (Do thinking machines exist?) Rev. Quest. Sci. 11, 209-230.

DUBOULOZ, P. and CORRIOL, J. (1951). A propos de la cybernetique. (In regard to cybernetics). Ann. med-psychol. 1, 1-10.

DUNBAR, M. J. (1950). Feedback systems and oceanography. Amer. Sci. 38, 4-9 599-603.

***E***

EARP, C.W. (1948). Relationship between rate of transmission of information, frequency, bandwidth, and signal-to-noise ratio. Elec. Comm. 25, 178-195.

EISENHART, C. (1949). Cybernetics - a new discipline. Science, 109, No.2834, 397-399.

EL-A'LEM, M.A. (1953). Cybernetics. (In Arabic) Egypt. J. Psychol. 8, 315-326.

ELIAS, P. (1953). Optics and Communication Theory. J. opt. Soc. Amer. 43, 229-232.

ELIAS, P. (1954). Error free coding. Trans. I.R.E. (PGIT), 4, 30

ELIAS, P. (1955). Coding for two noisy channels. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

ELIOT, T.D. Reactions to predictive assumptions. Amer. sociol. Rev. 2, 508-517.

ELISON, D.G. (1949a). The application of operational analysis to human motor behaviour. Psychol. Rev. 56, 9-17.

ELISON, D.G. (1949b). Application of servo theory to human motor behaviour. Proc. Ind. Acad. Sci. 58, 290.

ELLSON, D.G. (1955). A method for technological predictions. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

***F***

FAIRBANKS, G. (1954.). Systematic research in experimental phonetics. I- A theory of the speech mechanism as a servo-system. J. Speech Hearing Disorders, 19, 133-139.

FAIRTHORNE, R.A. ( ). Automata and information. J. Doc. (London), 8, 3, 164.

FAIRTHORNE, R.A. (1953). Information theory and clerical systems. J. Doc. (London), 9, 2, 101-116.

FAIRTHORNE, R.A. (1955). Some clerical operations and languages. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

FANO, R.M. ( ). The transmission of information (Part II). Technical report No 149, Research Laboratory of Electronics, M.I.T.

FANO, R.M. (1949). The transmission of informatiom.. Technical report No.65, Research Laboratory of Electronics, M.I.T.

FANO, R.M. (1950). The information theory point of view in speech communication. J. acoust. Soc. Amer. 22, 6, 691-696.

FARLEY, B.G. and CLARK, W.A. (1955). Simulation of self-organizing systems by a digital computer. Proc. Western Joint Computer Conf., I.R.E., A.I.E.E., A.C.M.

FARQUHARSON, R. (1955). Strategic information in games and in voting. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

FATTU, N.A. (1951). Computational technics. Rev. educ. Res. 21, 415-431.

FAVERGE, J.M. (1953a). Le language des communications dans l'analyse du travail. (The language of communications in job analysis.) Bull, Cent. Etud.. Rech. psychotech. 2(1), 2-12.

FAVERGE, J.M. (1953b). La theorie de l'information en psychologie experimentale. (The theory of information in experimental psychology. psychology.) Annee psychol. 53, 463-476.

FEINSTEIN, A. (1954). A new basic theorem of information theory. Trans. I.R.E. (PGIT), 4, 2.

FESTINGER, L et al. ( ). Theory and experiments in social communication. Ann Arbor, Mich.: Research Centre for Group Dynamics.

FISHER, R.A. (1935). The logic of inductive inference. J. roy statist. Soc. 98, 1, 39-54.

FISHER, R.A. (1953). Statistical information. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

FITTS, P.M. (1953). The influence of response coding on performance in motor tasks. In R.A. Patton (Ed.), Current trends in information theory. Pittsburg, Pa.: Univer. Of Pittsburg Press.

FITTS, P.M. (1954). The information capacity of the human motor system in controlling the amplitude of movement. USAF Pers. Train. Res. Cent. Res. Bull. No.54, 41. Also (1954) J. exp. Psychol. 47, 381-391.

FITTS, P.M. and MULLER, P. (1955). Rate of information transfer as a function of the penalty assigned to wrong decisions. Wright Air. Dev. Center Tech. Report.

FITTS, P.M. and SEEGER, C.M. (1953). S-R compatibility - spatial characteristics of stimulus and response codes. J. Exp. Psychol. 46, 199-210.

FITTS, P.M., WEINSTEIN, M., RAPPAPORT, M. ANDERSON, N. and LEONARD, J.A. (1956). Stimulus correlates of visual pattern recognition - a probability approach. J. Exp. Psychol. 51, 1-11.

FLEISHER, H. (1955). An introduction to the theory of information. Libr. Quart. 25, 326-332.

FRANK, L.K. (Ed.), (1948). Teleological mechanisms - symposium. N.Y. Acad. Sci. 50, Art. 4, 189.

FRICK, C.F. and. MILLER, G.A. (1951). A statistical description of operant conditioning. Amer. J. Psychol. 64, 20-36.

FRICK, F.C. and KLEMMER, E.T. (1951) .Assimilation of information from dot and matrix patterns. Amer. Psychol. 5, 80, 267. Also (1953). J. exp. Psychol. 45, 15-19.

FRIEDMAN, M. and SAVAGE, L.J. (1948). The utility analysis of choices involving risk. J. Polit. Econ. 56, 279.

FRITZ, E.L. and GRIER, G.W. Jr., (1955). Pragmatic communication. In H. Quastler (Ed.), Information theory in psychology. Glencoe: Free Press.

FRY, D.B. (1950). Communication theory and linguistic theory. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed, 120-125.

FRY, D.B. and DENES, P. (1953). Mechanical speech recognition. In W. Jackson (Ed.), Conmunication theory, second London symposium. London: Butterworths.

FRY, D.B. and DENES, P. (1955). Experiments in mechanical speech recognition. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

FUCKS, W. (1955). Mathematical theory of word formation. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

***G***

GABOR, D. (1946). Theory of communication. J. I.E.E. 93, 3, 439

GABOR, D. (1947a). Acoustical quanta and the theory of hearing. Nature, Lond., 159, 303.

GABOR, D. (1947b). New possibilities in speech transmission. J.Inst. elec. Engng, 94, 3, 369. Also (1948) J. I.E.E. 95, 3.

GABOR, D. (1950a). Communication theory and physics. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed. Also (1950) Phil. Mag. 41, 7, 1161. Also (1951) Rev. Opt. (theor. instrum.).

GABOR, D. (1950b). Communication theory, past, present and prospective.In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

GABOR, D. (1951). Lectures on communication theory. Cambridge, Mass: M.I.T.

GABOR, D. (1953). A summary of communication theory. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

GABOR, D. (1954). Communication theory and cybernetics. Trans. I.R.E. (P.G. on Non-Linear .Circuits).

GABOR, D. (1955). Optical transmission. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

GARDNER, M. (1952). Logic machines. Sci. Amer. 186, 3, 68-73.

GARNER, W.R. (1953). An informational analysis of absolute judgments of loudness. J. exp. Psychol. 46, 373-380.

GARNER, W.R. and HAKE, H (1951). The amount of information in absolute judgments. Psychol. Rev. 58, 446-459.

GARNER, W.R. and McGILL, W. J. ( ). Relation between uncertainty, variance, and correlation analysis.

GEORGE, F.H. (1953a). Formalization of language systems for behaviour theory. Psychol. Rev. 60, 4, 232-240.

GEORGE, F.H. (1953b). "Machines" as behavioural models. Rationalist Annu.

GEORGE, F.H. (1953c) A note on theory construction in science. Methodos, 5, 141-152.

GEORGE, F.H. (1957a). Minds and machines. III - Machines and human behaviour. B.B.C. Third programme talk, reported in The Listener, Jan 10.

GEORGE, F.H. (1957b). The applications of cybernetics. Technology, 5, 1, 182.

GEORGE, F.H. and HANDLON, J.H. (1955). Toward a general theory of behaviour. Methodos, 7, 25-44.

GERARD, R. W. (1951). Some of the problems concerning digital notions in the central nervous system. In H. von Foerster (Ed.), Transactions of the seventh conference on cybernetics. New York: Josiah Macy, Jr. Foundation.

GERARD, R.W. (1953a). Central excitation and inhibition. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

GERARD, R.W. (1953b). What is memory? Sci. Amer. 189, 118-126.

GITTLESON, Y. (1950). Sacred cows in collision. Amer. Sci. 38, 4, 603-609.

GLASER, R. and SCHWARTZ, T.A. (1954). Scoring problem - solving test items by measuring information. Educ. psychol. Measmt. 14, 665-671.

GOLAY, M.J.E. (1949). Notes on digital coding. Proc. I.R.E. 37, 657.

GOLD, T. (1950). Hearing. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

GOLDMAN, S. (1953a). Information theory. New York: Prentice-Hall. Also London: Constable.

GOLDMAN, S. (1953b). Information theory of noise reduction in modulation systems. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

GOLDMAN, S. (1953c). Some fundamentals of information theory. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

GOLDSTEIN, K. (1940). Human nature. Cambridge, Mass: Harvard Univer. Press.

GONSETH, F. (1950). L'organisation des robots sensorimoteurs et l'intuition geometrique. (The organisation of sensorimotor robots and the geometric intuition.) Dialectica, 4, 214-223.

GOOD, L.J. (1950). Probability and the weighing of evidence. Griffen.

GOOD, L.J. (1953). The appropriate mathematical tools for describing and analysing uncertainty. Paper given before the British Association, Sept. 8th. Also (1954) In C.F. Carter, G.P. Meredith, and G.L.S. Shackle (Eds.), Uncertainty and Business Decisions. Liverpool: Liverpool Univer. Press.

GOODWIN, R.M. (1947). Dynamic coupling with especial reference to markets having production lags. Econometrica, 15, 3, 181-204.

GRANT, D.A. (1953). Information theory and the discrimination of sequences in stimulus events. In R.A. Patton, Current trends in information theory. Pittsburgh: Univer. of Pittsburgh Press.

GRANT, D.A. (1954). The discrimination of sequences in stimulus events and the transmission of information. Amer. Psychologist, 9, 62-68.

GREGORY, R. L. (1955). An experimental treatment of vision as an information source and noisy channel. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

GREGORY, R.L. (1953). On physical model explanations in psychology. Brit. J. Phil. Sci. 4-, 192-197.

GRUENBERGER, F. (1953). Computing manual. Third edition. Milwaukee: Univer. of Wisconsin Press.

GUILLARD, G.Th. (1954). La. cybernetique. (Cybernetics). Paris: Presses Universitaires de France.

GUILLAUME, P. (1954a). Cybernetique et psychologie. (Cybernetics and psychology.) J. Psychol. norm. path. 47-51, 360-378.

GUILLAUME, P. (1954b). Cybernetique et psychologie. II - Machines et systemes physiques. (Cybernetics and Psychology. II - Machines and physical systems.) J. Psychol. Norm. Path. 47-51, 486-499.

***>H***

HAKE, H.W. (1955a). A note on the concept of "channel capacity" in psychology. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

HAKE, H.W. (1955b). The perception of frequency of occurrence and the development of "expectancy" in human experimental subjects. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

HALDANE, J.B.S. (1952). The mechanical chess-player. (Comment on Ashby, 1952). Brit. J. Phil. Sci., 3, 189-191.

HALSTEAD, W.C. (1947). Brain and intelligence. Chicago, Ill.: Univer. of Chicago Press.

HAMMING, R.W. (1950). Error detecting and error correcting codes. Bell Syst. tech. J. 29, 147-160.

HANSEL, C.E.M. (1950). New machines. Bull. Brit. psychol. Soc. 1, 10, 392.

HARARY, F. and ROSS, I.C. (1954). The number of complete cycles in a communication network. J. soc. Psychol. 40, 329-332.

HARTLEY, R.V.L. (1928). Transmission of information. Bell Syst. tech. J. 7, 535-537.

HARTMAN, B.0. and WETHERBEE, J.K. (1956). 'Beta' a special purpose computer for studies in the human control of complex equipment. U.S. Army med. Res. Lab. Rep. No.236, i.

HARTREE, D.R. (1948). An historical survey of digital calculating machines. Proc. roy. Soc. 195, 265.

HARTREE, D.R. (1949). Calculating instruments and machines. Urbana: Univer. of Illinois Press. Also (1950). Cambridge, England: Cambridge Univer. Press.

HARVARD UNIVERSITY COMPUTATION LABORATORY (1948). Symposium on large-scale digital calculating machinery. Ann. Comput. Lab. Harv. 16.

HARVARD UNIVERSITY COMPUTATION LABORATORY. (1950). Symposium on large-scale digital calculating machinery. Ann. Comput. Lab. Harv. 26.

HAUROWITZ, F. (1953). Protein synthesis and immunochemistry. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

HAYEK, F.A. (1952). The sensory order. London: Kegan Paul.

HAZELL, K. (1949). The C.N.S. is a living electrical system. Med. Pr. 221, 364-366.

HEBB, D.O. (1949). The organisation of behaviour. New York: Wiley.

HEFFERLINE, R.F. (1955). Communication theory: I. Integration of arts and science. Quart. J. Speech, 41, 223-233.

HERTZ, D. and LESSER, S. (1951). People in groups. Sci. Amer. 184, 2, 26-28.

HERTZ, D. and LIVINGSTONE, R.T. (1950) Contemporary organizational theory. Human relations, 3, 4.

HICK, W.E. (1948). The discontinuous functioning of the human operator in pursuit tasks. Quart. J. exp. Psychol. 1, 36.

HICK, W.E. (1950). Information theory in psychology. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed. 130-134

HICK, W.E. (1951). Information theory and intelligence tests. Brit. J. Psychol., Statist Sect., 4, 157-164.

HICK, W.E. (1952a). The mechanical chess-player. (Comment on Ashby, 1952). Brit. J. Phil. Sci. 3, 353-355.

HICK, W.E. (1952b). On the rate of gain of information. Quart. J. exp. Psychol. 4, 11-26.

HICK, W.E. (1954). The impact of information theory on psychology. Advanc. Sci. 40, 397.

HOAGLAND, H. (1949). Rhythmic behaviour of the nervous system. Science, 109, 157-164.

HOCHBERG, J. and McALISTER, E. (1953). A quantitative approach to figural 'goodness'. J. exp. Psychol. 46, 361-364.

HOCKETT, C.F. (1952). An approach to the quantification of semantic noise. Phil. Sci. 19, 257-260.

HOMANS, G. (1950). The human group. New York: Harcourt Brace.

HOUSEHOLDER, A.S. and LANDAHL, H.D. (1945). Mathematical biophysics of the central nervous system. Bloomington, Ind.: Principia Press.

HUFFMAN, D.A. (1953). A method for the construction of minimum-redundancy codes. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

HUFFMAN, D.A. (1955). The synthesis of linear sequential coding networks. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

HUGGINS, W.H. (1949). Linear systems and group dynamics. Mimeographed paper.

HUGGINS, W.H. (1953). A theory of hearing. In W. Jackson (Ed.), Communication theory, second London Symposium. London: Butterworths.

HUGGINS, W.H. and LICKLIDER, J.C.R. (1951). Place mechanisms of auditory frequency analysis. J. acoust. Soc. America, 23, 3, 290-299.

HUIZINGA, E. (1953). The sense of hearing - its significance in human beings. Proc. Int. Course Paedo-Audiology, Groningen University, 9-15.

HULL, C.I. (1937). Mind, mechanism and adaptive behaviour. Psychol. Rev. 44, 1-32.

HUTCHINSON, G.E. (1948). Circular Causal systems in Ecology. Ann. New York Acad. Sci. 50, art. 4, 221-245.

HUTCHINSON, G.E. (1953). Turbulence as random stimulation of sense organs. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

HYMAN, R. (1953). Stimulus information as a determinant of reaction time. J. exp. Psychol. 45, 188-196.

***I***

INNIS, H.A. (1949). The bias of communications. Canad. J. econ. polit. Sci. 15, 4, 457-476.

INSTITUTION OF RADIO ENGINEERS (1953). Convention record. Part 8 - Information theory.

IRWIN, M.R. (1953). Genes and antigens. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

***J***

JACOBSON, H. (1950). The information capacity of the human ear. Science, 112, 143-144.

JACOBSON, H. (1951a). Information and the human ear. J. acoust. Soc. Amer. 23, 463-471.

JACOBSON, H. (1951b). The information capacity of the human eye. Science, 113, 292-293.

JAMES, H.F., NICHOLLS, N.B. and PHILLIPS, R.S. (1948). Theory of servomechanisms. New York: Penguin Books.

JELONEK, Z. (1953). A comparison of transmssion systems. In W. Jackson, (Ed. ), Communication theory, second London symposium. London: Butterworths.

***K***

KALMUS, H. (1950). A cybernetical aspect of genetics. J. Hered. 41, 19-22.

KAPP, R. 0. (1955). The observer, the interpreter and the object observed. Methodos, 25-26, .3-12.

KAPP, R.O. (1954). Living and lifeless machines. Brit. J. Phil. Sci. 5, 91-103.

KECSKEMETI, P. (1952). Meaning, communication and value. Chicago, Ill: Univer. of Chicago Press.

KEMENY, J.G. (1953). A logical measure function. J. Symb. Logic. 18, 289.

KEMENY, J.G. (1955). Man viewed as a machine. Sci. Amer. (April), 58-67.

KENNEDY, J. L (1952). The uses and limitations of mathematical models, game theory, and systems analysis in planning end problem solution. In J.C. Flanagan et al (Eds.), Current trends - psychology in the world emergency. Pittsburgh, Pa.: Univer. of Pittsburg Press.

KING, G.W. (1952). Information. Sci. Amer. l87, 3.

KING, G.W. (1953). The Monte Carlo method as a natural mode of expression in operations research. J. Operat. Res. Soc. Amer. 1, 33-58.

KIRK, J.R. (1953). Communication theory and methods of fixing belief. Etc. Rev. gen. Semant. 10, 298-305.

KLEENE, S.C. (1951). Representation of events in nerve nets and finite automata. U.S. Air Force, Project Rand, Research Memorandum. Rand Corporation, Santa Monica, California. Also (1956) In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J: Princeton Univer. Press.

KLEIN, M.J. (1953). Order, organisation and entropy. Brit. J. Phil. Sci. 4, 158-160.

KLEMMER, E.T. (1955 ). Tables for computing informational measures. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

KLEMMER, E.T. and MULLER, P.F. Jr. (1953). The rate of handling information - key pressing responses to light patterns. U.S.A.F. Hum. Fact. Operat. Res. Lab. Memo. Report No. 34. Operations Applications Laboratory, Air Research and Development Command.

KOEFOED, J. (1955). A neuronic model of the inner ear. In E.C. Cherry, (Ed.), Information theory, third London symposium. London: Butterworths.

KOLMOGOROFF, A. (1942). Interpolation und Extrapolation von stationaren zufalligen Folgen. (Interpolation and extrapolation of stationary random sequences.) Bull. Acad. Sci., U.S.S.R. Ser. Math. 5, 3.

KONORSKI, J. (1950). Mechanisms of learning. Symposia of the Society for Experimental Biology. No.4 - Physiological mechanisns in animal behaviour. Cambridge, England: Cambridge Univer. Press.

KORSYBSKI, A. (1948). Science and sanity. (3rd ed.). Lancaster, Pa.: Science Press.

KREEZER, G. L (1949). An inverse decibel log frequenqy method for determination of the transfer functions of psychological systems. Science, 681-684.

KRULEE, G.K. (1954). Information theory and man-machine systems. J. Operat. Res. Soc. Amer. 2, 320-328.

KUBIE, L.S. (1930). A theoretical application to some neurological problems of the properties of excitation waves which move in closed circuits. Brain, 53, 166-177.

KUBIE, L.S. (1949). Neurotic potential and human adaptation. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the sixth conference. New York: Josiah Macy, Jr. Foundation.

KUBIE, L.S. (1951). The relationship of symbolic function in language formation and in neuroses. In H. von Foerster (Ed.), Cybernetics - circular , causal and feedback mechanisms in biological and social systems. Transactions of the seventh conference. New York: Josiah Macy Jr. Foundation.

KUBIE, L.S. (1952). Communication between sane and insane hypnosis. In H. Von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social. Systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

KUBIE, L.S. (1953). The place of emotions in the feedback concept. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New Yor:k: Josiah Macy, Jr. Foundation.

KULLBACK, S. (1952). An application of information theory to multivariate analysis. Ann. math. Statist. 23, 88-102.

KULLBACK, S. and LEIBLER, R.A. (1951). On information and sufficiency. Ann. math. Statist. 22, 79-87.

***L***

LAEMMEL, A.E. ( ). General theory of communication. Microwave Res. Inst. Polytechnic Brooklyn.

LAEMMEL, A.E. (1951). Characteristics of communication systems. Report R-233-50, PIB-178, Microwave Res. Inst., Polytechnic Inst. Brooklyn.

LAEMMEL, A.E. (1952). Efficiency of codes as a function of their message length. Symposium on applications of communication theory. London. I.E.E.

LAEMMEL, A.E. (1953). Efficiency of noise-reducing codes. In W.Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

LAEMMEL, A.E. (1955). A general class of codes and their physical realization. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

LANGER, S.K. (1942). Philosophy in a new key. Cambridge, Mass.: Harvard Univer. Press. Also (1948) New York: Penguin books.

LAPLUME, J. (1948). Sur le nombre de signaux discernables. (On the number of discernable signals). C. R. Acad. Sci. ,Paris. 226, 1348 - 1349.

LASHLEY, K.S. (1951). The problem of serial order in behaviour. In L.A. Jeffress (Ed.), Cerebral mechanisms in behaviour. New York: Wiley.

LAUER, H., NESNICK, R. and MATSON, I.E. (1945 ) Servomechanism fundamentals. New York: McGraw-Hill.

LAWRENCE, W. (1953). The synthesis of speech from signals which have a low information rate. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

LEAVER, E.W. and BROWN, J.J. (1951). Electronics and human beings. Harpers Mag. 203 (1215), 88-93.

LEAVITT, H.J. (1951). Some effects of certain conmunication patterns on group performance. J. abnorm. soc. Psychol. 46, 1, 38-50.

LEAVITT, H.J. and MUELLER, R.A.H. (1951). Some effects of feedback on communication. Hum. Relat. 4, 401-410.

LEE, B.S. (1950). Effects of delayed speech feedback. J. acoust. Soc. Amer. 22, 6, 824-826.

LEE, Y.W. ( ). Application of statistical methods to communication problems. Technical Report No.181, Research Laboratory of Electronics, M.I.T.

LEE, Y.W. and WIESNER, J.B. (1950) Correlation functions and communication applications. Electronics, 23, 6, 86-92.

LEONARD, J.A. (1954). The effect of partial advance information. Applied Psychology Research Unit. APU. 217/54.

LEONARD, J.A. (1955). Factors which influence channel capacity. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

LEVINSON, N. (1948). A heuristic exposition of Wiener's mathematical theory of prediction and filtering. Appendix C to N. Wiener, Cybernetics. New York: Wiley.

LEWIN, K. (1947). Frontiers in group dynamics, II. Hum. Relat. 1, 2.

LICKLIDER, J.C.R. (1949). The intelligibility and information content of quantized speech. Amer. Psychologist. 4, 234.

LICKLIDER, J.C.R. (1950). The manner in which and extent to which speech can be distorted and remain intelligible. In H. Von Foerster, (Ed), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the seventh conference. New York: Josiah Macy, Jr. Foundation.

LICKLIDER, J.C.R. (1951). A duplex theory of pitch perception. Experientia (Basel) 7, 4, 128-134

LICKLIDER, J.C.R. (1955). Auditory frequency analysis. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

LICKLIDER, J.C.R. and MILLER, G.A. (1951). The perception of speech. In S.S. Stevens (Ed.), Handbook of experimental psychology. New York: Wiley.

LINSCHITZ, H. (1953a). Information and physical entropy. .In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

LINSCHITZ, H. (1953b). The information content of a bacterial cell. In H. Quastler (Ed.), Information theory in biology. Urbana: Univer. of Illinois Press.

LINFOOT, E.H. (1955). Informations theory and optical images. J. opt. Soc. Amer. 45, 808-819.

LOCKE, W.N. and BOOTH, A.D. (1955). Machine translation of languages. New York: Technology Press, M.I.T. and Wiley. Also London: Chapman and Hall.

LOEB, J. (1953). Communication theory of transmission of simple drawings. In W.Jackson (Ed.), Comnunication theory, second London symposium. London: Butterworths.

LORGE, I. (1955). How the psychologist views communication. Teach. Coll. Rec. 57, 2, 72-19.

LOTKA, A.J. (1925). Elements of physical biology. Baltimore, Md: Williams and Wilkins.

LUCE, R.D. (......). A survey of the theory of selective information and some of its behavioural applications. Bur. Appl. Soc. Res. Tech. Report No. 8, Columbia Univer., New York.

LUCE, R.D. (1950). Connectivity and generalised cliques in sociometric structures. Psychometrika, 15, 169-190.

LUCE, R.D. and PERRY, A.D. (1949). A method of matrix analysis of group structure. Psychometrika 14, 95-116.

***M***

MAATSCH, J.L. and BEHAN, R.A. (1953).A more rigorous theoretical language. Psychol. Rev. 60, 3, 189-196.

MacDONALD, D.K.C. (1949). Some statistical properties of random noise. Proc. Cambridge. phil. Soc. (England), 45, 368.

MacDONALD, D.K.C. (1950). Fluctuations and theory of noise. In lnformation theory, first London symposium. London: Ministry of Supply. Mimeographed.

MacDONALD, D.K.C. (1952). Information theory and its application to taxonomy. J. appl. Phys. 23, 529.

MacDONALD, D.K.C. (1954). Information theory and knowledge. J. appl. Phys. 25, 619.

MACE, C.A. (1953). Homeostasis, needs and values. Brit. J. Psychol. 44, 4, 200-210.

MacGOLL, L.A. (1945). Servomechanisms. New York: Van Nostrand.

MacKAY, D.M (1956a). The epistemological problem for automata. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

MacKAY, D.M. (1949). On the combination of digital and analogical techniques in the design of analytical engines. Mimeographed. (May 20th)

MacKAY, D.M. (1950a). Entropy, time and information. In Information theory, first London Symposium. London: Ministry of Supply. Mimeographed.

MacKAY, D.M. (1950b). The nomenclature of information theory. In Information theory, first London Symposium. London: Ministry of Supply. Mimeographed. Also (1952) In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

MacKAY, D.M. (1950c). Quantal aspects of scientific information. Phil. Mag. 7, 41, 289-311. Also (1950) in Information theory, first London Symposium. London: Ministry of Supply. Mimeographed.

MacKAY, D.M. (1951a). In search of basic symbols. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

MacKAY, D.M. (1951b). Mind-like behaviour in artifacts. (Reply to Mays, 1952) Brit. J. Phil. Sci. 2, 105-121.

MacKAY, D.M. (1952a). Mentality in machines - symposium. Proc. Aristotelian Soc. Supplementary Vol. 26.

MacKAY, D.M. (1952b). Mind-like behaviour in artefacts. (Comment on May's comment, 1952). Brit. J. Phil. Sci. 3, 352-353.

MacKAY, D.M. (1953a). The effects of relaxation time on the relative efficiency of binary PCM, PIM, and PPM. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

MacKAY, D.M. (1953b). Generators of information. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

MacKAY, D.M. (1954a). On comparing the brain with machines. Advanc. Sci. 40. Also (1954) Amer. Scientist, 42, 261-268.

MacKAY, D.M. (1954b). Operational aspects of some fundamental concepts of human communication. Synthese, 9, 182.

MacKay, D.M. (1955a). The place of 'meaning' in the theory of information. In E.C. Cherry (Ed), Information theory, third London symposium. London: Butterworths.

MacKAY, D.M. (1955b). Supra-logical behaviour in automata. (Abstract) Acta Psychol. 11, 204-205.

MacKAY, D.M. (1956b). Towards an information-flow model of human behaviour. Brit. J. Psych. 47, 30.

MacKAY, D.M. and McCULLOCH, W.S. (1952). The limiting information capacity of a neuronal link. Bull. math. Biophysics, 14, 127.

MacMILLAN, R.H. (1951). An introduction to the theory of control. London: Cambridge Univer. Press.

MACRAE, D. G. (1951). Cybernetics and social science. Brit. J. Sociol. 2, 135-149.

MANDELBROT, B. (1951). Mecanique statistique et theorie de l'information. (Statistical mechanics and the theory of information.) C.R.Acad.Sci., Paris, 232, 1638-1640, and 2003-2005.

MANDELBROT, B. (1953a). Communication theory. London: Butterworths

MANDELBROT, B. (1954). Structure formelle des textes et communication: deux etudes. (Formal structure of texts and communication: two studies. Word, 10, 1-27.

MANDELBROT, B. (1955). On the language of taxonomy: an outline of a 'thermo-statistical' theory of systems of categories with Willis (natural) structure. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

MANDELBROT, B. 1953b) An informal theory of the statistical theory of language. In W. Jackson (Ed), Communication theory, second London symposium. London: Butterworths.

MARCOU, P. and DAGUET, J. (1955) New methods of speech transmission. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths

MASON, S.J. (1951). On the logic of feedback. D.Sc. thesis, M.I.T.

MAXWELL, C. (1868) On governors. Proc. Roy.Soc. 16, 270-283.

MAYNE, R. (1951). Some engineering aspects of the mechanism of body control. Elec. Engng. 70, 3.

MAYS, W. (1951). The hypothesis of cybernetics. (Comment on Wisdom, 1951). Brit. J. Phil. Sci. 2, 249-250.

MAYS, W. (1952a). Can machines think? Philosophy, 27, 148-162.

MAYS, W. (1952b). Mind-like behaviour in artefacts and the concept of mind. (Comment on MacKay, 1951). Brit. J. Phil. Sci. 3, 191 -193.

MAYS, W. (1956). Minds and machines-I. B.B.C. Third programne talk, reported in The Listener, Dec. 27.

McCALLUM, D.M. and SMITH, J.B. (1951a). Mechanized reasoning. Electron. Engng., 23, 278, 126-132.

McCALLUM, D.M. and SMITH, J.B. (1951b). Feedback logical computors. Electron. Engng., 23, 286, 458-461.

McCARTHY, J. (1956). The inversion of functions defined by Turing machines. In C.E. Shannon and J. McCarthy (Eds.), Automata studies, Princeton, NJ: Princeton Univer. Press.

McCULLOCH, W.S. (1944). The functional organization of the cerebral cortex. Physiol. Rev. 3, 390-407.

McCULLOCH, W.S. (1945). A heterarchy of values determined by the topology of nerve nets. Bull. Math. Biophys. 7, 89-93.

McCULLOCH, W.S. (1946). Finality and form. 15th James Arthus Lecture, New York Acad. Sci. Also (1952) Springfield, Ill.: Thomas.

McCULLOCH, W.S. (1947a). Machines that think and want. Lecture to American Psychological Association.

McCULLOCH, W.S. (1947b). Modes of functional organization of the cerebral cortex. Federation Proc. 6, 2, 448-452.

McCULLOCH, W.S. (1948a). A recapitulation of the theory, with a forecast of several extensions. Teleological Mechanisms. Ann. N.Y. Acad. Sci. 50, 4, 247-258.

McCULLOCH, W.S. (1948b). Through the den of the metaphysician. Lecture at the University of Virginia. Also (1951) Thales, Presses Universitaires de France, Paris. Also (1954) Brit. J. Phil. Sci. 5, 18-31.

McCULLOCH, W.S. (1949). The brain as a computing machine. Elec. Engng. 68, 492-497.

McCULLOCH, W.S. (1950). Why the mind is in the head. Dialectica, 4, 192-205. Also (1951) In L.A. Jefress (Ed.), Cerebral mechanisms in behaviour. New York: Wiley.

McCULLOCH, W.S. (1953). Information in the head. In R.A. Patton. (Ed.), Current trends in information theory, 92-118. Pittsburgh, PA.: Univer. of Pittsburgh Press.

McCULLOCH, W.S. (1955). Summary of the points of agreement reached in the previous nine conferences on cybernetics. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the tenth conference. New York: Josiah Macy, Jr. Foundation.

McCULLOCH, W.S. and PFEIFER, J. (1949). Digital computers called brains. Sci. Monthly, 69, 368-376.

McCULLOCH, W.S. and PITTS, W. (1943). A logical calculus of the ideas immanent in nervous activity. Bull. math. Biophys. 5, 115-133.

McCULLOCH, W.S. and PITTS, W. (1947). How we know universals. Bull. math. Biophys. 9, 127-147.

McCULLOCH, W.S. and PITTS, W. (1948). The statistical organization of nervous activity. Biometrics, 4, 91-99.

McGILL, W.J. (1954). Multivariate information transmission. Psychometrika, 19, 97-116.

McGILL, W.J. (1955a). Isomorphism in statistical analysis. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

McGILL, W.J. (1955b). The relation between uncertainty and variance. Proc. 1954 conf. test Probl. Educ. Test Serv. 37-42.

McGILL, W.J. and QUASTLER, H. (1955). Standardized nomenclature - an attempt. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

McMILLAN, B. (1953a). The basic theorems of information theory. Ann. math. Statist. 24, 196.

McMILLAN, B. (1953b). Mathematical aspects of informtion theory. In R.A. Patton, Current trends in information theory. Pittsburgh, Pa.: Pittsburgh Univer. Press.

MEAD, M. (1951). Experience in learning primitive languages through the use of learning high level linguistic abstractions. In H. von Foerster (Ed.), Cybernetics - crcular, causal and feedback mechanisms in biological and social systems. Transactions of the seventh conference. New York: Josiah Macy, Jr. Foundation.

MESZAR, J. (1953). Switching systems as mechanical brains. Bell labs. record, 31, 63-69.

MEYER-EPPLER, W. and DARIUS, G. (1955). Two-dimensiona1 photographic auto-correlation of pictures and alphabet letters. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

MILLER, G.A. (1947). Population, distance, and circulation of information. Amer. J. Psychol. 60, 276-284.

MILLER, G.A. (1950). Language engineering. J. acoust. Soc. Amer. 22, 6, 720-725.

MILLER, G.A. (1951a). Language and communication. New York: McGraw Hill.

MILLER, G.A. (1951b) Speech and language. In S.S. Stevens (Ed.). Handbook of experimental psychology. New York: Wiley.

MILLER, G.A. (1953a). Information theory and the study of speech. In R.A. Patton (Ed.), Current trends in information theory. Pittsburgh, Pa.: Univer. of Pittsburgh Press.

MIlLER, G.A. (1953b). What is information measurement? Amer. Psychologist, 8, 3-11.

MILLER, G.A. (1954a). Communication. Annu. Rev. Psychol.

MILLER, G.A. (1954b). Psycholinguistics. In G. Lindzey (Ed.), Handbook of social psychology II Cambridge, Mass: Addison-Wesley.

MILLER, G.A. (1955) Note on the bias of information estimates. In H. Quastler (Ed,), Information theory in psychology. Glencoe, Ill: Free Press.

MILLER, G.A. (1956) The magical number seven, plus or minus two - some limits on our capacity for processing information. Psychol. Rev. 63, 2, 81-97.

MILLER, G.A. and FRICK, C.F. (1949) .Statistical behaviouristics and sequences of responses. Psychol. Rev. 56, 6.

MILLER, G.A. and SELFRIDGE, J.A. (1950). Verbal context and the recall of meaningful material. Amer. J. Psychol. 63, 176-185.

MILLER, G.A., HEISER, G.A. and LITCHEN, W. (1951) The intelligibility of speech as a function of the context of test materials. J. Exp. Psychol. 41, 5.

MILLER, I. (1954). Auditory perception in relation to amount of information and speech-to-noise ratio. Dissertation Abstr. 14, 2136. Abstract of Ph.D. thesis, Purdue Univer.

MILLER, R.B., FOLLEY, J.D. Jr. and SMITH, P.R. (1953). Trouble shooting in electronics equipment, - a proposed method. Pittsburgh, Pa: Amer. Inst. for Research.

MINISTRY OF SUPPLY (1950). Bibliography of information on servomechanisms and related subjects. Prepared for the Interdepartmental Technical Committee on Servomechanisms. London: Technical Information Bureau, Ministry of Supply.

MINSKY, M.I. (1953). Theory of neural-analog reinforcement systems and its application to the brain-model problem. PhD dissertation, Princeton Univer.

MINSKY, M.I. (1954). Neural-analog networks and the brain-model problem. Princeton Univer. Microfilmed.

MINSKY, M.I. (1956). Some Universal elements for finite automata. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

MOOERS, C. (1955). Information retrieval on structured content. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

MOOERS, C. N. (1952). Machines for information retrieval, learning and translating. Invited paper circulated at the symposium on machine translation organized by Y. Bar-Hillel at M.I.T.

MOORE, E.F. (1956). Gedanken-experiments on sequential machines. In C.E. Shannon and J. Mcarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

MOORE, E.F. and TUMIN (1949). Some social functions of ignorance. Amer. sociol. Rev. 14, 6,787-795.

MOREHOUSE et al. (1950). An electro-analog method of investigating problems in economic dynamics - inventory oscillations. Econometrica, 18, 313-328.

MORRIS, C W. (1946). Signs, language and behaviour. New York: Prentice-Hall.

MOSIER, R.D. (1952). Cybernetics and the educative process. Calif. J. educ. Res. 3, 147-150. ,

MOWRER, O.H. (1954). Ego pscyhology, cybernetics, and learning theory. In Kentucky Symposium - learning theory, personality theory, and clinical research. New York: Wiley.

MUNDY-CASTLE, A.C. (1953). Cybernetics. S. African Med. J. 27, 49-53.

MUNSON, V.A. and KARLIN, J. E. (1954). Measurement of human channel transmission characteristics. J. acoust. Soc. Amer. 26, 542-553.

MURPHEE, O.D. (1954). Maximum rates of form perception and the alpha rhythm - an investigation and test of current nerve net theory. J. exp. Psychol. 48, 57-61.

MURRAY, F.J. (1948). The theory of mathematical machines. New York: Kings Crown Press.

***N***

NAGEL, E. (1951). Mechanistic explanations and organismic biology. Phil. phenomenol. Res. 11, 327-338.

NEGLEY, G. (1951). Cybernetics and theories of mind. J. Phil. 48, 19, 574-582.

NEWELL, A. (1955). A chess-playing machine. Proc. Western Joint Computer Conf. I.R.E, A.I.E.E,.A.C.M.

NEWMAN, E.B. (1951). The pattern of vowels and consonants in various languages. Amer. J. Psychol. 64, 369-379.

NEWMAN, E.B. (1951a). Computation methods useful in analysing series of binary data. Amer. J. Psychol. 64, 369-379.

NEWMAN, E.B. and GERSTMAN, L.J. (1952). A new method for analysing printed English. J. exp. Psychol. 44, 114-125.

NORTH, J. D. ( ). The rational behaviour of mechanically extended man. Boulton Paul Aircraft Ltd.

NORTH, J.D. (1955). Application of commmunication theory to the human operator. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

NORTHROP, F.S.C. (1948). The neurological and behaviouristic basis of the ordering of society by means of ideas. Science, 107, 2782, 411-417.

NYQUIST, H. (1924.) .Certain factors affecting telegraph speed. Bell Syst. tech. J. 3, 324.

NYQUIST, H. (1928). Certain topics in telegraphic transmission theory. Trans. A.I.E.E. 47, 617.

NYQUIST, H. (1932). Regeneration theory. Bell Syst. tech. J. 126.

***O***

OETINGER, A. (1952). Programming a. digital computer to learn. Phil. Mag. 7, 43, 1243-1263.

OGDEN, C.K. and RICHARDS, I.A. (1930). The meaning of meaning. London: Kegan Paul. Also New York: Harcourt Brace.

OLDFIELD, R.C. (1954). Memory mechanisms and the theory of schemata. Brit. J. Psychol. 45, 14.

OLIVER, B.M., PIERCE, J.R. and SHANNON, C.E. (1948). The philosphy of PCM. Proc. I.R.E. 36, 1324.

ORBELI, L.A. (1949). Vtoria signal naia sistema. (The second signal system). Neuropatol. i Psikhiat. 18(5), 8-19.

OSBORNE, J.W., QUASTLER, H., TWEEDELL, K.W. and WILSON, K.V. (1955). Human performance in information transmission - III. Technical report No. R-68, Control Systems Laboratory, Univer. of Illinois, Urbana.

OSGOOD, C.E. (1955). Fidelity and reliability. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

OSTOW, M. (1949). Entropy changes in mental activity. J. nerv. ment. Dis. 110, 502-506.

OSTOW, M. (1951). The entropy concept and psychic function. Amer. Scientist. 39, 140-145.

***P***

PAKSWER, S. (1954). Information, entropy, and inductive logic. Phil. Sci. 21, 254-259.

PATTON, R.A. (Ed.), (1953). Current trends in information theory. Pittsburgh, Pa.: Univer. of Pittsburgh Press.

PENFIELD, W. (1952). Memory mechanisms. A.M A. Arch. Neurol. Psychiat. 67, 178-198.

PETERS, R.W. (1954). Competing rnessages - the effect of interfering messages upon the reception of primary messages. US Naval Sch. Aviat. Med. Res. Rep. Project No. NM 001 064.01.27.

PETERSON, G.E. (1952). Information theory. 2 - Applications of information theory to research in experirnental phonetics. J. Speech Hearing Disorders 17, 175-187.

PETERSON, G.E. (1953). The information-bearing elements of speech. In W.Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

PIAGET, J. (1953). Structures operationelles et cybernetique. (Functional structures and cybernetics). Annee Psychol. 53, 379-390.

PIGORS, P. (1949 ). Effective communication in industry. What is its basis? National Ass. of Manufacturers, Lt. Rush Toland memorial study No. 1.

PINKERTON, R.C. (1956). Information theory and melody. Sci. Amer. 194-, 2, 77-86.

PINSKY, L. (1951). Do machines think about machines thinking? Mind, 60, 397-398.

PIRENNE, M.H. (1951). Mind-like behaviour in artefacts and the concept of mind. (Comment on MacKay, 1951). Brit. J. Phil. Sci. 2, 315.

PITTS, W. (1953). Investigations on synaptic transmission. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

POLANYI, M. (1951). The hypothesis of cybernetics. Brit. J. Phil. Sci. 2, 312.

POLLACK, I. (1951). The assimilation of sequentially encoded information. Amer. Psychologist, 5, 8, 266-267. Also (1953) Amer. J. Psychol., 66, 3, 421-435.

POLLACK, I. (1952). The information of elementary auditory displays. J. acoust. Soc. Amer. 24, 745-749.

POLLACK, I. and PICKS, L. (1954). Information of elementary multidimensional auditory displays. J. acoust. Soc. Amer. 26, 155.

POPPER, K.R. (1950). Indeterminism in quantum physics and in classical Physics. (Part II, section 9.) Brit. J. Phil. Sci. 1, 173-195.

POST, E. (1936). Finite combinatory processes - formulation 1. J. Symbol. Logic, 1, 103-105.

POULTON, E.C. (1953). Two-channel listening. J. exp. Psychol. 46, 91-96.

POULTON, E.C. (1954). Eye-hand span in simple serial tasks. J. exp. Psychol. 47, 403-410.

PRIGOGINE, I. (1947). Etude thermodynamique des phenomenes irreversibles. (The thermodynamic study of irreversible phenomena.) Paris.

PRIGOGINE, I. and WIAME, J.M. (1946). Biologie et thermodynamique des phenomenes irreversibles. (Biology and thermodynamics of irreversible phenomena.) Experientia. (Basel), 2, 450-451.

PRINZ, D.G. (1952). Robot chess. Research, 5, 261-266.

PUIG ADAM, P. (1951). Sobre cibernetica - genesis y problemas. (Concerning cybernetics - genesis and problems.) Rev. Psicol. gen. apl., Madrid, 6, 515-525.

### *Q*

QUASTLER, H. (1953a). Feedback mechanisms in cellular biology. In H. von Foerster (Ed.), Cybernetics -circular, causal and feedback mechansims in biological and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

QUASTLER, H. (1953b). The measure of specificity. In H. Quastler (Ed), Information theory in biology. Urbana: Univer. of Illinois Press.

QUASTLER, H. (1953c): The specificity of elementary biological functions. In H. Quastler (Ed.) Information theory in biology. Urbana, Ill: Univer. of Illinois Press.

QUASTLER, H. (1955a). Approximate estimation of information measures. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

QUASTLER, H. (1955b). Information theory terms and their pscyhological correlates. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

QUASTLER, H. (1955c). Studies of human channel capacity. In E.O. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

QUASTLER, H. and WULFF, V.J. (1955a). Human performance in information transmission - I and II. Technical report No. R-62, Control Systems Laboratory, Univer. of Illinois, Urbana.

QUASTLER, H. and WULFF, V.J. (1955b). Human performance in information transmission - V. Technical report No. R-70, Control Systems Laboratory, University of Illinois, Urbana.

### *R*

RABEL, G. (1948). Mathematical instruments and calculating machines. Science News, VII. London: Penguin Books, 122-125.

RAFFERTY, J.A. (1950). Mathematical model in biological theory. Amer. Scientist, 38, 4, 549.

RAPOPORT, A. (1950). Science and the goals of man. New York: Harper.

RAPOPORT, A. (1950-51). Mathematical biophysics, cybernetics and significs. Synthese, 8, 182-193.

RAPOPORT, A. (1953). What is information? Etc. Rev. gen. Semant. 10, 247-260.

RAPOPORT, A. (1955). Technological models of the nervous system. Psychiat. Res. Rep. No.2, 119-131.

RAPOPORT, A. and SHIMBEL, A. (1949a). Cybernetics and mathematical biology. Etc. Rev. gen. Semant.

RAPOPORT, A. and SHIMBEL, A. (1949b). Mathematical biophysics, cybernetics and general semantics. Etc. Rev. Gen. Semant. 6, 145-159.

RASHEVSKY, N. (1938). Mathematical biophysics. Chicago, Ill.: Univer. of Chicago Press. (Second edition, much revised, 1948.)

RASHEVSKY, N. (1945a) Mathematical biophysics of abstraction and logical thinking. Bull. Math. Biophys. 7, 133-148.

RASHEVSKY, N. (1945b) Some remarks on the Boolean algebra of nervous nets in mathematical biophysics. Bull. Math. Biophys. 7, 203-211.

RASHEVSKY, N. (1946). The neural mechanism of logical thinking. Bull. math. Biophys. 8, 1, 29-40.

RASHEVSKY, N. (1951). A note on imitative behaviour and information. Bull. math. Biophys. 13, 3.

RAYMOND, R. C. (1951). The well-informed heat engine. Amer. J. Phys. 19, 2, 109-111.

RAYMOND, R.C. (1950). Communication, entropy and life. Amer. Scientist, 38, 2, 273-278.

REICH, E. (1951). The game of 'gossip' analysed by the theory of information. Bull. math. Biophys. 13, 313-318.

RICE, S.O. (1944). Mathematical analysis of random noise. Bell Syst. tech. J. 23, 282-332 and 24, 46-156.

RICE. S.O. (1950). Communications in the presence of noise - probability of error for two encoding schemes. Bell Syst. tech. J. 29, 1, 60-93.

RICHARDS, D.L and SWAFFIELD, J. (1953). Measurement of the communciation rate of speech link - a preliminary appraisal of the problem. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

RICHARDS, D.L. (1953). Some aspects of the behaviour of telephone users as affected by the physical properties of the circuit. In W. Jackson (Ed.), Communication theory, second London symposium. London: Butterworths.

RICHARDS, I.A. (1952). Communication between men - meaning of language. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

RICHARDS, P.I. (1951). Machines which can learn. Amer. Scientist, 39, 4, 711- 716.

RICHARDS, P.I. (1952). On game-learning machines. Sci. Mon., N.Y., 74, 201-205.

RICHARDSON, L.F. (1939). Generalised foreign politics. Brit. J. Psychol. Monog. Suppl. 23.

RIGNANO, E. (1926). Man not a machine. London: Paul, Trench and Trubner.

RODDAM, T. (1949) Communication theory, old and new. Science news XII. London: Penguin Books.

ROGERS, M.S. (1953) An application of information theory to the problem of the relationship between meaningfullness of material and performance in a learning situation. Dissertation Abstr. 13,600. Univer. Microfilms, Ann Arbor, Mich., Publ. No. 5164-.

ROGERS, M.S. and GREEN, B.F.(1955).The moments of sample information when the alternatives are equally likely. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

ROSENBLITH, W.A. (1949). Cybernetics - book review of Wiener (1948b). Ann. Amer. Acad. 264, 187.

ROSENBLUETH, A. and WIENER, N. (1945). The role of models in Science. Phil. Sci. 12, 316-322.

ROSENBLUETH, A., WIENER N. and BIGELOW, J. (1943). Behaviour, purpose and teleology. Phil. Sci. 10, 1, 18-24.

ROTHSTEIN, J. (1951). Information, measurement, and quantum mechanics. Science, 114, 171-175.

RUARK, A.E. (1951). Information theory. Part of Report No.145, Programs Research Unit, Institute for Cooperative Research, The John Hopkins University.

RUESCH, J. (1952). The therapeutic process. IV - The tberapeutic process from the point of view of communication theory. Amer. J. Orthopsychiat. 22, 690-700.

RUESCH, J. and BATESON, G. (1949). Structure and process in social relations. Psychiatry, 12, 2, 105-124.

RUESCH, J. and BATESON, G. (1951). Communication. The social matrix of psychiatry. New York: Norton.

RUSHTON, W.A.H. (1950). The problem of the information which the brain receives from the eye. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

RUYER, R. (1952). Le probleme de l'informationet la cybernetique. (The problem of information and cybernetics.) J. Psychol. norm. path. 45, 385-418.

### *S*

SADOSKY, M. (1954). Cibernetica - realidades y falacias. (Cybernetics - facts and falacies.) Acta neuropsiquiat Argent. 1, 97-103.

SADOSKY, M. (1955). Cibernetica (conclusion) - matematicas, logia y maquinas. (Cybernetics (conclusion) - mathematics, logic and machines.) Acta. Neuropsiqiat. Argent. 1, 300-307.

SAMSON, E.W. (1953). Fundamental natural concepts of information theory. Etc. Rev. Gen. Semant. 10, 283-297.

SAMUEL, A.L. (1953). Computing bit by bit or digital computers made easy. Proc. I.R.E. 41, 10, 1223-1230.

SAMUELSON, P.A. (1947). Foundations of economic analysis. (part II and Appendix B.) Cambridge: Harvard Univer. Press.

SAPIR, E. (1931 ). Communication. Encyclopedia of the social sciences. Vol IV. New York: Macmillan.

SCHAFER, T.H. (1955). A basic experiment in detection. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

SCHNEIRIA, T.D. and PEIL, G. (1948). The army ant. Sci. American, 178, 6, 22-26.

SCHNEIRLA, T.D. (1951). The levels concept in the study of social organisation in animals. In J.H. Rohrer and M. Sherif (Eds.), Social psychology at the crossroads. New York: Harper.

SCHOUTEN, J.F. (1955). Ignorance, knowledge and information. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

SCHRAMM, W. (1955). Information theory and mass communication. Journalism Quart. 32, 131-146.

SCHRODINGER, E. (1944). What is life? Cambridge, Eng.: Cambridge Univer. Press. Also (1945) New York: Macmillan.

SCHUTZENBERGER, M.P. (1955). On some measures of information used in statistics. In E.C. Cherry (Ed. ), Information theory, third London symposium. London: Butterworths.

SELFRIDGE, O.G. (1955). Pattern recognition and learning. In E.C. Cherry (Ed.), Information theory, third Iondon symposium. London: Butterworths.

SENDERS, J.W. (1955). Man's capacity to use information from complex displays. In H. Quastler (Ed.), Iniformation theory in psychology. Glencoe, Ill: Free Press.

SENDERS, V.L (1955). The effect of number of subjects on the estimate of transmitted information. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

SENDERS, V.L. and COHEN, J. (1955). The effects of sequential dependencies on instrument reading performance. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

SERRELL, R. (1953). Elements of Boolean algebra for the study of information handling systems. Proc. I.R.E. 41, 10, 1366-1380.

SHANNON, C.E. (1938). A symbolic analysis of relay and switching circuits. Elec. Engng. Transactions Suppl. 57, 713-723.

SHANNON, C.E. (1948). A mathematical theory of communication. Bell Syst. tech. J. 27, 379-424 and 623-657.

SHANNON, C.E. (1949a). Communication in the presence of noise. Proc. I.R.E. 37, 10-21.

SHANNON, C.E. (1949b). Communication theory of secrecy systems. Bell Syst. tech. J. 28, 656-715.

SHANNON, C.E. (1949c). Synthesis of tvo-terminal switching circuits. Bell Syst. tech. J. 28, 59-98.

SHANNON, C.E. (1950a). Chess-playing machine. Sci. Amer. 182, 2, 48-51.

SHANNON, C.E. (1950b). Communication theory - exposition of fundamentals. In Information theory, first London symposium, London: Ministry of Supply. Mimeographed.

SHANNON, C.E. (1950c). General treatment of the problem of coding. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

SHANNON, C.E. (1950d). The lattice theory of information. In Informaation theory, first London symposium. London: Ministry of Supply. Mimeographed.

SHANNON, C.E. (1950e). Memory requirements in a telephone exchange. Bell Syst. tech. J. 29, 3, 343-349.

SHANNON, C.E. (1950f). Programming a computer for playing chess. Phil. Mag. 41, 256-275.

SHANNON, C.E. (1950g). Recent developments in communication theory. Electronics, 23, 80-84.

SHANNON, C.E. (1951a).. Prediction and entropy of printed English. Bell Syst. tech. J. 30, 1, 50-64.

SHANNON, C.E. (1951b). The redundancy of English. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the seventh conference. New York: Josiah Macy, Jr. Foundation.

SHANNON, C.E. (1952). Presentation of a maze-solving machine. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the eighth conference. New York: Josiah Macy, Jr. Foundation.

SHANNON, C.E. (1953). Computers and automata. Proc. I.R.E. 41, 1235-1241.

SHANNON, C.E. (1956). A universal Turing machine with two internal states. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

SHANNON, C.E. and WEAVER, W. (1949). The mathematical theory of communication. Urbana, Ill: Univer. of Illinois Press.

SHEPARD, H.A. ( ). Social system of a research group. Mimeographed.

SHIMBEL, A. (1949 ). Input-output problems in simple-nerve ganglion systems. Bull. math. Biophys. 11, 165-171.

SHIMBEL, A. (1952). Some elementary considerations of neural models. Bull. math. Biophys. 14, 68-71.

SHOLL, D.A. (1956). The organisation of the cerebral cortex. New York: Wiley.

SHOLL, D.A. and UTTLEY, A.M. (1953). Pattern discrimination and the visual cortex. Nature, London, 172, 387-388.

SIMON, H.A. ( ). .An exploration into the use of servomechanism theory in the study of production control. Cowels Commission discussion paper - Economics, No.288. Mimeographed copy for private circulation.

SIMON, H.A. (1948a). Administrative behaviour. New York: Macmillan.

SIMON, H.A. (1948b). A study of decision-making processes in administrative organisation. New York: Macmillan.

SIMON, H.A., SMITHBURG, D. and THOMPSON, V.A. (1950). Public administration. New York: Knopf.

SLATER, E. (1950). Statistics for the chess computer and the factor of mobility. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

SLEPIAN, D. (1955). A class of binary signalling alphabets. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

SLUCKIN, W. (1954). Minds and machines. London: Penguin Books.

SMITH, E.S. (1944). Automatic control engineering. New York: McGraw-Hill.

SMITH, K. (1951). Psychology and the concept of 'Life'. Psychol. Rev. 58, 5, 330.

SOMENZI, V. (1955). Can induction be mechanized? In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

SPIETH, W., CURTIS, J.F. and WEBSTER, J.C. (1954). Responding to one of two simultaneous messages. J. acoust. Soc. Amer. 26, 391-396.

SPILSBURY, R.T. (1952). Mentality in machines. Symposium. Proc. Aristotelian Soc. Supplementary Vol. 16.

STAGNER, R. (1951). Homeostasis as a unifying concept in personality theory. Psychol. Rev. 58, 5-17.

STEVENS, S. (1950). Proceedings of the speech communication conference at M.I.T.; introduction - a definition of communication. J. acoust. Soc. Amer. 22, 689-690.

STORR, A. (1956). A note on cybernetics and analytical psychology. J. anal. Psychol. 1, 93-95.

STRACHEY, C.S. (1952). Logical or non-mathematical programmes. Proc. Ass. Computing Machinery, Toronto, 46-49.

STRAUS, O.H. (1950). The relation of phonetics and linguistics to communication theory. J. acoust. Soc. Amer. 22, 6, 709-711.

STROUD, J.M. (1948). The moment function hypothesis. MA. Thesis, Stanford Univer.

STROUD, J.M. (1950). Psychological moment in perception - discussion. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the sixth conference. New York: Josiah Macy, Jr. Foundation.

STROUD, J.M. (1951). The development of language in early childhood. In H. von Foerster (Ed.), Cybernetics -circular, causal and feedback mechanisms in biological and soical systems. Transactions of the seventh conference. New York: Josiah Macy, Jr. Foundation.

STROUD, J.M. (1955). The fine structure of psychological time. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill.: Free Press.

SWEET, A.L. (1953). Some problems in the application of cognitive theory to personality functioning. J. Pers. 22, 41-51.

SZILARD, I. (1929). Uber die Entropieverminderung in einem thermodynamischen system bei Eingriffen intelligenter Wesen. (The diminution of entropy in a thermodynamic system caused by the intervention of intelligent beings.) Z. Physik, 53, 840-856.

***T***

TAKADA, Y. (1954). Tsushin riron ni tsuite. (On the mathematical theory of communication.) Jap. J. Psychol. 25, 110-11 7.

TANNER, W.P.Jr. (1955). On the design of psychophysical experiments. In H. Quastler (Ed.), Information theory in psychology. Glencoe, Ill: Free Press.

TAYLOR, R. (1950). Comments on a mechanistic conception of purposefulness. Phil. Sci. 17.

TAYLOR, W.K. (1955). Electrical simulation of some nervous system functional activities. In E.C. Cherry (Ed.), Information theory, third Londan symposium. London: Butterworths.

THALER, G.J. and BROWN, R.G. (1953). Servomechanism analysis. New York: McGraw-Hill.

THOMAS, W.H. (1953). Fundamentals of digital computer programming. Proc. I.R.E. 41, 10, 1245-1249.

THOMS0N, R. and SLUCKIN W. (1954). Machines, robots and minds. Durham Univer. J., (England) 46, 116-122.

THOMSON, R. and SLUCKIN, W. (1953). Cybernetics and mental functioning. Brit. J. Phil. Sci. 3, 130-146.

TOLMAN, E.C. (1932). Purposive behaviour in animals and men. Berkeley: Univer. of California Press.

TOLMAN, E.C. (1938). Principles of statistical mechanics. Oxford: Clarendon Press.

TRIMMER, J.D. (1949). Instrumentation and cybernetics. Sci. Mon. N.Y. 69, 328-331.

TRIMMER, J.D. (1950). Response of physical systems. New York: Wiley.

TSIEN, H.S. (1951). Engineering cybernetics. New York: McGraw-Hill.

TULLER, W.G. ( ). Theoretical limitations on the rate of transmission of information. Technical Report No. 114, Research Laboratory of Electronics, M.I.T. Also (1949). Proc. I.R.E. 37, 468

TURING, A.M. (1937). On computable numbers with reference to the Entscheidungsproblem. Proc. London math. Soc. 2-42, 230-265.

TURING, A.M. (1950). Computing machinery and intelligence. Mind, 59, 433-460. Also (1954). Methodos, 23, 6.

TURING, A.M. (1948). Intelligent machinery. Unpublished paper.

TUSTIN, A. (1953). Do modern mechanisms help us to understand the mind? Brit. J. Psychol. 44, 1, 24.

TWEEDELL, K.S. (1953). Identical twinning and the information content of zygotes. In H. Quastler (Ed.), Information theory in Biology. Urbana, Ill: Univer. of Illinois Press.

***U***

UTTLEY, A.M. (1950). Information, machines and brains. In Informaation theory, first London symposium. London: Ministry of Supply. Mimeographed.

UTTLEY, A.M. (1954a). The classification of signals in the nervous system. Ministry of Supply, R.R.E. memorandum No. 1047. Also (1954) E.E.G. Clin. Neurophysiol. 6, 479-494.

UTTLEY, A.M. (1954b) The probability of neural connections. Ministry of Supply, R.R.E. memorandum No 1948. Also (1955) Proc. roy. Soc., series B, 144, 916.

UTTLEY, A.M. (1955). The conditional probability of signals in the nervous system. Ministry of Supply, R.R.E. memorandunr No.109.

UTTLEY, A.M. (1956a). Conditional probability machines and conditioned reflexes. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

UTTLEY, A.M. (1956b). Temporal and spatial patterns in a conditional probability machine. In C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

***V***

van der POL, B. (1955). An iterative translation test. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

van SOEST, J.L. (1955). Some consequences of the finiteness of information. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

van VLECK, J. and MIDDLETON, D. (1946). A theoretical comparison of the visual, aural, and meter reception of pulsed signals in the presence of noise. J. appl. Phys. 17, 940.

VIGNERON, H. (1914). Les automates. (Automata) La Natura.

VILLE, J. (1948). Theorie et applications de signal analytique. (Theory and applications of analytic signals.) Cables et transmission, 2, 61.

von BERTALANFFY, L (1942). Theoretische Biologie (Theoretical biology.) Berlin.

von BERTALANFFY, L. (1940). Der Organismus als physikalisches System, betrachtet. (The organism considered as a physical system.) Naturwissenschaften, 28, 521-531.

von BERTALANFFY, L. (1944). Bemerkungen zum Modell der Biologischen Elementareinheiten. (Observations on a model for the elementary units of biology.) Naturwissenschaften, 32, 26-32.

von BERTALANFFY, L. (1948). Das Weltbild der Biologie. (The biological attitude.) In Weltbild und Menschenbild, III. Internat. Hochschulwochen. des Oesterr. College, Salzburg. 251-274.

von BERTALANFFY, L. (1949). Das biologische Weltbild. (The biological attitude.) Bern. Also (1952) as Problems of Life. London: Watts.

von BERTALANFFY, L. (1950a). An outline of general system theory. Brit. J. Phil. Sci. 1, 134.

von BERTALANFFY, L. (1950b). The theory of open systems in physics and biology. Science, III. 23.

von BERTALANFFY, L. (1952). Theoretical models in biology and psychology. In D. Krech and G.S. Klein (Eds.), Theoretical models in personality theory. Durham, N.C.: Duke Univer. Press.

von FOERSTER, H (1950). Quantum theory of memory. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the sixth conference. New York: Josiah Macy, Jr. Foundation.

von FOERSTER, H. (1948). Das Gedachtnis. (Memory.) Vienna.

von NEUMANN, J. (1949). Cybernetics - book review of Wiener (1948b) Physics Today, 2, 5, 33-34.

von NEUMANN, J. (1951). The general and logical theory of automata. In LA. Jeffress (Ed.), Cerebral Mechanisms in Behaviour. New York: Wiley.

von NEUMANN, J. (1952). Probabilistic logics and the synthesis of reliable organisns from unreliable components. California Institute of Technology Lectures - notes taken by R.S. Pierce. Also (1956) in C.E. Shannon and J. McCarthy (Eds.), Automata Studies. Princeton, N.J.: Princeton Univer. Press.

von NEUMANN, J. and MORGENSTERN, A. (1947). Theory of games and of economic behaviour. Princeton, N.J.: Princeton Univer. Press.

***W***

WAISHE, F.M.R. (1952). The hypothesis of cybernetics. (Comment on Wisdom, 1951). Brit. J. Phil. Sci. 2, 161-163.

WALL, P.D., LETTVIN, J.Y., McCULLOCH, W.S. and PITTS, W.H. (1955). Factors limiting the maximum impulse transmitting ability of an afferent system of nerve fibres. In E.C. Cherry (Ed.), Information theory, third London symposium. London: Butterworths.

WALTER, W. G. (1955). Studies on activity of the brain. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the tenth conference. New York: Josiah Macy, Jr. Foundation.

WALTER, W.G. (1950a). An electro-mechanical "animal ". Dialectica, 4, 206-213. Also (1950 Discovery, 11, 90-93.

WALTER, W.G. (1950b). Features in the electro-physiology of mental mechanisms. In D. Richter (Ed.), Perceptives in Neuropsychiatry. London: H.K. Lewis.

WALTER, W.G. (1950c). The functions of electrical rhythms in the brain. J. ment. Sci. 96, 402.

WALTER, W.G. (1950d). An imitation of life. Sci. Amer. 182, 5.

WALTER, W.G. (1950e). Possible features of brain functions and their imitation. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

WALTER, W.G. (1950f). Rhythm and reason. E.E.G. Clin. Neurophysiol. 2, 203.

WALTER, W.G. (1951). A machine that learns. Sci. Amer. 185, 2, 60-63.

WALTER, W.G. (1952). Patterns in your head. Discovery, 13, 56-62.

WALTER, W.G. (1953). The living brain. London: Duckworth.

WALTER, W.G. (1954). Theoretical properties of diffuse projection systems in relation to behaviour and consciousness. In Brain Mechanisms and Consciousness - Symposium. Oxford: Blackwell.

WALTER, W.G. and DOVEY, V.J. (1947). Etude analytique des rhythmes corticaux induits par une stimulation lumineuse intermittente. (An analytic study of cortical rhythms induced by an intermittent light stimulus.) Marseille Med. I, 240-248.

WALTER, W.G. and WALTER, V.J. (1949). Central (cortical) effects of rhythmic sensory (visual) stimulation. EEG. clin. Neurophysiol. 1, 57-86.

WALTER, W.G., DOVEY, V.J. and. SHIPTON, H. (1946). Analysis of the electric response of the human cortex to photic stimulation. Nature, London, 158, 540-541.

WEAVER, W. (1948a). Probability, rarity, interest, and surprise. Sci. Mon., N.Y.,67.

WEAVER, W. (1948b) Science and complexity. Amer. Scientist, 36, 4, 536-544.

WEAVER, W. (1949). The mathematics of commmunication. Sci. Amer. 181, 1, 11-15.

WEAVER, W. (1952). Information theory: 1. Information theory to 1951 - a non-technical review. J. Speech Hearing Disorders.17, 166-174.

WEAVER, W. (1953). Recent contributions to the mathematical theory of communication. Etc. Rev. gen. Semant. 10, 261-281.

WEBER, C.O. (1949). Homeostasis and servo-mechanisms for what? Psychol. Rev. 56, 234-239.

WEBSTER, J.C. and THOMPSON, P.O. (1954). Responding to both of two overlapping messages. J. acoust. Soc. Amer. 26, 396-402.

WEI, T. (1948). On matrices of neural nets. Bull. math. Biophys. 10, 63-67.

WEINBURG, M. (1951). Mechanism in neurosis. Amer. Sci. 39, 74-99.

WERNER, H. (1951). On the development of word meanings. In H. Von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisns in biological and social systems. Transactions of the seventh conference. New York: Josiah Macy, Jr. Foundation.

WESTCOTT, J.H (1950). Criteria of prediction and discrimination. In Information theory, first London symposium. London: Ministry of Supply. Mimeographed.

WESTON, J.D. (1949). A note on the theory of communication. Phil. Mag. 40, 449.

WHORF, B.L. (1950) .Four articles on metalinguistics. Reprinted from Technolog;y Rev. and Language, Culture and Personality. Washington D.C.: Foreign Service Inst., Dept. of State.

WIENER, N. (1948a). Cybernetics. Sci. Amer. 179, 5, 14-19.

WIENER, N. (1948b). Cybernetics; or control and communication in the animal and the machine. New York: Wiley.

WIENER, N. (1948c) Time, communication, and the nervous system. In L.K. Frank et al. (Eds.), Teleological Mechanisms - Symposium. Ann. N.Y. Acad. Sci. 50, 197-220.

WIENER, N. (1949a). Extrapolation, interpolation and smoothing of stationary time series. .New York: Wiley.

WIENER, N. (1949b). New concept of communication engineering. Electronics, 22, 1, 74-77.

WIENER, N. (1950a). The human use of human beings - Cybernetics and society. Boston, Mass: Houghton Mifflin.

WIENER, N. (1950b). Sensory prothesis. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of the sixth conference, New York: Josiah Macy, Jr. Foundation.

WIENER, N. (1950c). Speech, language and learning. J. acoust. Soc. Amer. 22, 6, 696-697.

WIENER, N. and ROSENBLUETH, A. (1950). Purposeful and non-purposeful behavior. Phil. Sci. 17.

WILKES, M.V. (1951a). Automatic calculating machines. J. roy. Soc. Arts, 100, 56-90.

WILKES, M.V. (1951b). Can machines think? Spectator 6424, 177-178. Also.(1953) Proc. I.R.E., 41, 10, 1230-1234.

WILKES, M.V., WHEELER, D.J. and GILL, S. (1951). The preparation of programs for an electronic digital computer. Cambridge, Mass.: Addison-Wesley.

WILLIS, R. (1954). Estimating the scalability of a series of items. Psychol. Bull. 51, 511-516.

WILSON, K. van N. (1954). Information transmission and optimal coding in natural language message. Dissertation Abstr. 14, 1802-1803. Abstract of Ph.D thesis, Univer. of Illinois.

WISDOM, J.O. (1951). The hypothesis of cybernetics. Brit. J. Phil. Sci. 2, 1-24.

WISDOM, J.O. (1952). Mentality in machines - Symposium. Proc. Aristotelian Soc. Supplementary Vol. 26.

WOODWARD, P.M. (1950). Theory of radar information. In Information theory, first London Symposium. London: Ministry of Supply. Mimeographed.

WOODWARD, P.M. (1953). Probability and information theory. New York: McGraw-Hill.

WOODWARD, P.M. and DAVIES, I.L. (1950). A theory of radar information. Phil. Mag. 41, 1001.

WOODWARD, P.M. and DAVIES, I.L. (1952). Information theory and inverse probability in telecommunication. Proc. I.E.E. 99, 3, 37.

WRIGHT, H.W. (1954). The significance of communication for psychological theory. Canad. J. Psychol. 8, 32-40.

WYCOFF, L.B., Jr. (1954). A mathematical model and an electronic model for learning. Psychol. Rev. 61, 89.

***X***

***Y***

YNGVE, V.H. (1954). The machine and the man. Mech. Translation, 1, 20-22.

YNGVE, V.H. (1955). The translation of languages by machine. In E.C. Cherry (Ed.), Infomation theory, third London symposium. London: Butterworths.

YOUNG, J.Z. (1951a). Doubt and certainty in science. Oxford: Clarendon Press.

YOUNG, J.Z. (1951b). Growth and plasticity in the nervous system. Proc. roy. Soc., London, Series B, 139, 18.

YOUNG, J.Z. (1953) .Discrimination and learning in octopus. In H. von Foerster (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological. and social systems. Transactions of the ninth conference. New York: Josiah Macy, Jr. Foundation.

***Z***

ZIPF, G.K. (1949). Human behaviour and the principle of least effort. Cambridge Mass: Addison Wesley.

***SYMPOSIA***

ADOLPH, A. (Ed.), (1943). Physiological regulations. Lancaster, PA.: Cartell Press.

AERO MEDICAL LABORATORY. (1948). Application of operational analysis to human motor behaviour. Memo. Report MCREXD 694-2J.

BOWDEN, B.V. (Ed.), (1953). Faster than thought. London: Pitman.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. (1954). Symposium on cybernetics. Advancement of Sci. 40.

CHERRY, E.C. (Ed.), (1955). Information theory, third London symposium, Ministry of Supply. September 12-16, 1955. London: Butterworths. New York: Academic Press.

de BROGLIE, L. (Ed.), ( ). La cybernetique. (Communication theory.) Report of conference. Paris: Rev. Opt.

FERRANTI LTD. (1951). The Ferranti Nimrod digital calculator.

HARVARD UNIVERSITY COMPUTATION LABORATORY. (1951). Synthesis of electronic computing and control circuits. Cambridge, Mass.: Harvard Univer. Press.

HJGH SPEED AUTOMATIC CALCULATING MACHINES. (1950). Report of conference at the University Mathematical Laboratory, Cambridge, England. Ministry of Supply.

INFORMATION THEORY. (1950). First London symposium, Ministry of Supply. London: Mimeographed. Also (1950) Proc. I.R.E.

JACKSON, W. (Ed.), (1953). Communication theory, second London syposium, Ministry of Supply. London: Butterworths. New York: Academic Press.

JEFFRESS, L.A. (Ed.), (1951). Cerebra1 mechanisms in behaviour. The Hixon Symposium. New York: Wiley.

LICKLIDER, J.C.R. (Ed.), (1955). Problems in human communication and control. Cambridge, Mass.

QUASTLER, H. (Ed.), (1953). Essays on the use of information theory in biology. Urbana, Ill.: Univer. of Illinois Press.

QUASTLER, H. (Ed.), (1955). Information theory in psychology. Glencoe, Ill.: Free Press.

RICHTER, D. (Ed.), (1950). Persectives in neuropsychiatry. London: H.K. Lewis.

SCIENTIFIC AMERICAN EDITORS. (1955). Automatic control. New York: Simon and Schuster.

SERVOMECHANISMS. (1951). Selected Government Research Report, Vol. 5, London: H.M. Stationery office.

SHANNON, C.E. and McCARTHY, J. (Eds.), (1956). Automata studies. Ann. Math. Stud. No. 34, Princeton, N.J.: Princeton Univer. Press.

SIGNIFICS CONFERENCE. (1953). Semantic and signific aspects of modern theories of communication. Synthese, IX, 3, 3-5.

TILTS, P.M. (Ed.), (1951). Human engineering for an effective air-navigation and traffic control. National Research Council. 12, 88.

TUSTIN, A. (Ed.), (1951). D.S.I.R., Cranfield confererence on automatic control. London: Butterworths.

UNIVERSITY COLLEGE LONDON. (1955). Studies in communication. Communications research centre. London: Secker and Warburg.

von FOERSTER, H. (Ed.), Cybernetics - circular, causal and feedback mechanisms in biological and social systems. Transactions of: (1950). Sixth conference, March 24-25, 1949. (1951). Seventh conference, March 23-24,1950. (1952). Eighth conference, March 15-16,1951. (1953). Ninth conference, March 20-2l, 1952. (1955). Tenth conference, April 22-24, 1953. New York: Josiah Macy, Jr. Foundation.

WISDOM, J.O., SPILBURY, R.J., and MacKAY, D.M. (1952) Mentality in machines - symposium. Proc. Aristotelian Soc., supplementary Vol., 26.

DJ Stewart: Bibliography of Cybernetics KN
MARCOU, P. and DAGUET, J. (1955) New methods of speech transmission. In EC Cherry (Ed.), Information theory, third London symposium. London: Butterworths

Frankfurt Kurnit Klein & Selz PC
... power and money have an enormous impact on both the speaker and those who listen to that speech, and because we have new methods of speech transmission. ...

AES Electronic Library: The Intelligibility of Speech Transposed …
P. Marcou and J. Daguet, "New Methods of Speech Transmission," Ann. Telecomm. 11, 118 (1956). 19. MR Schroeder, BF Logan and AJ Prestigiacomo, "New Methods ...

The Third London Symposium on Information Theory*
New Methods of Speech Transmission". The method. involves feeding the speech wave into a single-sideband. suppressed-carrier modulator, passing the output ...

# *ESP:*

The Central Intelligence Agency has investigated the controversial phenomenon called parapsychology as it relates to intelligence collection. The unknown author of this next segment was involved with many aspects of the last such investigations. This paper summarizes selected highlights of the experiences of the author and others. The intent is not historical completeness. Files are available for those interested in details. Instead the intent is to record some certainly interesting and possibly useful data and opinions. This record is likely to be of future benefit to those who will be required to evaluate intelligence-related aspects of parapsychology.

The Agency took the initiative by sponsoring serious parapsychological research, but circumstances, biases, and fear of ridicule prevented CIA from completing a scientific investigation of parapsychology and its relevance to national security. During this research period, CIA was buffeted with investigations concerning illegalities and improprieties of all sorts. This situation, perhaps properly so, raised the sensitivity of CIA's involvement in unusual activities. The "Proxmire Effect," where the fear that certain Government research contracts would be claimed to be ill-founded and held up for scorn, was another factor precluding CIA from sensitive areas of research. Also, there tend to be two types of reactions to parapsychology: positive or negative, with little in between. Parapsychological data, almost by definition, are elusive and unexplained. Add a history replete with proven frauds and many people instantly reject the subject, saying, in effect, "I would not believe this stuff even if it were true." Others, who must have had personal "conversion" experiences, tend to be equally convinced that one unexplained success establishes a phenomenon. These prejudices make it difficult to evaluate parapsychology carefully and scientifically.

Tantalizing but incomplete data have been generated by CIA-sponsored research. These data show, among other things, that on occasion unexplained results of genuine intelligence significance occur. This is not to say that parapsychology is a proven intelligence tool; it is to say that the evaluation is not yet complete and more research is needed.

Attention is confined to psychokinetics and remote viewing. Psychokinetics is the purported ability of a person to interact with a machine or other object by unexplained means. Remote viewing is akin to clairvoyance in that a person claims to sense information about a site or person removed from a known sensory link.

Anecdotal reports of extrasensory perception (ESP) capabilities have reached U.S. national security agencies at least since World War II, when Hitler was said to rely on astrologers and seers. Suggestions for military applications of ESP continued to be received after World War II. For example, in 1952 the Department of Defense was lectured on the possible usefulness of extrasensory perception in psychological warfare. [1] Over the years, reports continued to accumulate. In 1961, the reports

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[1] A. Puharich, "On the Possible Usefulness of Extrasensory Perception in Psychological Warfare," delivered to a 1952 Pentagon conference, *The Washington Post,* August 7, 1977.

induced one of the earliest U.S. government parapsychology investigations when the chief of CIA's Office of Technical Service (then the Technical Services Division) became interested in the claims of ESP. Technical project officers soon contacted Stephen I. Abrams, the Director of the Parapsychological Laboratory, Oxford University, England. Under the auspices of Project ULTRA, Abrams prepared a review article which claimed ESP was demonstrated but not understood or controllable. [2] The report was read with interest but produced no further action for another decade.

Two laser physicists, Dr. Russell Targ and Dr. Harold E. Puthoff, re-awakened CIA research in parapsychology. Targ had been avocationally interested in parapsychology for most of his adult life. As an experimentalist, he was interested in scientific observations of parapsychology. Puthoff became interested in the field in the early 1970s. He was a theoretician who was exploring new fields of research after extensive work in quantum electronics.

In April of 1972, Targ met with CIA personnel from the Office of Strategic Intelligence (OSI) and discussed the subject of paranormal abilities. Targ revealed that he had contacts with people who purported to have seen and documented some Soviet investigations of psychokinesis. Films of Soviets moving inanimate objects by "mental powers" were made available to analysts from OSI. They, in turn, contacted personnel from the Office of Research and Development (ORD) and OTS. An ORD Project Officer then visited Targ who had recently joined the Stanford Research Institute (SRI). Targ proposed that some psychokinetic verification investigations could be done at SRI in conjunction with Puthoff.

These proposals were quickly followed by a laboratory demonstration. A man was found by Targ and Puthoff who apparently had psychokinetic abilities. He was taken on a surprise visit to a superconducting shielded magnetometer being used in quark (high energy particle) experiments by Dr. A. Hebbard of Stanford University Physics Department. The quark experiment required that the magnetometer be as well shielded as technology would allow. Nevertheless, when the subject placed his attention on the interior of the magnetometer, the output signal was visibly disturbed, indicating a change in the internal magnetic field. Several other correlations of his mental efforts with signal variations were observed. These variations were never seen before or after the visit. The event was summarized and transmitted to the Agency in the form of a letter to an OSI analyst [3] and as discussions with OTS and ORD officers.

The Office of Technical Services took the first action. With the approval of the same manager who supported the ESP studies a decade previously, an OTS project officer contracted for a demonstration with the previously mentioned man for a few days in August, 1972. During this demonstration, the subject was asked to describe objects hidden out of sight by the CIA personnel. The subject did well. The descriptions were so startlingly accurate that the OTD and ORD representatives suggested that the work be continued and expanded. The same Director of OTS reviewed the data, approved another $2,500 work order, and encouraged the development of a more complete research plan.

By October, 1972, I was the Project Officer. I was chosen because of my physics background to work with the physicists from SRI. The Office of Technical Service funded a $50,000 expanded effort in parapsychology. [4] The expanded investigation included tests of several abilities of both the original subject and a new one. Curious data began to appear; the paranormal abilities seemed individualistic. For example, one subject, by mental effort, apparently caused an increase in the temperature measured by a thermistor; the action could not be duplicated by the second subject. The second subject was able to reproduce, with impressive accuracy, information inside sealed envelopes. Under identical conditions, the first subject could reproduce nothing. Perhaps even more disturbing, repeating the same experiment with the same subject did not yield consistent results. I began to have serious feelings of being involved with a fraud.

Approximately halfway through this project, the SRI contractors were invited to review their results. After careful consideration of the security and sensitivity factors, the results were shared and discussed with selected Agency personnel during that and subsequent meetings. In February, 1973, the most recent data were reviewed; thereafter, several ORD officers showed definite interest in contributing their own expertise and office funding.

The possibility of a joint OTS/ORD program continued to develop. The Office of Research and Development sent new Project Officers to SRI during February, 1973, and the reports which were brought back convinced ORD to become involved. Interest was translated into action when ORD requested an increase in the scope of the effort and transferred funds to OTS. [5] About this time, a third sensitive subject, Pat Price, became available at SRI, and the remote viewing experiments in which a subject describes his impressions of remote objects or locations began in earnest. The possibility that such useful abilities were real motivated all concerned to move ahead quickly.

The contract required additional management review before it could be continued or its scope increased. The initial review went from OTS and ORD to Mr. William Colby, then the DDO. On 24 April, Mr. Colby decided that the Executive Management Committee should pass judgment on this potentially sensitive project. By the middle of May, 1973, the approval request went through the Management Committee. An approval memorandum was written for the signature of the DCI, then Dr. James Schlesinger. [6] Mr. Colby took the memorandum to the DCI a few days later. I was soon told not to increase the scope of the project and not to anticipate any follow-on in this area. The project was too sensitive and potentially embarrassing. It should be tabled. It is interesting to note that OTS was then being investigated for involvement in the Watergate affair, and that in May, 1973, the DCI issued a memorandum to all CIA employees requesting the reporting of any activities that may have been illegal and improper. As Project Officer, clearly my sense of timing had not been guided by useful paranormal abilities!

During the summer of 1973, SRI continued working informally with an OSI officer on a remote viewing experiment which eventually stimulated more CIA-sponsored investigations of parapsychology. The target was a vacation property in the eastern United States. The experiment began with the passing of nothing more than the geographic coordinates of the vacation property to the SRI physicists who, in turn, passed them to the two subjects, one of whom was Pat Price. No maps were permitted, and the subjects were asked to give an immediate response of what they remotely viewed at these coordinates. The subject came back with descriptions which were apparent misses. They both talked about a military-like facility. Nevertheless, a striking correlation of the two independent descriptions was noted. The correlation caused the OSI officer to drive to the site and investigate in more detail.

To the surprise of the OSI officer, he soon discovered a sensitive government installation a few miles from the vacation property. This discovery led to a request to have Price provide information concerning the interior workings of this particular site. All the data produced by the two subjects were reviewed in CIA and the Agency concerned.

The evaluation was, as usual, mixed. [7] Pat Price, who had no military or intelligence background, provided a list of project titles associated with current and past activities including one of extreme sensitivity. Also, the codename of the site was provided. Other information concerning the physical layout of the site was accurate. Some information, such as the names of the people at the site, proved incorrect.

These experiments took several months to be analyzed and reviewed within the Agency. Now Mr. Colby was DCI, and the new directors of OTS and ORD were favorably impressed by the data. In the fall of 1973, a Statement of Work was outlined, and SRI was asked to propose another program. A jointly funded ORD and OTS program was begun in February, 1974. [8] The author again was the Project Officer. The project proceeded on the premise that the phenomena existed; the objective was to develop and utilize them.

The ORD funds were devoted to basic studies such as the identification of measurable physiological or psychological characteristics of psychic individuals, and the establishment of experimental protocols for validating paranormal abilities. The OTS funds were to evaluate the operational utility of psychic subjects without regard to the detailed understanding of paranormal functioning. If the paranormal functioning was sufficiently reproducible, we were confident applications would be found.

Before many months had passed, difficulties developed in the project. Our tasking in the basic research area proved to be more extensive than time and funds would allow. The contractors wanted to compromise by doing all of the tasks with less completeness. The ORD scientists insisted that with such a controversial topic, fewer but more rigorous results would be of more value. The rigor of the research became a serious issue between the ORD project officers and SRI, with myself generally taking a position between the righteousness of the contractor and indignation of the researchers. Several meetings occurred over that issue.

As an example of the kinds of disputes which developed over the basic research, consider the evaluation of the significance of data from the "ESP teaching machine" experiments. This machine was a four-state electronic random number generator used to test for paranormal abilities. SRI claimed the machine randomly cycled through four states, and the subject indicates the current machine state by pressing a button. The state of the machine and the subject's choice were recorded for later analysis. A subject "guessing" should, on the average, be correct 25 percent of the time. SRI had a subject who averaged a statistically very significant 29 percent for more than 2,500 trials.

I requested a review of the experiment and analysis, and two ORD officers quickly and skeptically responded. They first argued that the ESP machine was

possibly not random. They further argued the subjects probably learned the nonrandom machine patterns and thereby produced higher scores. [9] During this review, it was noted that whether the machine was random or not, the data taken during the experiment could be analyzed to determine actual machine statistics. The machine randomness was the unimportant, because the subject's performance could then be compared with actual machine performance. [10] The ORD Project Officers, however, did not believe it would be worth the effort to do the extra analysis of the actual data.

I disagreed. I had the Office of Joint Computer Services redo the data analysis. The conclusion was that during the experiment "no evidence of nonrandomness was discovered" and there was "no solid reason *how* he was able to be so successful." [11] I further ordered the subject retested. He averaged more than 28 percent during another 2,500 trials. This information was given in written and oral form to the ORD Project Officers, who maintained there must be yet another flaw in the experiment or analysis, but it was not worth finding. Because of more pressing demands, the issue could not be pursued to a more definite conclusion.

Concurrent with this deteriorating state of affairs, new Directors of ORD and OTS were named again. Since neither Director had any background or experience in paranormal research, the new Director of ORD reviewed the parapsychology project and had reservations. I requested a meeting in which he said he could not accept this reality of paranormal functioning, but he understood his bias. He said that inasmuch as he could not make an objective decision in this field, he could simply follow the advice of his staff. The ORD Project Officers were feeling their own frustrations and uncertainties concerning the work and now had to face this unusual kind of skepticism of their new Director. The skepticism about the believability of the phenomenon and quality of the basic research adversely affected the opinions of many people in OTS. Support for the project was vanishing rapidly.

As these pressures mounted, the first intelligence collection operation using parapsychology was attempted. The target was the Semipalatinsk *U*nidentified *R*esearch and *D*evelopment *F*acility-2 (URDF-3, formerly known as PNUTS). The experimental collection would use our best subject, Pat Price. From experience it was obvious that Price produced bad data as well as good. Borrowing from classical communications theory concepts, this "noisy channel" of information could nevertheless be useful if it were characterized. An elaborate protocol was designed which would accomplish two characterization measurements. First, we needed assurance the channel was collecting useful data. I reviewed the photos of URDF-3 and chose two features which, if Price described them, would show the channel at least partially working. Referring to Figure 1a, these features were the tall crane and the four structures resembling oil well derricks. It was agreed that if Price described these structures, I would be prepared to have him sign a secrecy agreement, making him witting, and collect more relevant intelligence details. Secondly, after a working channel was thus established, a signal-to-noise or quality characterization was required. This would be done by periodic tests of the channel -- that is, periodically Price would be asked to describe features of URDF-3 which were known. The accuracy of these descriptions would be used to estimate the quality of the data we had no obvious way of verifying.

2] S. I. Abrams, "Extrasensory Perception," Draft report, 14 December 1965.
[3] H. E. Puthoff; Stanford Research Institute; Letter to K. Green/OSI, June 27, 1972.
[4] Office of Technical Service Contract 8473, 1 October 1972 (CONFIDENTIAL).
[5] C/TSD; Memorandum for Assistant Deputy Director for Operations; Subject: Request for Approval of Contract; 20 April 1973 (SECRET).
[6] W. E. Colby; DDO; Memorandum for Director of Central Intelligence; Subject: Request for Approval of Contract; 4 May 1973 (SECRET).
[7] K. Green; LSD/OSI; Memorandum for the Record; Subject: Verification of Remote Viewing Experiments at Stanford Research Institute; 9 November 1973. (SECRET)
[8] Office of Technical Service Contract, FAN 4125-4099 Office of Research and Development Contract, FAN 4162-8103; 1 February 1974 (CONFIDENTIAL).
[9] L. W. Rook; LSR/ORD; Memorandum for OTS/CB; Subject: Evidence for Non-Randomness of Four-State Electronic Random Stimulus Generator; 12 June 1975 (CONFIDENTIAL).
[10] S. L. Cianci; LSR/ORD; Memorandum for OTS/CB; Subject: Response to Requested Critique, SRI Random Stimulus Generator Results; 12 June 1975 (CONFIDENTIAL).2-c
[11] G. Burow; OJCS/AD/BD; Memorandum for Dr. Kress; Subject: Analysis of the Subject-Machine Relationship; 8 October 1975 (CONFIDENTIAL).

The experiment began with my branch chief and me briefing Targ and Puthoff in a motel. Later, at SRI, Price was briefed by Targ and Puthoff. Since Targ and Puthoff presumably knew nothing about URDF-3, this protocol guarded against cueing and/or telepathy. Initially Price was given only the geographic coordinates, a world atlas map marked with the approximate location of URDF-3, and told it was a Soviet RD&E test site. Overnight, he produced the drawing on the bottom right of Figure 1b. Price further mentioned that this was a "damned big crane" because he saw a person walk by and he only came up to the axles on the wheels (note sketch on left, Figure 1b). This performance caught my attention; but with two more days of work, we never heard about the derricks. Eventually, a decision was needed. Because the crane was so impressive, my branch chief and I decided the derricks description requirement should be relaxed and we should continue.

When the decision was made to make Price witting, I decided to test him. My branch chief and I sat in a conference room while Targ and Puthoff brought a smiling Pat Price into the room. I was introduced as the sponsor, and I immediately asked Price if he knew me.

Yes.

Name?

Ken Kress.

Occupation?

Works for CIA.

Since I was then a covert employee, the response was meaningful. After having Price sign a secrecy agreement, and some discussions, I confronted him again. I rolled out a large version of Figure 1a and asked if he had viewed this site.

Yes, of course!

Why didn't you see the four derricks?

Wait, I'll check.

Price closed his eyes, put on his glasses (he "sees" better that way) and in a few seconds answered "I didn't see them because they are not there any more." Since my data were three or four months old, there was no rejoinder to the implied accusation that my data were not good. We proceeded and completed a voluminous data package.

In a few weeks, the latest URDF-3 reconnaissance was checked. Two derricks were partially disassembled, but basically all four were visible. In general, most of Price's data were wrong or could not be evaluated. He did, nevertheless, produce some amazing descriptions, like buildings then under construction, spherical tank sections, and the crane in Figure 1b. Two analysts, a photo interpreter at IAS [12] and a nuclear analyst at Los Alamos Scientific Laboratories agreed that Price's description of the crane was accurate; the nuclear analyst wrote that "one: he, the subject, actually saw it through remote viewing, or two: he was informed what to draw by someone knowledgeable of URDF-3." [13] But, again, since there was so much bad information mixed in with the good, the overall result was not considered useful. As proof of remote viewing, the data are at best inconclusive. The ORD officers concluded that since there were no control experiments to compare with, the data were nothing but lucky guessing.

[12] W. T. Strand; C/ESO/IAS; Memorandum for Director, Officer of Technical Service; Subject: Evaluation of Data on Semipalatinsk Unidentified R&D Facility No. 3, USSR; 20 August 1974 (SECRET).

[13] D. Stillman; Los Alamos Scientific Laboratory; "An Analysis of a Remote Viewing Experiment of URDF-3"; 4 December 1975 (CONFIDENTIAL).

I began to doubt my own objectivity in evaluating the significance of paranormal abilities to intelligence collection. It was clear that the SRI contractors were claiming success while ORD advisors were saying the experiments were not meaningful because of poor experimental design. As a check on myself, I asked for a critique of the investigation from a disinterested consultant, a theoretical physicist with broad intellectual background. His first task was to evaluate the field of parapsychology without knowledge of the CIA data. After he had completed this critique, I asked him to acquaint himself with the CIA data and then to reassess the field. The first investigation produced genuine interest in paranormal functioning as a valid research area. After being acquainted with CIA data, his conclusion was, "a large body of reliable experimental evidence points to the inescapable conclusion that extrasensory perception does exist as a real phenomenon, albeit characterized by rarity and lack of reliability." [14] This judgment by a competent scientist gave impetus to continue serious inquiry into parapsychology.

Because of the general skepticism and mixed results of the various operational experiments, a final challenge was issued by OTS management: OTS is not in the research business; do something of genuine operational significance. Price was chosen, and suggestions were solicited from operational personnel in both OTS and the DDO. An intriguing idea was selected from audio collection systems. A test to determine if remote viewing could help was suggested. The interiors of two foreign embassies were known to the audio teams who had made entries several years previously. Price was to visit these embassies by his remote viewing capability, locate the coderooms, and come up with information that might allow a member of the audio team to determine whether Price was likely to be of operational use in subsequent operations. Price was given operationally acceptable data such as the exterior photographs and the geographical coordinates of the embassies.

In both cases, Price correctly located the coderooms. He produced copious data, such as the location of interior doors and colors of marble stairs and fireplaces that were accurate and specific. As usual, much was also vague and incorrect. Regardless, the operations officer involved concluded, "It is my considered opinion that this technique -- whatever it is -- offers definite operational possibilities. [15]

This result was reviewed within OTS and the DDO, and various suggestions for potential follow-on activities were formulated. [16] This package of requirements, plus the final results of the current contract, were reviewed at several meetings within OTS and ORD. The results of those meetings are as follows:

1. According to the ORD Project Officers, the research was not productive or even competent; therefore, research support to SRI was dropped. The Director

2. Because of the mixed results, the operational utility of the capability was considered questionable but deserved further testing.

3. To achieve better security, all the operations-oriented testing with the contractor was stopped, and a personal services contract with Price was started.

4. Since I was judged to be a positively biased advocate of paranormal functioning, the testing and evaluation of Price would be transferred to a more pragmatic OTS operations psychologist.

The OTS psychologist picked up his new responsibilities and chose to complete an unfinished DDO requirement. The origin of the requirement went back to the fall of 1974 when several OTS engineers became aware of the parapsychology project in OTS and had volunteered to attempt remote viewing. They passed initial remote viewing tests at SRI with some apparent successes. To test these OTS insiders further, I chose a suggested requirement to obtain information about a Libyan site described only by its geographic coordinates. The OTS engineers described new construction which could be an SA-5 missile training site. [17] The Libyan Desk officer was immediately impressed. He then revealed to me that an agent had reported essentially the same story. More coordinates were quickly furnished but were put aside by me.

The second set of Libyan geographic coordinates was passed by the OTS psychologist to Price. A report describing a guerrilla training site was quickly returned. It contained a map-like drawing of the complex. Price described a related underwater sabotage training facility site several hundred kilometers away on the sea coast. This information was passed to the Libyan Desk. Some data were evaluated immediately, some were evaluated only after ordering special reconnaissance.

The underwater sabotage training facility description was similar to a collateral agent's report. The Libyan Desk officer quickly escalated the requirement to what was going on inside those buildings, the plans and intentions, etc. [18] The second requirements list was passed to Pat Price. Price died of a heart attack a few days later, and the program stopped. There have been no further CIA-sponsored intelligence collection tests.

Since July, 1975, there has been only modest CIA and Intelligence Community Staff interest in parapsychology. The Office of Scientific Intelligence completed a study about Soviet military and KGB applied parapsychology. [19] During November of 1976, Director George Bush became aware that official Soviets were visiting and questioning Puthoff and Targ at SRI about their work in parapsychology. Mr. Bush requested and received a briefing on CIA's investigations into parapsychology. Before there was any official reaction, he left the Agency. Various intelligence community groups, such as the Human Resources Subcommittee on R&D, have exhaustively reviewed parapsychology in CIA, DOD, and the open research, but have failed to conclude whether parapsychology is or is not a worthwhile area for further investigation. Several proposals from SRI and other contractors were received by CIA but none were accepted. There are no current plans for CIA to fund parapsychology investigations.

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[14] J. A. Ball; "An Overview of Extrasensory Perception"; Report to CIA, 27 January 1975.

[15] S/AOB/OTS; Memorandum for the Record; Subject: Parapsychology/"Remote Viewing"; 20 April 1976 (SECRET).

[16] Chief/Division D/DDO; Memorandum for C/D&E; Subject: Perceptual Augmentation Techniques; 24 January 1975 (SECRET); AC/SE/DDO; Memorandum for C/D&E; Subject: Perceptual Augmentation Testing; 14 January 1975 (SECRET); C/EA/DDO; Memorandum for Director of Technical Service; Subject: Exploration of Operational Potential of "Paranormals"; 5 February 1975 (SECRET); C/Libya/EL/NE/DDO; Memorandum for OTS/CB; Subject: Libyan Desk Requirement for Psychic Experiments Relating to Libya; 31 January 1975 (SECRET); CI/Staff/DDO; Memorandum for the Record; Subject: SRI Experiment; 12 December 1974 (SECRET). of OTS felt the OTS charter would not support research; therefore, all Agency funding in paranormal research stopped.

[17] OTS/SDB; Notes on Interviews with F. P., E. L., C. J., K. G., and V. C., January 1975 (SECRET).

[18] DDO/NE; Memorandum for OTS/BAB; Subject: Experimental Collection Activity Relating to Libya; 8 October 1975 (SECRET).

[19] T. Hamilton; LSD/OSI; "Soviet and East European Parapsychology Research," SI 77-10012, April 1977 (SECRET/NOFORN).

*Postscript*

At this point, I have traced the action and reaction of various elements of CIA to what is certainly an unconventional and highly controversial subject. Also of interest are the concurrent reactions of other agencies to parapsychology. In August, 1973, parapsychology was discussed with several members of DIA. The DIA people were basically interested in the Soviet activities in this area, and expressed considerable interest in our own fledgling results. Numerous meetings have occurred during the past several years. DIA remains interested on a low priority basis.

The Army Materiel Command learned of CIA interest in the paranormal. We discovered the Army interest was generated by data which emerged from Vietnam. Apparently certain individuals called point men, who led patrols into hostile territory, had far fewer casualties from booby traps and ambushes than the average. These point men, needless to say, had a loyal following of men and, in general, greatly helped the morale of their troops under a brutal, stressful situation. The Army gave extensive physical and psychological tests to a group of unusually successful point men and came to no conclusion other than perhaps that paranormal capabilities may be the explanation! The Army was most interested in CIA results and wanted to stay closely informed. After a few more follow-up meetings, the Army Materiel Command was never heard from again.

The Defense Advanced Research Projects Agency (DARPA) reported that they had not only a showing of interest but a hostile response as well to the subject area. At one time, we felt we had the strong interest of some people at DARPA to discuss our data. The SRI contractors and I went to a briefing where we had a several-hour confrontation with an assemblage of hostile DARPA people who had been convened especially to debunk our results. After a long, inconclusive, emotional discussion, we left. Contacts with DARPA stopped for several years.

The Navy reviewed part of the work and became interested. Some groups developed strong interest, and minor funding was provided to SRI by Navy to replicate one of SRI's earlier experiments under more controlled conditions. The experiment was replicated. Then the Navy asked SRI to repeat the same experiment under different conditions. An effect was observed, but it was not the same as the previous observations. About this same time, the Navy became very concerned about this research being "mind warfare"-related. Funding was stopped.

The active funding for parapsychology now has shifted to the Air Force's Foreign Technology Division with the addition of modest testing being completed by another group at DARPA. These investigations are not yet completed, but a second phase is funded by the Air Force. The Air Force project is attempting to evaluate whether signals and communications can be sent and received by paranormal functioning. Also aircraft and missile intelligence which can be verified is being gathered and evaluated. To date the results are more consistent than those seen during the CIA research, but still they are mixed. Some simple experiments seemed very impressive and conclusive. The more complex experiments are difficult to assess.

In the non-government world an explosion of interest in unclassified parapsychology research occurred after the first publication of CIA-sponsored projects. Books have been written, prestigious professional societies have had sessions on parapsychology, and several national news reports have been broadcast and printed. [20] Director Turner revealed publicly that CIA has had operational interest in parapsychology. [21] The open publication of these investigations is generally healthy and helpful. It shows a reduction of associated emotionalism and bias. These publications will also stimulate other scientific investigations into parapsychology.

There is a less positive aspect to open interest and publications. Before adequate assessment was made by CIA and others, we may have allowed some important national security information out into the public domain. It is my opinion that, as it relates to intelligence, sufficient understanding and assessment of parapsychology has not been achieved. There are observations, such as the original magnetic experiments at Stanford University, the OSI remote viewing, the OTS-coderoom experiments, and others done for the Department of Defense, that defy explanation. Coincidence is not likely, and fraud has not been discovered. The implication of these data cannot be determined until the assessment is done.

If the above is true, how is it that the phenomenon remains controversial and receives so little official government support? Why is it that the proper assessment was never made? This state of affairs occurs because of the elementary understanding of parapsychology and because of the peculiarities of the intelligence and military organizations which have attempted the assessments. There is no fundamental understanding of the mechanisms of paranormal functioning, and the reproducibility remains poor. The research and experiments have successfully demonstrated abilities but have not explained them nor made them reproducible. Past and current support of parapsychology comes from applications-oriented intelligence and military agencies. The people managing such agencies demand quick and relevant results. The intelligence and military agencies, therefore, press for results before there is sufficient experimental reproducibility or understanding of the physical mechanisms. Unless there is a major breakthrough in understanding, the situation is not likely to change as long as applications-oriented agencies are funding parapsychology. Agencies must commit long-term basic research funds and learn to confine attention to testing only abilities which at least appear reproducible enough to be used to augment other hard collection techniques (example: use parapsychology to help target hard intelligence collection techniques and determine in the take is thereby increased). Parapsychology, like other technical issues, can then rise or fall on its merits and not stumble over bureaucratic charters and conjectures proposed by people who are irrevocably on one side or the other in the controversial area.

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[20] R. Targ and H. Puthoff; "Information Transfer Under Conditions of Sensory Shielding"; Nature, CC LII, 602-607 (October 18, 1974); H. Puthoff and R. Targ; "A Perceptual Channel for Information Transfer Over Kilometer Distances; Historical Perspective and Recent Research"; Proceedings of the IEEE, LXIV (March 1976, Number 3, 329-354); R. Targ and H. Puthoff; "Mind-Research Scientists Look at Psychic Ability"; Delacarte Press (1977); J. Wilhelm; "The Search for Superman"; Dell (1974); IEEE Conference on Man; Systems and Cybernetics; Washington (1976 and 1977); NBC Nightly News; 4 and 5 August 1976; NBC Today; 9 August 1976; J. Wilhelm, "Psychic Spying?"; *The Washington Post*, Outlook Section, August 7, 1977.

[21] J. O'Leary, "Turner Denies CIA Bugging of South Korea's Park," *The Washington Star*, 9 August 1977.

*BZ - quinuclidinyl benzilate lasts up to 80 hours….*

# *INSPECTOR GENERAL'S REPORT ON ARMY MANUALS*

The Department of Defense's Inspector General issued a report February 21 admitting that in using certain army manuals in training Latin American militaries, "from 1982 through early 1991, many mistakes were made and repeated by numerous and continuously changing personnel in several organizations from Panama to Georgia to Washington, D.C." Despite this, the report concludes there is no "evidence that the lengthy episode was a deliberate attempt to violate Department of Defense policies." Therefore, there is no reason to pursue the issue of individual responsibility. In essence, the report claims that because these numerous U.S. personnel did not know that it was against U.S. policy to train Latin American militaries to use threats or force with prisoners, "neutralize" opponents, hold prisoners in clandestine jails, and infiltrate and spy upon civilian organizations and opposition political parties, all techniques described in the manuals, no disciplinary action was necessary. The report does not examine any systemic problem that might have led to "numerous and changing personnel" over a ten-year period lacking a working knowledge of human rights. Thus the report fails to assign either individual or collective responsibility for training Latin American militaries to violate human rights and use profoundly anti-democratic methods--a frame of mind that led Latin American militaries to kill thousands of civilians in the wars of the 1980s. If this failure to assign accountability happened abroad, we would call it impunity.

The Inspector General's report, however, does contend that since the 1991-92 investigation into the manuals, little corrective action has been taken to ensure that such abhorrent training materials are no longer used. The Department of Defense's principal corrective action in response to the manuals was to issue a March 1992 memorandum regarding proper oversight of materials for training foreign militaries and intelligence services. The memo lacked the force of a directive, was overlooked at most agencies, and did not make agencies more likely to seek approval for foreign training materials from the Office of the Secretary of Defense. The memo also focused on the mobile training teams sent abroad, neglecting the role of the School of the Americas. The Inspector General's main recommendation is to reissue this memo as a directive, which on 2/5/97 the Assistant Secretary of Defense's office agreed to do. Issuing a vague directive, however, is a feeble response to a serious systemic failure. The Inspector General's report keeps the School of the Americas at the center of this controversy by asserting that it was at the School of the Americas that these objectionable materials from the 1960s were put back into circulation. "Formulation of a 382-hour Spanish language course of instruction on military intelligence for foreign students at the SOA was the genesis of a nearly 10-year problem."

* No Admission, No Accountability The Pentagon and the School of the Americas admit that the recently declassified manuals contain passages that violate U.S. policy--references to executions, beatings, blackmail, use of truth serum and the payment of bounties for enemy dead. But their public statements to date attempt to minimize the implications by speaking of "two dozen short passages" or "words or phrases" that contradict U.S. policy included in hundreds of pages of innocuous text. The Inspector General's report also takes this minimizing approach, referring to "several passages." An analysis and selection of excerpts from the army training manuals prepared by the Latin America Working Group reveal that their entire framework is in direct contradiction to democratic values. In the name of defending democracy, these manuals trained Latin American militaries in profoundly anti-democratic methods. A 1980s CIA manual declassified in January is even more abhorrent, in its explicit discussion of "coercive techniques." Passages from this manual are also included in the LAWG packet. The Pentagon has told the public that the offending material has been withdrawn. However, there are compelling reasons to question whether U.S. training materials for Latin American militaries have been thoroughly reviewed and revised. First, the slow, piecemeal surfacing of these manuals and the limited investigations at each point, usually in response to efforts by journalists, members of Congress and human rights advocates, suggest that there may be many other objectionable training materials still in circulation. Materials from the most intense days of the Cold War in the 1960s, which should never have been created in the first place, kept on being repackaged and reused despite a series of scandals and investigations that should have prompted a thorough revision of all materials and retraining of the U.S. military and intelligence personnel involved in drafting such materials or failing to provide proper oversight. The Inspector General's report is hardly reassuring on this issue. Oversight appears not to have greatly improved since 1992. The second reason to question whether the curriculum has been updated is that as of this writing the U.S. government has not even admitted the full scope of the problem. While the Pentagon acknowledges that the manuals' references to beatings and executions are unacceptable, it has not commented upon the fact that the manuals trained Latin American militaries in techniques that violate democratic principles and the rule of law. To cite just one example, the manuals advise Latin American militaries to spy on opposition political parties.

When the U.S. government spied on an opposition party, it was called Watergate, and a President faced impeachment because of it. But the Pentagon's statements do not even mention this as a problem. To rectify the damage these manuals did to Latin America and to U.S. democratic values, a much more thorough accounting is needed than contained in this extremely weak Inspector General's report.

* Individuals and agencies must be held accountable for the production of the manuals and the failure to oversee them, with disciplinary action taken; this should include the CIA as well as the army manuals;

* If, as the Inspector General contends, no laws were broken, then laws must be changed to make it illegal to teach foreign militaries and intelligence services to use torture and other techniques that violate fundamental human rights;

* There must be a thorough review, with participation by human rights experts, of all materials, including not only manuals but also lesson plans and readings, used in training foreign militaries and intelligence services; this must be far deeper than removing a couple of dozen phrases;

* Better systems for regular oversight and accountability must be set up;

* The government should engage in a wider public debate about whether, in today's world, U.S. training for Latin American military and intelligence forces is necessary.

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The Latin America Working Group (LAWG) is a coalition of over sixty organizations including churches, human rights groups, grassroots organizations and development agencies committed to a just U.S. policy towards Latin America.

*A memo declassified in November 1996 and released to the National Security Archive this week detailing a phone conversation between Major Vic Tise, the instructor at the School of the Americas when the lesson plans for counterintelligence training were drawn up in 1982, and the Office of the Assistant Secretary of Defense on 31 July 1991, sheds light on the origin of the manuals. Major Tise states that military intelligence training (or a certain kind of military intelligence training) given by the United States to Latin American countries from 1965-66 until 1976 was halted by the Carter Administration "for fear the training would contribute to human rights violations in other countries." When Major Tise was asked in 1982 to develop counterintelligence course materials, he turned to Project X materials. The materials he developed were then sent to high-level army supervisors who sent them back "approved but UNCHANGED."

Recently Declassified Army and CIA Manuals Used in Latin America:
An Analysis of Their Content
by Lisa Haugaard, Latin America Working Group
February 18, 1997

On September 20, 1996, the Pentagon released to the public seven training manuals prepared by the U.S. military and used between 1987 and 1991 for intelligence training courses in Latin America and at the U.S. Army School of the Americas (SOA). A selection of excerpts was distributed to the press at that time. The Pentagon press release accompanying the excerpts states that a 1991-92 investigation into the manuals concluded that "two dozen short passages in six of the manuals, which total 1169 pages, contained material that either was not or could be interpreted not to be consistent with U.S. policy." A January 1997 "information paper" sent out by the School of the Americas in response to public inquiries on the manuals claims that SOA training material merely contained several passages with "words or phrases inconsistent with U.S. government policy." A close reading of all seven manuals, however, reveals many more passages, and indeed an entire framework, that should be deemed inconsistent with U.S. policy and democratic standards. This memo contains excerpts from these manuals, and two other CIA manuals declassified in January 1997 in response to a Freedom of Information Act (FOIA) request by the Baltimore Sun.

The army manual excerpts highlighted by the Pentagon advocate tactics such as executing guerrillas, blackmail, false imprisonment, physical abuse, use of truth serum to obtain information and payment of bounties for enemy dead. Counterintelligence agents are advised that one of their functions is "recommending targets for neutralization," a term which is defined in one manual as "detaining or discrediting" but which "was commonly used at the time as a euphemism for execution or destruction," according to a Pentagon official (Washington Post, September 21, 1996). What is not included in these excerpts, however, is the larger context. The seven army manuals train Latin American militaries to infiltrate and spy upon civilians, including student groups, unions, charitable organizations and political parties; to confuse armed insurgencies with legal political opposition; and to disregard or get around any laws regarding due process, arrest and detention. What the manuals leave out is as important as what they include, and what they leave out is any understanding of democracy and the rule of law.

The release of the seven army manuals was the result of extensive public and congressional pressure. The manuals were mentioned in a passing reference in the President's advisory Intelligence Oversight Board's June 1996 report on Guatemala; this report was made public in response to the high level of interest and pressure from human rights and grassroots organizations. Representative Joseph Kennedy (D-MA) then asked the administration to declassify the manuals in their entirety. The CIA manuals were only released after the Baltimore Sun threatened a lawsuit.

The Seven Army Manuals

The seven Spanish-language manuals were drafted in 1987 by U.S. Army military intelligence officers in Panama. They were based in part on lesson plans used by SOA instructors since 1982. The manuals as well as the SOA lesson plans, in turn, were also based in part on older material dating back to the 1960s from "Project X," the U.S. Army's Foreign Intelligence Assistance Program, which provided training not just to Latin American nations but to U.S. allies around the world. "Project X" materials had been retained in the files of the Army Intelligence School at Fort Huachuca, Arizona.

The U.S. government estimates that as many as a thousand copies of these manuals may have been distributed at the SOA and throughout Latin America. The manuals were used by U.S. military Mobile Training Teams in Latin America and were distributed both to students in these courses and to Latin American intelligence schools in Colombia, Ecuador, El Salvador, Guatemala and Peru. In 1989, the manuals were used at the School of the Americas in military intelligence courses attended by students from Bolivia, Colombia, Costa Rica, the Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Peru and Venezuela.

The manuals are entitled, "Handling of Sources," "Counterintelligence," "Revolutionary War, Guerillas and Communist Ideology," "Terrorism and the Urban Guerilla," "Interrogation," "Combat Intelligence," and "Analysis I." The manuals do indeed appear to be older material that was inconsistently updated. Examples from 1988 in El Salvador have been inserted into "Counterintelligence," but in some manuals there are references that do not seem to have been updated since the 1960s.

THE MANUALS' CONTENT.

The unstated aim of the manuals is to train Latin American militaries to identify and suppress anti-government movements. Throughout the eleven hundred pages of the manuals, there are few mentions of democracy, human rights, or the rule of law. Instead, the manuals provide detailed techniques for infiltrating social movements, interrogating suspects, surveillance, maintaining military secrecy, recruiting and retaining spies, and controlling the population. While the excerpts released by the Pentagon are a useful and not misleading selection of the most egregious passages, the ones most clearly advocating torture, execution and blackmail, they do not provide adequate insight into the manuals' highly objectionable framework.

In the name of defending democracy, the manuals advocate profoundly undemocratic methods. A lack of distinction between civilian movements and armed rebellion. Perhaps the most persistent and nefarious aspect of the manuals is the lack of distinction between legitimate political and civic opposition and armed rebellion. The "Counterintelligence" manual, for example, defines as potential counterintelligence targets "local or national political party teams, or parties that have goals, beliefs or ideologies contrary or in opposition to the National Government," or "teams or hostile organizations whose objective is to create dissension or cause restlessness among the civilian population in the area of operations." (p. 228) This manual recommends that the army create a "black list" of "persons whose capture and detention are of foremost importance to the armed forces" (p. 225), which should include not only "enemy agents" but also "subversive persons," "political leaders known or suspected as hostile toward the Armed Forces or the political interests of the National Government," and "collaborators and sympathizers of the enemy," known or suspect. Throughout the manuals, refugees and displaced persons are highlighted as possible subversives who should be monitored. Universities are described as breeding grounds for terrorists, and priests and nuns are identified as having been involved in terrorist operations. The militaries are advised to infiltrate youth groups, student groups, labor unions, political parties and community organizations.

Even electoral activity is suspect:

The insurgents "can resort to subverting the government by means of elections in which the insurgents cause the replacement of an unfriendly government official to one favorable to their cause"; "insurgent activity" can include funding campaigns and participating in political races as candidates. ("Revolutionary War, Guerillas and Communist Ideology," p. 51)

One of the most pernicious passages, in "Combat Intelligence," lists various indicators of guerilla presence. "Indicators of an imminent attack by guerillas" include demonstrations by minority groups, civilians including children who don't want to associate with U.S. troops or their own country's troops, celebration of national or religious festivals, or the presence of strangers. "Indicators of control by guerillas" over a certain civilian population include the refusal to provide intelligence to government forces or the construction of new houses. Indications that insurgents are conducting psychological operations include accusations of government corruption, circulating petitions, attempts to discredit the government or armed forces, calling government leaders U.S. puppets, urging youth to avoid the draft, demonstrations or strikes, or accusations of police or army brutality. Thus any expression of criticism of the government, armed forces or U.S. troops or any other expression of popular discontent is cited as a possible indicator of guerilla activity. This manual recommends drawing maps that use different colors to depict the civilian population as "loyal to the government," "ambivalent," "possibly loyal to the insurgents" and "areas controlled by the insurgents." (p. 148)

Superficial treatment of legal and human rights considerations. In certain passages, legal and human rights considerations appear to have been added after the fact or in a superficial manner. For example, the Geneva convention is inserted at the beginning of "Interrogation," and the rights of a suspect being interrogated are mentioned repeatedly in the "Counter-intelligence" sections that are specifically devoted to interrogation. These references, however, are not integrated into the text in most of the manuals and are contradicted in other passages. At times the manuals present a distorted picture of human rights conventions. For example, readers are taught that an insurgent "Does not have a legal status as a prisoner of war under the Geneva convention," implying that there are no international conventions covering their treatment. ("Revolutionary War, Guerillas and Communist Ideology," p. 61.)

Ignoring the rule of law. However, in most of the discussions of techniques, legal considerations are simply absent. For example, throughout the manuals there is discussion of detaining suspects without mention of proper procedures for arrest, obtaining admissible evidence, trial and conviction. There is no mention of warrants or the right to contact an attorney or any comparable local laws. In fact, it is recommended throughout that detainees be kept in isolation and not be allowed to contact anyone. The interrogator may use a false name and at no time has to offer the detainee a reason for being detained. The description of the holding facilities in several of the manuals makes it clear that these are clandestine jails. Few distinctions are made between the treatment of armed guerillas and civilians. At no time do the manuals state that the person detained or arrested must first be suspected of having committed an illegal activity.

The only rationale needed for arrest or detention is that the intelligence agent needs some kind of information from the person. Advocating spying on and controlling the civilian population. There is absolutely no discussion of the propriety of spying on and infiltrating civilian groups; instead, it is actively advocated in a number of the manuals. "Counterintelligence" includes a discussion of kinds of censorship without any mention that it might be in any way undesirable. Throughout the manuals, there is little discussion of the proper relationship between the civilian government and military authorities. Indeed, in certain places the civilian government appears to be treated as one more source to be reported upon. Several manuals describe techniques for "controlling the population" which include curfews, military checkpoints, house-to-house searches, issuance of ID cards and rationing. These techniques are advocated without any discussion of any limitations on their use, such as only during a declared state of war or state of emergency. In fact, there is no reference to laws or the role of the legislature in regulating such actions. A purely military response. Several of the manuals purport to teach militaries and intelligence services about how insurgencies develop and how to control them. The description of how insurgencies develop is, in most of the manuals, simplistic and dated.

There are cursory references to the role government repression can play in providing a rationale for insurgencies. However, this is not treated in any depth. The brief histories of El Salvador and Guatemala, for example, in "Terrorism and the Urban Guerilla" skip over any repression, human rights violations or problems in democratic governance that contributed to the growth of revolutionary movements in those countries. Insurgents are viewed simplistically as solely manipulating popular discontent and are depicted as always buying into Soviet-style Marxism. While "Combat Intelligence" offers a more sophisticated explanation of underlying reasons insurgencies might develop, such as the strains created by rapid modernization, the existence of corrupt elites and government repression, neither this manual nor any other offers any discussion of the steps a civilian government might take to make a political response to popular discontent.

The only response taught for popular discontent and the beginnings of an insurgency is a military and counterintelligence response. There is no mention of any limitations on when to use military and counterintelligence methods. The CIA Manuals On January 24, 1997, two additional manuals were declassified in response to a FOIA request filed by the Baltimore Sun in 1994. The first, "Human Resource Exploitation Training Manual--1983," was used in at least seven U.S. training courses conducted in Latin American countries, including Honduras, between 1982 and 1987, according to a June 1988 memo placed inside the manual (the discrepancy between the 1982 use and the 1983 date on the manual is not explained). The 1983 manual originally surfaced in response to a congressional hearing in June 1988, which was prompted by allegations by the New York Times that the United States had taught Honduran military officers who used torture.

The second manual, "KUBARK Counterintelligence Interrogation," dated July 1963, is the source of much of the material in "Human Resource Exploitation." The 1988 hearing was not the first time such manuals had surfaced. In 1984, a CIA manual for training the Nicaraguan contras in psychological operations was discovered and created a considerable scandal. The two manuals declassified in January 1997 deal exclusively with interrogation. These CIA materials are even more obviously unprincipled than the army manuals, in that they each have an entire chapter devoted to "coercive techniques." These manuals recommend arresting suspects early in the morning by surprise, blindfolding them, and stripping them naked. Suspects should be held incommunicado and should be deprived of any kind of normal routine in eating and sleeping. Interrogation rooms should be windowless, soundproof, dark and without toilets. The manuals do advise that torture techniques can backfire and that the threat of pain is often more effective than pain itself. However, they then go on to describe coercive techniques to be used "to induce psychological regression in the subject by bringing a superior outside force to bear on his will to resist." ("Human Resource Exploitation," p. K-1)

These techniques include prolonged constraint, prolonged exertion, extremes of heat, cold, or moisture, deprivation of food or sleep, disrupting routines, solitary confinement, threats of pain, deprivation of sensory stimuli, hypnosis, and use of drugs or placebos. Like the army manuals, "Human Resource Exploitation" is dismissive of the rule of law. It states the importance of knowing local laws regarding detention but then notes, "Illegal detention always requires prior HQS [headquarters] approval." (p. B-2) The manual refers to one or two weeks of practical work with prisoners as part of the course, suggesting that U.S. trainers may have worked with Latin American militaries in interrogating actual detainees. In a superficial attempt to correct the worst of the 1983 manual, in 1985 a page advising against using coercive techniques was inserted and handwritten changes were introduced haphazardly into the text. For example, "While we do not stress the use of coercive techniques, we do want to make you aware of them and the proper way to use them," has been altered to, "While we deplore the use of coercive techniques, we do want to make you aware of them so that you may avoid them." (p. A-2) However, the entire chapter on coercive techniques is still provided, again with some items crossed out. Throughout, the reader can read perfectly well the original underneath the "corrected" items.

These corrections were made in response to the 1984 scandal when the CIA training manual for the contras hit the front pages of the newspapers. The second manual, entitled "KUBARK Counterintelligence Interrogation--July 1963," is clearly the source of much of the 1983 manual; some passages are lifted verbatim. The KUBARK manual was written for use by U.S. agents against communist, notably Soviet, subversion, not for use in training foreign military services. KUBARK has a similar section on coercive techniques, and includes some even more abhorrent references than the 1983 manual, such as two references to the use of electric shock. The KUBARK manual may or may not have been used directly by U.S. agents operating in Latin America; it apparently was intended for U.S. agents operating worldwide. The KUBARK manual is included here not because in its precise form it was used in Latin America in recent years. Rather, it is included because it shows the provenance of the 1983 CIA manual which was, like many of the seven army manuals, based on sixties era material.

Problems with Oversight

In late 1991, under the Bush Administration, the Office of the Assistant to the Secretary of Defense for Intelligence Oversight launched an investigation into the seven army manuals. The Pentagon provided the resulting report to the congressional intelligence committees. The investigation concluded that the manuals' authors and SOA instructors "erroneously assumed that the manuals, as well as the lesson plans, represented approved doctrine." When interviewed by the investigators, the manuals' authors stated that they believed intelligence oversight regulations applied only to U.S. personnel and not to the training of foreign personnel--in other words, that U.S. instructors could teach abusive techniques to foreign militaries that they could not legally perform themselves. The Bush Administration ordered the retrieval and destruction of the manuals, and the U.S. Southern Command advised Latin American governments that the handbooks did not represent official U.S. policy. However, the whole episode was treated as an isolated incident.

The individuals responsible for writing and teaching the lesson plans were not disciplined, nor were the authors and the instructors who believed teaching human rights violations was consistent with U.S. policy retrained. Indeed, as explained in the next section, many aspects of the manuals that violate human rights standards and democratic principles were never even commented upon in the 1991-92 investigation, the 1996 Pentagon press release, or the School of the Americas' response to public inquiries. In 1992, the Office of the Assistant to the Secretary of Defense for Intelligence Oversight did issue recommendations that "the Joint Staff should establish a policy to ensure that intelligence and counterintelligence training for foreign military personnel by Combatant Commands is consistent with U.S. and DoD policy," and that training materials should go through proper channels for approval. However, it is not at all clear to what extent these recommendations were followed and what steps have been taken to rethink the kinds of training offered to Latin American and other foreign militaries. A Defense Department Inspector General's report is expected to be released shortly; it may or may not answer some of these questions. The slow, piecemeal surfacing of these manuals and the limited investigations at each point suggest that there may be many other inappropriate training materials still in circulation.

Materials from the most intense days of the Cold War in the 1960s, which should never have been created in the first place, kept on being repackaged and reused despite a series of scandals and investigations that should have prompted a thorough revision of all materials and retraining of the U.S. military and intelligence personnel involved in drafting such materials or failing to provide proper oversight. Conclusion: Not an Abstract Violation of Human Rights The training provided by these manuals, the lesson plans and Project X is not some abstract violation of human rights principles. These methods were actively followed by Latin American militaries, particularly in the 1970s and 1980s; in Chile and Argentina's "dirty wars" in which thousands of dissidents disappeared; by military dictatorships in Brazil, Paraguay and Uruguay; in the Central American wars, where tens of thousands of civilians were killed; and in the Andean countries, where human rights violations still abound. In most cases, the militaries being trained were actively involved not just in suppressing armed rebellion but also in repressing democratic, civic opposition. NOTE: Many thanks to the invaluable assistance of Carlos Osorio at the National Security Archive and Suzy Glucksman in Rep. Joseph Kennedy's office.

EXCERPTS

The following collection of excerpts does not contain all the objectionable passages within the manuals, but rather offers a sampling ofthem. Some of the Pentagon's selection of excerpts are included, to give a full flavor, but most of the excerpts were not included in the Pentagon's more limited selection. The excerpts chosen include not only the worst passages that most clearly violate human rights or democratic standards, but also passages that advise against torture, to give a more balanced picture of the content. Also included are selections that reveal the simplistic and dated approach that is typical of the manuals. From the army manual "Counterintelligence": "CIVILIAN SECURITY: In all cases the mission of the military forces has priority over the well-being of the civilians in the area. Examples of the civilian security measures are: Systematic registering of the civilian personnel, including the neutral foreigners and enemies: This is done by the civilian affairs agency and includes the distribution of rationing cards, work permits, travel permits and permits for crossing borders.... Surveillance of suspect political groups: one should find out whether other groups are sympathetic to enemy cause. Such groups must always be considered potential agents." ("Counterintelligence," pp. 10-11)

"Figure #2

Black Lists

THESE CONTAIN THE IDENTITIES AND LOCATIONS OF PERSONS WHOSE CAPTURE AND DETENTION ARE OF FOREMOST IMPORTANCE TO THE ARMED FORCES:
EXAMPLES

a. Enemy agents known or suspects [sic], persons involved in espionage, sabotage, politics, and subversive persons.

b. Hostile para-military guerilla team leaders, known or suspects.

c. Political leaders known or suspected as hostile toward the Armed Forces or the political interests of the National Government.

d. Known or suspected leaders of enemy governments whose presence in the area of operations represent a threat the [sic] national security.

e. Collaborators and sympathizers of the enemy, known or suspects whose presence in the area of operations represent a threat to the national security.

f. Military and civilian enemies, known or suspected of having participated in intelligence activities, counter-intelligence, security, police or political indoctrination between the troops or among civilians.

g. Other personalities identified by the G2 as of immediate detention. This could include local political personalities, chiefs of police, and municipal leaders or leaders of the enemy's government departments." ("Counterintelligence," p.225)

"FIGURE #6
ORGANIZATIONS AND TEAMS

[This list refers to targets to be detected and "neutralized." While the explanation of the term neutralized in this chapter includes detaining and discrediting but not killing, the term often is used to mean killing.]

1. Local or national political party teams, or parties that have goals, beliefs or ideologies contrary or in opposition to the National Government.
2. Para-military organizations including student teams, police, military and veterans, or ex-fighter teams that are hostile towards the National Government.

3. Teams or hostile organizations whose objective is to create dissension or cause restlessness among the civilian population in the area of operations.

4. The central offices of these hostile organizations according to what the Commander of the Armed Forces says will be immediately neutralized. Personalities related with these offices will be arrested and detained.

5. Teams that operate undercover or clandestinely and their infrastructure.

6. Intelligence networks."("Counterintelligence," p. 228.) From the army manual "Handling of Sources":

"The mere elimination of the guerillas does not change in any way the insurgents' basic organization. In order to achieve a permanent victory, the internal defense operations should be planned with the goal of attacking the insurgent organization before the guerillas begin their operations, an attack which includes the secret subversive elements as well as their military arm once the movement reaches the second phase." ("Handling of Sources," p. 5)

"We have already seen how a relatively small number of individuals can come to control an organization by infiltration and fixed elections. The government can inform itself in a timely way about insurgents' activity in these organizations, by placing its agents in all organizations that it suspects could interest the insurgent group. Among the main organizations of this type can be mentioned political parties, unions and youth and student groups." ("Handling of Sources," p. 7)

"AGE: The employees [paid government informants] worthy of greatest confidence are mature, objective and emotionally stable individuals.... Children are, at least, very observant and can provide precise information about things they have seen and heard, if they are interrogated in the appropriate manner."("Handling of Sources," p. 26)

"The CI [counterintelligence] agent should take advantage of the aid programs through which the government provides food, clothing, health care and housing for the population. As these are programs with which the government is identified, it is possible to persuade the individuals who have benefitted from them to collaborate in the search for people ready to work with the government." ("Handling of Sources," p. 34)

"Teachers, doctors, social workers and clergy in a local area also can provide a lot of information to the CI agent. These individuals usually have a close relationship with the population and enjoy their respect. They usually maintain a variety of files that can be a useful source of information."
("Handling of Sources," p. 35)
"The CI agent must offer presents and compensation for information leading to the arrest, capture or death of guerillas." ("Handling of Sources," p. 35, included in Pentagon's excerpts.)

"Before the guerillas take control: The CI agent should consider all organizations as possible guerilla sympathizers. He ought to train and locate informants inside these organizations to inform him about activities and discover any indication of a latent insurrection. We are especially interested in identifying the members of the guerillas commando structure, its political structure and base of support. By infiltrating informants in the diverse youth, workers, political, business, social and charitable organizations, we can identify the organizations that include guerillas among their members. The agent can also identify the relatives of these guerillas, their supporters and sympathizers of the insurrectionary movement.... The CI agent also should investigate other organizations that are not yet under the guerillas' control, since doubtless these will include members who sympathize with the insurrectionary movement; for that reason, it is essential to identify those persons."
("Handling of Sources," p. 75)

"The CI agent could cause the arrest of the employee's parents, imprison the employee or give him a beating as part of the placement plan of said employee in the guerilla organization."
("Handling of Sources, p. 79, included in Pentagon's excerpts.)

"The employee's value can be increased... by means of arrests, executions or pacification."
("Handling of Sources," p. 80, included in Pentagon's excerpts.)

"If the agent suspects that he could have difficulty in separating an employee, it will be necessary to make up a reason to convince the employee that the separation is to his advantage. This could be by convincing him that he has been compromised by the guerillas. That continuing working for the government could result in serious consequences for the employee and his family. If the employee does not believe this story, other measures could be taken to convince him placing anonymous telegrams or sending anonymous letters. Many other techniques could be used which are only limited by the agent's imagination."("Handling of Sources," p. 155, included in Pentagon's excerpts)

From "Terrorism and the Urban Guerilla":"Guatemala and Costa RicaHistorically, the United States has had little to do with Guatemala and Costa Rica. Generally speaking, Costa Rica has always been a model of a stable democracy. In the middle of the 1950s, Guatemala was governed by a communist government. A coup d'etat directed by the United States replaced the government. During this time, the international communist Ernesto Che Guevara appeared in Guatemala. Apparently, the CIA head in Guatemala, H.R. Alderman had Guevara in prison but he was freed, thinking he didn't have much importance within the communist movement. The rest is history; Guevara went to Mexico where he joined Fidel Castro's forces to invade Cuba. Now that we know a little about the history of Central America, we are going to study each country from the point of view of terrorism."("Terrorism and the Urban Guerilla," p. 69)

"Another function of the CI agents is to recommend CI targets for neutralization. CI targets can include people, installations, organizations, and documents and materials. A CI target is someone or something that fits within the previously described categories; it may or may not be hostile. Persons who are targets can often prove to be valuable sources of intelligence. Some example of these targets are government officials, political leaders, and members of the infrastructure. Installations that are targets can provide information of significant value. The continued operation of these installations during combat can put in danger the commander's mission.... Organizations or groups that are able to be a potential threat to the government also must be identified as targets. Even though the threat may not be apparent, insurgents frequently hide subversive activity behind front organizations. Examples of hostile organizations or groups are paramilitary groups, labor unions, and dissident groups."
("Terrorism and the Urban Guerilla," p. 112)

"CI agents are also involved in recommending measures of control and [sic] of population to the authorities. These recommendations are based in the domestic and external support for the insurgents as well as the capacity to carry them out. These measures can be divided into three forms of control: surveillance, restriction and coercion. These measures are designed principally to detect and control the movement of human and material resources. The adequate application of these measures will break the support relationship between the population and the insurgent and at the same time provide a physically and physiologically secure environment for the population." ("Terrorism and the Urban Guerilla," p. 113)

"Measures of Controlling the Population and Resources

1. Surveillance. To control the movement of supplies, equipment, and people, it will be necessary to control and monitor the population's activities. Surveillance measures are used to identify insurgents, identify those who support them, and

identify the manner in which aid is provided to the insurgents. Restrictive measures are those that are aimed to isolate the insurgent from the general population, physically and psychologically, denying him his principal source of supply.

1. ID Cards. An effective system of identification is fundamental to the program for controlling the population and resources.

2. Registration. A program of registering families is used to supplement the system of ID cards. This is the system of inventorying all families by house, making a list of all members of the family who live in the house along with the family's resources. One can also note the presence of insurgent tendencies and affiliations among the population.

3. Control by block. The purpose of block-by-block control is to detect the individuals who are supporting or sympathizing with the insurgents and the type of support they are providing.

4. Police patrols. Police patrols can be compared to reconnaissance patrols. Their purpose is to detect sources of insurgent support, sympathizers, and routes used by the insurgent forces for intelligence, logistics, and routine activities and to act to prevent these activities. Restrictive Measures. Once the collection of information about the insurgents' supply system has been effective, the government forces can efficiently implement restrictive measures.

Control of travel and transportation. A program of control of the population and resources must include a system of passes.Curfew. Curfews can be an effective method to restrict movement between specific hours through a specific area or specific routes. The purpose is to permit the authorities to identify violators and take actions based on the premise that anyone who violates the curfew is an insurgent or sympathizes with the insurgents until he can prove the contrary.Checkpoints. It is of little use to establish a program of passes and ID cards unless there is a system of verifying these official papers. Therefore, establishing checkpoints in all travel routes is necessary once the use of passes has started...." ("Terrorism and the Urban Guerilla," pp. 118-119)

From the army manual "Revolutionary War, Guerillas and Communist Ideology": "It is essential that domestic defense intelligence agencies obtain information about the political party or parties that support the insurgent movement, the quantity of influence that the insurgents exercise, and the presence of the insurgent movement in the nonviolent public attacks against the government." ("Revolutionary War, Guerillas and Communist Ideology," 1989, p. 49)

"The subversive actions are directed towards achieving changes in the political, economic and social structure of society, frequently through psychological means. In this way, the insurgent tries to influence the opinions, attitudes, feelings and desires of friendly, hostile and neutral people to achieve behavior that is favorable to his objectives. During Phase I (subversion), intellectual and emotional persuasion is the principal arm of the insurrection." ("Revolutionary War, Guerillas and Communist Ideology," 1989, p. 50)

"The insurgents try to influence the direction, control and authority that is exercised over the nation in general and in the administration of the political system. The insurgents are active in the areas of political nominations, political organizations, political education, and judicial laws. They can resort to subverting the government by means of elections in which the insurgents cause the replacement of an unfriendly government official to one favorable to their cause. The insurgent activity can include disbursing campaign funds to gain members and organizing political meetings for their candidates. They can attempt to use bribes or place informants in key areas to counteract government action. They can launch propaganda attacks to discredit and ridicule political leaders and government officials. Also, insurgent leaders can participate in political races as candidates for government posts." ("Revolutionary War, Guerillas and Communist Ideology," 1989, p. 51)

"The CI [counterintelligence] personnel must be able to.... D. Recommend CI targets for exploitation. The CI targets include personalities, organizations and groups, as well as documents and materials. A CI target is someone or something that its within these categories and that can or cannot be hostile to our cause. Persons who sympathize with our cause are also of CI interest since it is not avorable to our interests to protect these people or groups." [sic; meaning of last sentence unclear in Spanish] F. Recommend measures of controlling the population and resources....

These measures fall within three types of control: surveillance, restriction, and enforcement. The surveillance measures include searches, ID cards and pass books, and control over areas. Restrictive measures include curfews, travel passes, rationing, and restricted areas. Enforcement measures include arrest and exile."
("Revolutionary War, Guerillas and Communist Ideology," 1989, pp. 73-74.)

Communism is "a kind of pseudo-religion, given that it has a founder, a mythology, a sacred book, a clergy, a place of pilgrimage and an inquisition. The founder is Marx; the mythology is communist theory; the sacred book is Das Kapital; the clergy are members of the Communist Party; the place of pilgrimage is Moscow; and the inquisition [by] the state (KGB) and others. Truly, as Marx said, communism is 'the spectre surrounding Europe.' Today this spectre is surrounding the whole world.

You can't hope to convince a devoted communist of the errors in his doctrine, but you ought to be able to point out to an impartial person the fallacies of the communist ideology; and you ought to feel more justified in the validity of the democratic doctrine in light of the fallacies you have learned to discover in communist doctrine." ("Revolutionary War, Guerillas and Communist Ideology," 1989, p. 128)

From army manual "Combat Intelligence":"Indications of an Imminent Guerilla Attack. Demonstrations by minority groups. Increase in propaganda activities in a particular area. The guerilla forces, in general, begin to distribute propaganda of various types, in which they include the approximate hour and date of an attack about to take place. This is a positive indication that they are going to launch an attack. Actions like that act to improve the image that the guerillas present to the people. Such actions help them achieve control over the population.

In some zones, the local population, including children, don't speak or associate with U.S. troops or host country troops. This invariably indicates one of two things: that guerillas dominate the area or that they intend to launch an attack. A high level of desertions among the paramilitary forces in the host country. Visits of strangers to towns, cities, etc. Celebration of national and religious festivals, as well as birthdays of leaders or key people in the guerilla forces or in a sponsoring power."
("Combat Intelligence," pp. 161-2)

"Indicators of Control [of the Population] by the Guerilla Forces. The local populace refuse to provide intelligence to government forces." ("Combat Intelligence, p. 163)

"II. Are the insurgents carrying out psychological operations?

Propaganda (indicator)

(1) Accusations of government corruption.
(2) Circulation of petitions that embrace the insurgents' demands.
(3) Attempts to discredit or ridicule government or military officials.
(4) Characterization of government and political leaders as U.S. puppets.
(5) Promotion of a popular front government.
(6) Propaganda urging youth to avoid the draft or soldiers to desert
(7) Characterization of the armed forces as the enemy of the people.
(8) Slogans against the government, the armed forces, or the United States
(spoken, posters, graffiti, pamphlets, commercial radio, etc.)
(9) Petitions or pamphlets that embrace Cuban or Nicaraguan philosophy.
(10) Appeals to people to sympathize with or participate in demonstrations or strikes.
(11) Accusations that the government has failed in its responsibility to meet the basic needs of the people.
(12) Accusations that the military and police are corrupt or that they aren't with the people.
(13) Accusations of brutality or torture by the police or armed forces.
(14) Propaganda in favor of revolutionary groups, Cuba, or Nicaragua.
(15) Propaganda with the objective of linking certain ethnic groups in a united international class.

Promotion of popular discontent. (indicator)

(1) Labor discontent.
(a) Energetic campaigns of union organizing or recruiting.
(b) Extremist propaganda in favor of the interests of the workers.
(c) Violent workers' demonstrations.
(d) Worker demonstrations against the government.
(e) Strikes.
(f) Changes in labor leadership.
(g) Persecution of labor leaders by the security forces or private groups.

(2) Rural Discontent.
(a) Demonstrations to demand agrarian reform.
(b) Land takeovers.
(c) Persecution of peasant leaders by security forces or private groups.

(3) Economic Discontent.
(a) Peasants refuse to pay taxes or rents.
(b) Protests about high unemployment, low salaries, or against the national economic plan.

(4) Religious Discontent.
(a) Clergy embracing liberation theology.
(b) Clergy involved in activities concerning political, rural or labor discontent.
(c) Adult men receiving refuge or food from clergy or help from them....

Popular organizing. (indicator)

Unusual meetings among the population.
Migration of population from areas previously occupied
The population avoids travelling, working, or living in certain areas.
Civilians avoid military forces or show their displeasure at cooperating with them....."
("Combat Intelligence," pp. 167-169)

From CIA manual "Human Resource Exploitation Manual -1983":

"I. Control - The capacity to cause or change certain types of human behavior by implying or using physical or psychological means to induce compliance. Compliance may be voluntary or involuntary.Control can rarely be established without control of the environment. By controlling the subject's physical environment, we will be able to control his psychological state of mind." ("Human Resource Exploitation Manual - 1983," p. A-6)

"Design and Management of a Facility [for questioning detainees]

II. Security Considerations
A. Should be constructed in a reasonably secure area, secure from demonstrations, riots, etc.
B. Should not be easily observed from outside by unauthorized personnel.
C. Should be able to withstand an attack.
E. Overhead and bunker protection from shelling.
G. Firing ports in the outside wall of the facility.
H. External fencing of dense material to detonate rockets.
I. Entry and exit of all personnel must be strictly controlled by a system of badges, with photos, identifying personnel and indicating areas of access (e.g. different color backgrounds). Badges never leave the facility. They are picked up and turned at reception." ("Human Resource Exploitation Manual - 1983," p. E-2)

"Tapes [of interrogation] can be edited and spliced, with effective results, if the tampering can be kept hidden. For instance, it is more effective for a subject to hear a taped confession of an accomplice than to merely be told by the 'questioner' that he has confessed." ("Human Resource Exploitation Manual - 1983," p. E-7)

I. Apprehension.

A. The manner and timing of arrest can contribute substantially to the 'questioner's' purpose and should be planned to achieve surprise and the maximum amount of mental discomfort. He should therefore be arrested at a moment when he least expects it and when his mental and physical resistance is at its lowest.The ideal time at which to make an arrest is in the early hours of the morning. When arrested at this time, most subjects experience intense feelings of shock, insecurity, and psychological stress and for the most part have great difficulty adjusting to the situation.
B. As to the manner of the arrest, it is very important that the arresting party behave in such a manner as to impress the subject with their efficiency. The subject should be rudely awakened and immediately blindfolded and handcuffed....

- Handling upon arrival at the facility.

- Subject is brought into the facility blindfolded and handcuffed and should remain so during the entire processing.
- Any time the subject is moved for any reason, he should be blindfolded and handcuffed.
- Subject should be required to comply immediately and precisely with all instructions.
- Subject is completely stripped and told to take a shower. Blindfold remains in place while showering and guard
- watches throughout.
- Subject is given a thorough medical examination, including all body cavities, by the facility doctor or nurse.
- Total isolation should be maintained until after the first questioning' session. Conditions can be adjusted after this
- session.

C. Subject should be made to believe that he has been forsaken by his comrades.

- M. Throughout his detention, subject must be convinced that his questioner' controls his ultimate destiny, and that his absolute cooperation is necessary for survival."

("Human Resource Exploitation Manual - 1983," p. F-1-F-3)

D. News from Home

- Allowing a subject to receive carefully selected letters from home can help create an effect desired by the 'questioner.' For example, the subject may get the idea that his relatives are under duress or suffering.
- A suggestion at the proper time that his cooperation or confession can help protect the innocent may be effective."

("Human Resource Exploitation Manual - 1983," p. J-6)

E. A cooperative witness can sometimes be coached to exaggerate the subject's involvement or accuse him of a worse crime than the matter at hand. Upon hearing these remarks from a recording, a subject may confess the truth about the lesser guilt in order to provide himself with an alibi.

F. If the witness refuses to denounce the subject, the 'questioner' elicits and records remarks from him denouncing someone else known to him, for example, a criminal who was recently convicted in court. During the next session with the subject, these remarks, edited as necessary, are played back so that the subject is persuaded that he is the subject of the remarks."

("Human Resource Exploitation Manual - 1983," p. J-8)

G. Threats and Fear

The threat of coercion usually weakens or destroys resistance more effectively than coercion itself. For example, the threat to inflict pain can trigger fears more damaging than the immediate sensation of pain. In fact, most people underestimate their capacity to withstand pain. In general, direct physical brutality creates only resentment, hostility, and further defiance. The effectiveness of a threat depends on the personality of the subject, whether he believes the 'questioner' can and will carry out the threat, and on what he believes to be the reason for the threat. A threat should be delivered coldly, not shouted in anger, or made in response to the subject's own expressions of hostility."

( "Human Resource Exploitation Manual - 1983," p. K-8)

H. Are coercive techniques to be used? Have all supervisors in your direct chain of command been notified and given approval? Has headquarters given approval?"

( "Human Resource Exploitation Manual - 1983," p. L-4)

"VII. Exploitation and Disposal

I. What disposition of the subject is to be made after 'questioning' ends?

1. If the subject is suspected of being a hostile agent, and he has not confessed, what measures will be taken to ensure that his is not allowed to operate as before?

2. If the subject is to be used operationally, what effect (if any) will the 'questioning' have upon the operation?

3. If the subject is to be turned over to another service, how much will he be able to tell them about your service and methods?

4. If the subject is to be turned over to the courts for prosecution, will he be able to cause embarrassment to your service because of his detention and 'questioning'?

B. Have any promises been made to the subject which are unfulfilled when 'questioning' ends? Is he vengeful or likely to strike back? How?

C. Has a quit-claim been obtained?

D. If psychological regression was induced in the subject during the 'questioning' process, how is it planned to restore him to his original mental condition?"

("Human Resource Exploitation Manual - 1983," p. L-6 - L-7)

Excerpts from the CIA's "KUBARK Counterintelligence Interrogation - July 1963":

"The interrogation of a resistant source who is a staff or agent member of an Orbit intelligence or security service or of a clandestine Communist organization is one of the most exacting of professional tasks. Usually the odds still favor the interrogator, but they are sharply cut by the training, experience, patience and toughness of the interrogatee. In such circumstances the interrogator needs all the help that he can get. And a principal source of aid today is scientific findings. The intelligence service which is able to bring pertinent, modern knowledge to bear upon its problems enjoys huge advantages over a service which conducts its clandestine business in eighteenth century fashion. It is true that American psychologists have devoted somewhat more attention to Communist interrogation techniques, particularly "brainwashing" than to U.S. practices. Yet they have conducted scientific inquiries into many subjects that are closely related to interrogation: the effects of debility and isolation, the polygraph, reactions to pain and fear, hypnosis and heightened suggestibility, narcosis, etc...."

"The legislation which founded KUBARK specifically denied it any law-enforcement or police powers. Yet detention in a controlled environment and perhaps for a lengthy period is frequently essential to a successful counterintelligence interrogation of a recalcitrant source. [section whited out] This necessity, obviously, should be determined as early as possible.

The legality of detaining and questioning a person, and of the methods employed, [section whited out]."

("KUBARK Counterintelligence Interrogation--July 1963," p. 7)

"Interrogations conducted under compulsion or duress are especially likely to involve illegality and to entail damaging consequences for KUBARK. Therefore prior Headquarters approval at the KUDOVE level must be obtained for the interrogation of any source against his will and under any of the following circumstances:

1. If bodily harm is to be inflicted.
2. If medical, chemical, or electrical methods or materials are to be used
to induce acquiescence.
5. [whited out]
6.

("KUBARK Counterintelligence Interrogation--July 1963," p. 8)

"The profound moral objection to applying duress past the point of irreversibly psychological damage has been stated. Judging the validity of other ethical arguments about coercion exceeds the scope of this paper. What is fully clear, however, is that controlled coercive manipulation of an interrogatee may impair his ability to make fine distinctions but will not alter his ability to answer correctly such gross questions as 'Are you a Soviet agent? What is your assignment now? who is your present case officer?"

("KUBARK Counterintelligence Interrogation--July 1963," p. 84)

"The following are the principal coercive techniques of interrogation:

arrest, detention, deprivation of sensory stimuli through solitary confinement or similar methods, threats and fear, debility, pain, heightened suggestibility and hypnosis, narcosis, and induced regression."

("KUBARK Counterintelligence Interrogation--July 1963," p. 85)

"1. The more completely the place of confinement eliminates sensory stimuli, the more rapidly and deeply will the interrogatee be affected. Results produced only after weeks or months of imprisonment in an ordinary cell can be duplicated in hours or days in a cell which has no light (or weak artificial light which never varies), which is sound-proofed, in which odors are eliminated, etc. An environment still more subject to control, such as water-tank or iron lung, is even more effective."

("KUBARK Counterintelligence Interrogation--July 1963," p. 90)

"If a coercive technique is to be used, or if two or more are to be employed jointly, they should be chosen for their effect upon the individual and carefully selected to match his personality."

("KUBARK Counterintelligence Interrogation--July 1963," p. 103)

"38. Are coercive techniques to be employed? If so, have all field personnel in the interrogator's direct chain of command been notified? Have they approved?

39. Has prior Headquarters permission been obtained?

43. Are threats to be employed as part of a plan? Has the nature of the threat been matched to that of the interrogatee?"

("KUBARK Counterintelligence Interrogation--July 1963," p. 109)

[Note on translation of excerpts: The excerpts from "Terrorism and the Urban Guerilla," "Revolutionary War, Guerillas and Communist Ideology," "Combat Intelligence" and the selections from "Handling of Sources" not included in the Pentagon's excerpts were translated by the author of this memo. "Counterintelligence," "Human Resource Exploitation" and "KUBARK" were available in English. In some cases the Spanish appears to be a bad translation from English.]

# The Survivability of Survivability

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"It's too bad she won't live. But then again, who does?" Gaff in Ridley Scott's "Bladerunner", 1982.

## Introduction

Survivability is typically defined along the following lines: the ability to continue to fulfill a mission even in the face of attacks and failures. Crucial here is the acknowledgement that it is impossible to foil all attacks and prevent all failures. No single component of a system is immune to failure or subversion. There appear to be a number of technical obstructions to progress towards the goal of designing and evaluating survivable systems:

## Lack of precise definitions and focus

The above definition is fine as far as it goes, but to evaluate a system we need more precise, formal definitions. Some attempts have been made to provide at least frameworks in which such definitions could be formulated but these seem not to have been widely accepted. Our first problem then is that we have no clear criteria against which to measure success or progress.A process algebraic formulation using a weakened form of non-interference in which acceptable performance in the face of certain envelopes of attack/failures can be defined is proposed in [7]. This is presented in the process algebra CSP. Given the unbounded, dynamic nature of many of the systems of interest it may be necessary to use a dynamic calculus such as the pi-calculus or ambient-calculus.

## Survivability is a relative attribute

It is clear that survivability cannot be viewed as a binary, absolute property. To boldly assert that a system is survivable is clearly absurd. A system can at best be survivable in the face of certain classes of attack or failure. Safes are traditionally classified according to how long they can be expected to resist certain types of attack, such as break-ins or fire. We need analogous measures for survivable systems.

One problem here is perhaps a psychological one: there is an ingrained tendency for people with an information security background to think in absolute terms. Much of the early work on information security sought absolute definitions of say secrecy. More recently there has been a recognition that absolute security is unattainable but the mindset lives on.

There seem to be two ways forward: to construct measures of acceptable performance in the face of certain classes of attack, as suggested above, or to construct survivability orderings, perhaps analogous to the security ordering of Jacob [5]. The latter is attractive mathematically but is perhaps not satisfactory from a practical point of view: simply knowing that one system is "better" than another is not really very satisfying. A framework in which survivability orderings can be defined is presented in [8]. In essence a system P is deemed at least as survivable as Q with respect to some mission defined by M, written $P \geq_M Q$, if: $\forall \varphi \in \Psi\ M||P||\varphi \text{ refines}_{FD} M||Q||\varphi$

In other words, in the presence of any hostile environment $\varphi$ from some class $\Psi$, and when restricted to behaviors associated with the mission M, P provided at least as much functionality as Q. Traditionally the problem has been viewed principally from the defender's point. A healthier approach would be to take a more game-theoretic approach and view the problem from both the defensive and offensive perspectives. This is akin to the evaluation of a cryptographic device: you really need to adopt the cryptanalyst's mindset. This also acknowledges the relative nature of the attribute: there will always be an attacker with sufficient resources, time and determination to defeat any given set of countermeasures. A key ingredient of survivability seems to be containment of damage: bounded attack effort should result in bounded damage.

Containment should be in space and time: only a finite portion of the system or its functionality should be affected and the system should recover within finite time of attack activity ceasing Note that damage might also be contained with respect to levels of abstraction of the system: damage manifest at one level might be masked at a higher level. Perhaps a "universal" characteristic of survivability is the way damage scales with intensity of attack. Ideally damage should scale at most roughly linearly with attack effort. This seems to give a sort of general, dimensionless characterization. Coming up with natural measures of attack effort and damage can be a little delicate though.

## Probability assumptions

An obstacle to the dependability position seems to be that the usual assumptions about failure modes and rates are inappropriate for survivable systems. It is far from clear that we come up with tractable models of survivable systems that include reasonably faithful failure modes and hostile capabilities. Can we develop models that are reasonably independent of the details of failures modes, probabilities and correlations (given that in the context of survivable systems these are largely unknowable)? Unfortunately, given current engineering practice, such models are unlikely to be faithful to reality. A system that is amenable to analysis in this sense will also probably be robust and resilient. That is, the characteristics that make a system easy to analyze are probably the same as those that make if survivable. Small, localized damage should result in small, localized degradation of service. One possible response to the above observations is to try to develop guidelines for the development of robust, resilient systems and architectures, perhaps along the lines of the Abadi and Needham [1]. Whether such guidelines would ever be followed is another problem.

## The need to reason about open, unbounded systems

Typically the systems we need to consider will be open and unbounded. Consequently we are attempting to establish properties of highly uncertain systems existing in an uncertain, shifting environment. Indeed the boundary between the system and its environment becomes blurred.
A possible reaction is take an agent-centric point of view and abandon attempts to prove global properties. Rather, try to show that from the point of view of individual agents the system provides certain standards of service. Thus the properties of interest should be derivable from certain assumptions about parts of the system under the agent's control, or at least trusted, along with minimal assumptions about the rest of the universe. This is akin to the approach taken in the analysis of security protocols in particular the strand spaces approach [6, 9].

Data-independence, abstraction and induction techniques have been used successfully to prove conventional) properties of unbounded systems, [10]. It seems likely that similar techniques can be used for survivability properties.

## The need to handle partial and faulty information about the global state

A survivable system will be made up of components with (local) interactions with the other components and the environment. Each component will need to take actions based on partial and probably faulty knowledge of the state of other components as well as the state of the (possibly hostile) environment. Note further, that hostile agents will probably be trying to subvert the communications mechanisms between the system components.

## The need to reason about adaptive, self-stabilizing and emergent properties

It would appear to be necessary for any survivable system to incorporate emergent algorithms and mechanisms. Unfortunately we are still not very good at reasoning about emergent properties, in particular, our usual inductive, modular styles or reasoning are typically inappropriate. Simulation tools like EASEL may help us develop better intuitions about emergent behaviors and help us develop techniques for reasoning about them [4].

## The fact that survivability has so many aspects

The design and evaluation of a survivable system calls for consideration of dependability, reliability, security, adaptability etc. as well as efficiency, cost-effectiveness. It is thus hardly surprising that this has proved to be a challenging enterprise, especially given that it is far from clear that any clean separation of concerns is possible.

## All those nasty economic, legal and policy obstacles

We will not dwell on these issues; they have been discussed at length by many people far better qualified than us. However, for completeness we say a few words.

Ordinary market forces tend to drive solutions towards a minimalist approach: just-in-time etc. As a result
systems tend to be meta-stable: slight perturbations and they collapse. Achieving robust solutions tend to call for over-engineered solutions, but these are inevitably more expensive.

Building a survivable infrastructure is rather like working towards a cleaner environment: it requires a degree of responsibility and even altruism on the part of the people managing the components, qualities that can be rather thin on the ground in context driven purely by market forces. Combating this may require policy intervention and regulation to encourage the development and deployment of more robust survivable systems.

Another source of major problems is the universal insistence on using COTS components and the accompanying dogma that COTS components lead to cheaper and more effective solutions. Since we can have only uncertain knowledge of the behavior of COTS components and their interactions this leads to the issue mentioned above.

## Is survivability survivable?

In the light of all this, is the pursuit of survivability the 21st century equivalent of the pursuit for the
philosopher's stone? Perhaps survivability is beyond the reach of mere mortals and the best that we can hope for is longer mean times to fatality.

Can it survive attacks, failures and accidents? In other words, can survivability as a discipline survive
these obstructions? Is survivability itself an emergent computation? Is the approach for defining and understanding survivability the same that we seek for the systems we describe as survivable?

## Conclusions

It is clear that the design and evaluation of survivable systems is an immensely challenging task. Even the
question of establishing precise criteria for evaluating the survivability of systems is difficult. Maybe the rather disappointing level of progress that we have witnessed is in fact roughly what we should

expect from a new discipline. It might be instructive to look at the history of various other emerging disciplines such as security and artificial intelligence and compare their patterns of evolution. In security it took a couple of decades to reach the stage of having well-defined criteria for the evaluation of secure systems in the form of the "Orange Book" and even then these were controversial and have since been superseded [3].

Even now there is no consensus as to the correct formal definition of secrecy. On the other hand, maybe survivability is more akin to alchemy. We suggest that the way forward is to put aside the philosophizing and get our teeth into some realistic examples. Currently we are looking at models of "worm wars": worm systems seeking to propagate and attack a network along with "benign worms": seeking to defend the network. Both the worm system and the network are regarded as survivable systems with competing missions. This reflects rather nicely the two sided, gametheoretic nature of the problem. This work will appear in a separate paper [2].

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## References

[1] Abadi, M., Needham, R.: "Prudent engineering practice for cryptographic protocols"; IEEE Transactions on Software Engineering (1996), 22(1), pp 6-15.
[2] Dietrich S. et al, "Worm Wars", to appear.
[3] DOD 5200.28-STD, Department of Defense Trusted Computer System Evaluation Criteria (TCSEC) ("The Orange Book"), National Computer Security Center, December 1985.
[4] Fisher D., "Design and Implementation of Easel, a language for simulating highly distributed systems", at http://www.cert.org/research/.
[5] Jacob, J. "Basic theorems about security". Journal of Computer Security, 1(4), pp 385-411, 1992.
[6] F. Javier Thayer Fabrega et al. "Strand spaces: Why is a security protocol correct?", Proceedings of the 1998 IEEE Symposium on Security and Privacy, pp 160-171. IEEE Computer Society Press, May 1998.
[7] Ryan P. Y. A., "Mathematical Models of Computer Security", Proceedings of the FOSAD 2000 Summer School, to appear Springer LNCS 2172.
[8] Ryan P. Y. A. et al, "Survivability, the Universe and Everything", to appear.
[9] Ryan P. Y. A. et al, "Modelling and Analysis of Security Protocols", Pearson 2001.
[10] Broadfoot P et al, "Automating data-independence", ESORICS, LNCS 1895, Springer 2000.

# *Hurlburt Field Base Library- Special Operations Military History*

## I. BACKGROUND AND ANALYSIS

Ahmad, Eqbal. _ Revolutionary War and Counter-Insurgency. _ Revolutionary War: Western Response. Ed. David S. Sullivan and Martin J. Sattler. New York: Columbia University Press, 1971: 1-47. (301.63 Rev)
An essay on potential pitfalls in relying on military forces for response in low-intensity conflict.
Alexiev, Alexander A. Marxism and Resistance In the Third World: Cause and Effect. Santa Monica, Calif.: Rand Corporation, 1989. [RAND report R-3639] (321.094 Ale)
American Military Policy In Small Wars: The Case of El Salvador. A Special Report from the Institute for Foreign Policy Analysis. McLean, Va.: Pergamon-Brassey _s, 1988.(355.032 Ame)
An interim assessment of the American experience in El Salvador. Authors address a wide range of issues, including the multidisciplinary challenge of counter-insurgency operations.
Anderson, Ewan W. Atlas of World Political Flashpoints: A Sourcebook In Geopolitical Crisis. New York: Facts On File, 1993. (R 327.101 And)
Andrade, Dale. Ashes to Ashes: The Phoenix Program and the Vietnam War. Lexington, Mass.: Lexington Books, 1990. (959.70434 And)
Arendt, Hannah. On Revolution. New York: Viking Press, 1965. (321 Are)
An examination of three classic revolutions, the American, the French, and the Russian--with an analysis of revolution for our time.
Armed Forces and Modern Counter-Insurgency. Ed. Ian F. W. Beckett and John Pimlott. New York: St. Martin _s Press, 1985. (355.02184 Arm)
Armies In Low-Intensity Conflict: A Comparative Study of Institutional Adaptation to New Forms of Warfare. Ed. D. Charters and M. Tugwell. New York: Pergamon, 1988.(355.0215 Arm)
Ayers, Charles M. Operational Considerations for Military Involvement in Low Intensity Conflict. Langley Air Force Base, Va.: Army-Air Force Center for Low Intensity Conflict,1987.
Barber, Willard Foster. Internal Security and Military Power: Counterinsurgency and Civic Action In Latin America. Columbus: Ohio State University Press, 1966. (301.29 Bar)
Bayo, Alberto. 150 Questions for a Guerrilla. [N.p].: Paladin, 1975. (355.4 Bay)
Beaumont, Roger A. Joint Military Operations: A Short History. Westport: Greenwood, 1993.
Bercuson, David. The Secret Army. New York: Stein & Day, 1983. (956.042 Ber)
Information on the Israeli War of Independence of 1948-49 and of foreign involvement in developing an Israeli military capability.
Blank, Stephen A. Studying Soviet Low-Intensity Conflicts. Maxwell Air Force Base, Ala.: Air University Press, 1989. (355.0215 Bla)
Blaufarb, Douglas S. The Counterinsurgency Era: U.S. Doctrine and Performance, 1950 to the Present. New York: Free Press, 1977. (355.02184 Bla)
Bohrer, David. America _s special forces. Osceola, WI ; MBI Pub. Co., 1998. (356.167 Boh)
Boykin, William G. The Origins of the United States Special Operations Command. Carlisle Barracks, Pa.: Army War College, 1992. (356.167 Boy)
Breuer, William. The Secret War With Germany: Deception, Espionage, and Dirty Tricks, 1939-1945. Novato, Calif.: Presidio Press, 1988. (940.5485 Bre)
Butler, Bradley L. Planning Considerations for the Combat Employment of Air Power In Peacetime Contingency Operations. Langley Air Force Base, Va.: Army-Air Force Center for Low Intensity Conflict, 1988. (358.403 But)
Cabezas, Omar. Fire From the Mountain: The Making of a Sandinista. New York: Crown, 1985. (972.85083 Cab)
Cable, Larry. Conflict of Myths: The Development of American Counterinsurgency Doctrine and the Vietnam War. New York: NYU Press, 1986. (959.90433 Cab)
Covers a lot more than the Vietnam War. Makes the crucial distinction between insurgency and partisan warfare.
Campbell, Arthur. Guerrillas: A History and Analysis. New York: John Day, 1968. (355.4 Cam)
Castle, Timothy N. One day too long : top secret site 85 and the bombing of North Vietnam.

New York : Columbia University Press, 1999. (959.70434 Cas)
Cayetano Carpio, Salvador. Listen, Companero: Conversations With Central American Revolutionary Leaders, El Salvador, Guatemala, Nicaragua. Berkeley, Calif.: Center for the Study of the Americas; San Francisco, Calif.: Solidarity Publications, 1983. (972.8052 Cay)
Celmer, Marc A. Terrorism, U.S. Strategy, and Reagan Policies. New York: Greenwood Press, 1987. (363.32 Cel)
Chaliand, Gerard. Revolution in the Third World: Myths and Prospects. New York: Viking Press, 1977. (320.5 Cha)
Chapman, William. Inside the Philippine Revolution. New York: Chapman, 1987. (959.904 Cha)
Cilliers, J.K. Counter-Insurgency in Rhodesia. Dover, N.H.: Croom Helm, 1985. (968.9104 Cil)
Cohan, Al S. Theories of Revolution: An Introduction. New York: Wiley, 1975. (301.6333 Coh)
Colburn, Forrest D. The Vogue of Revolution in Poor Countries. Princeton, N.J.: Princeton University Press, 1994. (320.91724 Col)
Collins, John M. America _s Small Wars: Lessons for the Future. Washington, D.C.: Pergamon-Brassey _s, 1991. (355.03347 Col)
---. Special Operations Forces: An Assessment. Washington, D.C.: National Defense University Press, 1994. (356.16 Col)
Cordesman, Anthony and Abraham Wagner. The Lessons of Modern War. Boulder, Colo.: Westview Press, 1990. (355.48 Cor)
Arab-Israeli Conflicts, Iran-Iraq War, Afghan and Falklands Conflicts.
Cross, James Eliot. Conflict in the Shadows: The Nature and Politics of Guerrilla War. New York: Doubleday, 1963. (355.4 Cro)
Crouch, Thomas W. Compilation of LIC References and Bibliography, Vols. I and II. Langley Air Force Base, Va.: Army-Air Force Center for Low Intensity Conflict, 1988. (355.021 Cro)
Crozier, Brian. The Rebels: A Study of Post-War Insurrections. Boston: Beacon Press, 1960. (909.82 Cro)
Cuddihee, Michael A. Special Operations Forces--Responsive, Capable and Ready. Maxwell Air Force Base, Ala.: Air University, Press, 1990. (356.167 Cud)
Currey, Cecil B. Victory At Any Cost: The Genius of Viet Nam _s Gen. Vo Nguyen Giap. Brassey _s, 1997. (959.70434 Cur)
Davis, Richard. The 31 Initiatives: A Study in Air Force-Army Cooperation. Washington, D.C.: Office of Air Force History, 1987. (355.02 Dav)
Debray, Regis. Revolution in the Revolution? Armed Struggle and Political Struggle in Latin America. New York: MR Press, 1967. (355.4 Deb)
Degenhardt, Henry W. Political Dissent: An International Guide to Dissident, Extra-Parliamentary, Guerrilla, and Illegal Political Movements. Detroit: Gale Research, 1983. (R 322.42 Deg)
Dictionary of the Vietnam War. Ed. James S. Olson. Westport, Conn.: Greenwood Press, 1988. (R 959.7043 Dic)
Dixon, Cecil Aubrey. Communist Guerrilla Warfare. New York: Praeger, 1954. (940.54 Dix)
Donnelly, Thomas, et al. Operation Just Cause : the storming of Panama. New York: Lexington Books, 1991. (327.73072 Don)
Drew, Dennis M. Insurgency and Counterinsurgency: American Military Dilemmas and Doctrinal Proposals. Maxwell Air Force Base, Ala.: Air University Press, 1988. (355.0218 Dre)
Elliot, Jeffrey. The Arms Control, Disarmament, and Military Security Dictionary. Santa Barbara, Calif.: ABC-CLIO, 1989. (R 327.4 Ell)
Encyclopedia of the American Military: Studies of the History, Traditions, Policies, Institutions, and Roles of the Armed Forces in War and Peace. New York: Scribner _s, 1994. (R 355.00973 Enc)
Contains numerous overview essays on SOF topics such as _ unconventional warfare. _
Eshel, David. The U.S. Rapid Deployment Forces. New York: ARCO, 1985. (355.35 Esh)
Farcau, Bruce W. The Coup: Tactics in the Seizure of Power. Westport, Conn.: Praeger, 1994. (321.09 Far)

Gambone, Leo. Pave Low III: That Others May Live. ASD History Office, AFSC, [n.d.]. (623.746 Gam)
Gann, Lewis H. Guerrillas in History. Stanford, Calif.: Hoover Institution Press, 1971. (355.021 Gan)
Glick, Edward B. Peaceful Conflict: The Non-Military Use of the Military. Harrisburg, Pa.: Stackpole Books, 1967. (355 Gli)
An early book outlining constructive use of armies as a means of dealing with the inevitable unrest in developing countries. The civic action role is clarified through interviews with players like Edward Lansdale.
Godson, Roy. Dirty Tricks or Trump Cards: U.S. Covert Action and Counterintelligence. Washington, D.C.: Brassey _s, 1995. (327.1273 God)
Great Powers and Little Wars: The Limits of Power. Ed. A. Hamish Ion and E.J. Errington. Westport, Conn.: Praeger, 1993. (355.0215 Gre)
Useful nuggets of wisdom can be gleaned from this thought-provoking collection. Examples from the past stand as a warning against current and future misapplication of military strength and the misuse of military forces.
Greene, Thomas H. Comparative Revolutionary Movements. 3rd ed. New York: Prentice-Hall, 1990. (321.094 Gre)
Greentree, Todd R. The United States and the Politics of Conflict in the Developing World: A Policy Study. Washington, D.C.: Center for the Study of Foreign Affairs, U.S. Dept. of State, 1990. (327.73 Gre)
Gross, Liza. Handbook of Leftist Guerrilla Groups in Latin America and the Caribbean. Boulder, Colo.: Westview Press, 1995. (972.9 Gro)
The Guerrilla--And How to Fight Him. Ed. T.N. Greene. New York: Praeger, 1962. (355.4 Mar)
A collection of case studies on insurgent warfare.
Guevara, Ernesto (Che). Che Guevara on Revolution: A Documentary Overview. Coral Cables, Fla.: University of Miami Press, 1969. (323.2 Gue)
Guerrilla Warfare and Counterinsurgency: U.S. - Soviet Policy in the Third World. Coral Gables, Fla.: University of Miami Press, 1969. (323.2 Gue)
Guilmartin, John Francis. A Very Short War: The Mayaguez and the Battle of Koh Tang. College Station, Texas: A&M University Press, 1995. (959.70434 Gui)
Hartcup, Guy. Camouflage: A History of Concealment and Deception in War. New York: Scribner, 1980. (355.4 Har)
Hinkle, Warren. The Fish Is Red: The Story of the Secret War Against Castro. New York: Harper and Row, 1981. (327.73 Hin)
Hoffman, Bruce. An Agenda for Research On Terrorism and LIC in the 1990 _s. Santa Monica, Calif.: Rand Corporation, 1991. [RAND paper p-7791] (355.0218 Hof)
---. Commando Raids, 1946-1983. Santa Monica, Calif.: Rand Corporation, 1985. [RAND paper N-2316] (355.35 Hof)
A survey of 100 actions since WW II.
Hosmer, Stephen T. The Army _s Role in Counterinsurgency and Insurgency. Santa Monica, Calif.: Rand Corporation, 1990. [RAND report R-3947-A] (355.02184 Hos)
Howard, Stephen P. Special Operations Forces and Unmanned Aerial Vehicles: Sooner or Later? Maxwell Air Force Base, Ala.: Air University Press, 1996. (358.414 How)
International Military and Defense Encyclopedia. Ed. Trevor N. Dupuy, et al. Washington, D.C.: Brassey _s, 1993. (R 355.003 Int)
Isby, David. War in a Distant Country: Afghanistan: Invasion and Resistance. London: Arms and Armour Press, 1989. (958.1045 Isb)
Janke, Peter. Guerrilla and Terrorist Organisations: A World Directory and Bibliography. New York: Macmillan, 1983. (322.42 Jan)
Jessup, John. A Chronology of Conflict and Resolution, 1945-1985. New York: Greenwood Press, 1989. (R 355.02 Jes)
Joes, Anthony James. Modern Guerrilla Insurgency. Westport, Conn.: Praeger, 1992. (355.0218 Joe)
Johnson, Chalmers. Revolutionary Change. 2nd ed. Stanford: Calif.: Stanford University Press, 1982. (303.64 Joh)

Katjaviv, Peter H. A History of Resistance in Namibia. London: J. Currey, Paris: Unesco Press, (968.81 Kat)
Kelly, Francis. U.S. Army Special Forces, 1961-1971. Washington, D.C.: Dept. of the Army, 1973. (959.70434 Kel)
Kelly, Ross S. Special Operations and National Purpose. Lexington, Mass.: Lexington Books, 1989. (355.0218 Kel)
Kempe, Frederick. Divorcing the Dictator: America _ s Bungled Affair With Noriega. New York: Putnam, 1990. (327.73072 Kem)
Kitson, Frank. Low-Intensity Operations. Harrisburg, Pa.: Stackpole, 1971. (355.3 Kit)
Kitson _s views on special operations and units are set forth on pp. 139, 191-196 and 198.
Klingaman, Jerome W. Policy and Strategy Foundations for Low-Intensity Warfare. Maxwell Air Force Base, Ala.: Air University Press, 1986. (355.0335 Kli)
Kropotkin, Petr Alekseevich. Selected Writings on Anarchism and Revolution. Cambridge, Mass.: M.I.T. Press, 1970. (335.83 Kro)
LaFeber, Walter. Inevitable Revolutions: The United States in Central America. New York: Norton, 1983. (327.73072 LaF)
Lanning, Michael Lee. Inside the VC and the NVA: The Real Story of North Vietnam _s Armed Forces. New York: Fawcett Columbine, 1992. (959.70434 Lan)
Lansdale, Edward Geary. In the Midst of Wars: An American _s Mission to Southeast Asia. New York : Fordham University Press, 1991. (959.7043 Lan)
Laqueur, Walter Ze _ev. Guerrilla: A Historical and Critical Study. Boston: Little, Brown, 1976. (355.02 Laq)
Excellent survey of case studies on insurgent warfare.
Lenaham, Rod. Crippled eagle : a historical perspective of U.S. special operations 1976-1996. Charleston, S.C. : Narwhal Press, 1998. (355.422 Len)
The Lessons of Recent Wars in the Third World. Ed. Robert E. Harkavy and Stephanie G. Neuman. Lexington, Mass.: Lexington Books, 1987. (355 Les)
Linn, Brian McAllister. The U.S. Army and Counterinsurgency in the Philippine War, 1899-1902. Chapel Hill: University of North Carolina Press, 1989. (959.9031 Lin)
Lipset, Seymour Martin. Revolution and Counterrevolution; Change and Persistence inSocial Structures. New York: Basic Books, 1969. (306.2 Lip)
Low-Intensity Conflict and Modern Technology. Maxwell Air Force Base, Ala.: Air University Press, 1986. (355.021 Low)
Low-Intensity Conflict in the Third World. Maxwell Air Force Base, Ala.: Air University Press, 1988. (355.0215 Low)
Low-Intensity Conflict LIC Status Report. Washington, D.D.: ASD/SOLIC, 1992. (355.0215 Kli)
Low-Intensity Conflict: Old Threats in a New World. Boulder, Colo.: Westview Press, 1992. (909.828 Low)
Low-Intensity Warfare: Counterinsurgency, Proinsurgency, and Antiterrorism in the Eighties. Ed. Michael T. Klare and Peter Kornbluh. New York: Pantheon Books, 1988. (355.0335 Low)
Luttwak, Edward. Coup D _Etat: A Practical Handbook. Cambridge, Mass.: Harvard University Press, 1979. (321.09 Lut)
Lynch, Gregory R. The Role of Non-Lethal Weapons in _ Special Wars _ . Monterey, Calif.: Naval Postgraduate School, 1995. (355.4 Lyn)
Mallin, Jay. Terror and Urban Guerrillas: A Study of tactics and Documents. Miami, Fla.: University of Miami Press, 1971. (321 Mal)
The men behind the Trident : SEAL Team One in Vietnam. [Annapolis, MD]: Naval Institute Press, 1997. (959.70434 Men)
Managing contemporary conflict : pillars of success. Boulder, Colo.: Westview Press, 1996. (355.03307 Man)
Mao, Tse-tung. Basic Tactics. New York: Praeger, 1966. (355.4 Mao)
---. Mao Tse-tung on Guerrilla Warfare. Baltimore, Md.: The Nautical & Aviation Publishing Company of America, 1992. (355.0218 Mao)
Designed as a guide for the Chinese Communist guerrilla forces in the war against Japan, the original edition was published as a pamphlet in China in 1937. This new edition includes an

introduction that places Mao in his historical context and discusses the unexpected events that have affected the validity of Mao _s theory and practices.
Marquis, Susan L. Unconventional warfare : rebuilding U.S. special operations forces. Washington, D.C. : Brookings Institution, c1997. (356.16 Mar)
McConnell, Malcolm. Just Cause: The Real Story of America _s High-Tech Invasion of Panama. New York: St. Martin _s Press, 1991. (327.73072 McC)
McFadden, Robert D. No Hiding Place: The New York Times Inside Report on the Hostage Crisis. New York: Times Books, 1981. (955.054 McF)
The Iranian hostage crisis, 1979-1981.
McRaven, William H. Spec Ops: Case Studies in Special Operations Warfare: Theory and Practice. Novato, Calif.: Presidio Press, 1995. (356.16 McR)
---. The Theory of Special Operations. Monterey, Calif.: Naval Postgraduate School, 1993. (356.167 McR)
Mercier, Vega Luis. Guerrillas in Latin America: The Technique of the Counter-State. New York: Praeger, 1969. (355.4 Mer)
Meyer, Karl. The Cuban Invasion: The Chronicle of a Disaster. New York: Praeger, 1962. (972.91 Mey)
The Military Balance, 1995-1996. London: The International Institute for Strategic Studies, 1992. (R 355.03 Mil)
The most cited international order-of-battle; includes data on airborne, commando, and other special units of many nations.
Mitchell, Janice L. Special Operations Forces As Humanitarians?--You Bet! Newport, R.I.: Naval War College, 1993. (367.167 Mit)
Mitchell, John M. Roles for Special Operations Forces in the 1990 _s. Carlisle Barracks, Pa.: Army War College, 1993. (356.167 Mit)
Mockler, Anthony. The New Mercenaries. New York: Paragon House, 1987. (355.35 Moc)
The first chapter discusses origins, definitions and the overlap with corps d _elite of modern mercenary forces.
Nadel, Joel. Special men and special missions : inside American special operations forces, 1945 to present. Pennsylvania : Stackpole Books, 1994. (356.167 Nad)
Newton, Richard D. Reinventing the Wheel: Structuring Air Forces for Foreign Internal Defense. Maxwell Air Force Base, Ala.: Air University Press, 1991. (355.0215 New)
Ney, Virgil. Notes On Guerrilla War: Principles and Practices. Washington, D.C.: Command Publications, 1961. (355.4 Ney)
Nicaragua, Unfinsihed Revolution: The New Nicaraqua Reader. Ed. Peter Rosset and John Vandermeer. New York: Grove Press, 1986. (972.85 Nic)
Operation Just Cause: the U.S. intervention in Panama. Ed. Bruce Watson and Peter Tsouras. Boulder, Colo.: Westview Press, 1991. (327.73 Ope)
Orlov, Alexander. Handbook of Intelligence and Guerrilla Warfare. Ann Arbor: University of Michigan Press, 1963. (355.3 Orl)
O _Shaughnessy, Hugh. Grenada: A Eyewitness Account of the U.S. Invasion and the Caribbean History That Provoked It. New York: Dodd, Mead, 1984. (972.984 O _S)
Paret, Peter. Guerrillas in the 1960s. Princeton, N.J.: Center for International Studies, Princeton University Press, 1962. (355.4 Par)
Delineates the strengths and limitations of this type of warfare.
Pike, Douglas Eugene. Viet Con: The Organization and Techniques of the National Liberation Front of South Vietnam. Cambridge, Mass.: MIT Press, 1966. (959.7 Pik)
Pirnie, Bruce. Analysis of Special Operations Forces in Decision Aids: Current Shortfalls. Santa Monica, Calif.: Rand Corporation, 1994. [RAND note N-3536-SOCOM/JS] (355.48 Pir)
Pomeroy, William J. Guerrilla Warfare and Marxism: A Collection of Writings from Karl Marx to the Present on Armed Struggles for Liberation and for Socialism. New York: International Publishers, 1968. (335.438 Pom)
Prados, John. Presidents _ Secret Wars: CIA and Pentagon Covert Operations Since World War II. New York: William Morow, 1986. (327.12 Pra)
A detailed review of U.S. worldwide paramilitary operations/policies, concluding that _ they have contributed little to American national security, _ calling for an end to CIA involvement in the

conduct of covert operations. Includes details on command and control structures and key policy documents.
Pye, Lucian W. Guerrilla Communism in Malaya: Its Social and Political Meaning. Westport, Conn.: Greenwood Press, 1981. (322.42 Pye)
Queen, Richard. Inside and Out: Hostage to Iran, Hostage to Myself. New York: Putnam, 1981. (955.054 Que)
Race, Jeffrey. War Comes to Long An: revolutionary conflict in a Vietnamese Province. Berkeley, Calif.: University of California Press, 1971. (959.70431 Rac)
A detailed account of conflict in a single Vietnamese province captures many of the basic principles of revolutionary war.
Rejai, Mostafa. World Revolutionary Leaders. New Brunswick, N.J.: Rutgers University Press, 1983. (303.64 Rej)
Reske, Charles F. MAC-V-SOG Command history, Annex B, 1971-1972 : the last secret of the Vietnam war. Sharon Center, Ohio : Alpha Publications,1990. (959.70434 Res)
Responding to Low-Intensity Conflict Challenges. Maxwell Air Force Base, Ala.: Air University Press, 1990. (355.0215 Res)
Revolution and Counterrevolution in Central America and the Caribbean. Boulder: Colo.: Westview Press, 1984. (972.9052 Rev)
Revolutionary War: Western Responses. Ed. David S. Sullivan and Martin I. Sattler. New York: Columbia University Press, 1971. (301.63 Rev)
Deals with the nature and dynamics of revolutionary war, its domestic and international repercussions.
Rice, Edward V. Wars of the Third Kind: Conflict in Underdeveloped Countries. Berkeley, Calif.: University of California Press, 1988. (909 Ric)
The Roots of Counterinsurgency: Armies and Guerrilla Warfare, 1900-1945. Ed. Ian Beckett. London: Blandford Press, 1988. (909.82 Roo)
Salinger, Pierre. America Held Hostage: The Secret Negotiations. Garden City, N.Y.: Doubleday, 1981. (327.735 Sal)
The Iranian Hostage Crisis, 1979-1981.
Sandford, Gregory W. The New Jewel Movement: Grenada _s Revolution 1979-1983. Washington, D.C.: Foreign Service Institute, U.S. Dept. of State, 1985. (972.9845 San)
Sarkesian, Sam Charles. America _s Forgotten Wars: The Counterrevolutionary Past and Lessons for the Future. Westport, Conn.: Greenwood Press, 1984. (973 Sar)
---. _ Special Operations, Low-Intensity Conflict (Unconventional Conflicts), and the Clinton Defense Strategy. _ Clinton and Post-Cold War Defense. Ed. Stephen J. Cimbala. Westport, Conn.: Praeger, 1996. 102-121. (355.03307 Cli)
---. The New Battlefield: The United States and Unconventional Conflicts. Westport, Conn.: Greenwood Press, 1986. (355.021 Sar)
One of the most important recent works by a preeminent defense intellectual and Special Forces veteran, laying forth problems and options. Details of the structure of U.S. special units and budgeting.
Schlesinger, Arthur M. A Thousand Days: John F. Kennedy in the White House. Boston: Houghton Mifflin, 1965. (973.922 Sch)
Recollections of the Kennedy administration by a noted historian and advisor, including details on Kennedy _s interest in the doctrine and minutiae of special forces and the problems of _ overmilitarization _ and over-Americanization of the U.S. response in counterinsurgency operations.
Scott, Charles W. Pieces of the Game: The Human Drama of Americans Held Hostage in Iran. Atlanta: Peachtree Publishers, 1984. (955.054 Sco)
Seven Military Classics of Ancient China. Boulder, Colo.: Westview Press, 1993. (355.02 Wu)
Presents the Eastern tradition of strategic thought emphasizing outwitting one _s opponent through speed, stealth, flexibility, and a minimum of force.
Shafer, D. Michael. Deadly Paradigms: The Failure of U.S. Counterinsurgency Policy. Princeton, N.J.: Princeton University Press, 1988. (327.73 Sha)
Rutgers University professor argues American policymakers have consistently and fundamentally misperceived the political context of revolutionary wars directed against American clients

and our strategic policies have failed accordingly.
Shultz, Richard H. The Soviet Union and Revolutionary Warfare: Principles, Practices, and Regional Comparisons. Stanford, Calif.: Hoover Institution Press, 1988. (355 Shu)
Sick, Gary. All Fall Down: America _s Tragic Encounter With Iran. New York: Random House, 1985. (355.054 Sic)
Simpson, Charles. Inside the Green Berets: The First Thirty Years. Novato, Calif.: Presidio Press, 1984. (356.167 Sim)
Skocpol, Theda. States and Social Revolutions: A Comparative Analysis of France, Russia, and China. Cambridge: Cambridge University Press, 1979. (301.6333 Sko)
Smith, Myron J. The Secret Wars, A Guide to Sources in English. 3 vols. Santa Barbara, Calif.: ABC-Clio, 1981. (016.35534 Smi)
Contents: v. 1. Intelligence, propaganda and psychological warfare, resistance movements, secret operations, 1939-1945.--v. 2. Intelligence, propaganda and psychological warfare, covert operations, 1945-1980.--v. 3. International terrorism, 1968-1980.
Sontag, Sherry. Blind Man _ s bluff : the untold story of American submarine espionage. New York : Public Affairs, 1998. (359.984 Son)
Soviet Strategic Deception. Ed. Brian Dailey and Patrick Parker. Stanford, Calif.: Hoover, 1977. (355.0335 Con)
Special Operation Forces: Roles and Missions in the Aftermath of the Cold War. N.p.: U.S. Special Operations Command, 1995. (940.559 Spe)
Steven, David. Third World Coups d _Etat and International Security. Baltimore: Johns Hopkins University Press, 1987. (321.09 Ste)
Strategy for Conquest: Communist Documents on Guerrilla Warfare. Comp. Jay Mallin. Coral Gables, Fla.: University of Miami Press, 1970. (355.4 Mal)
Selections from the writings of Mao Tse-tung, Vo Nguyen Giap, Hoang Van Thoi, _ Che _ Guevara, Raul Castro, Alberto Bayo, Lin Piao.
Sturgill, Claude C. Low-Intensity Conflict in American History. Westport, Conn.: Praeger, 1993. (355.03307 Stu)
Sully, Francois. Age of the Guerrilla: The New Warfare. New York: Parent _s Magazine Press, 1968. (355.425 Sul)
Sun, Pin. Sun Pin Military Methods. Boulder, Colo.: Westview Press, 1995. (355.02 Sun)
Taber, Robert. The War of the Flea: A Study of Guerrilla Warfare Theory and Practice. New York: Lyle Stuart, 1965. (355.4 Tab)
Tanham, George K. Communist Revolutionary Warfare: From the Vietminh to the Viet Cong. Rev. ed. New York: Praeger, 1967. (959.7 Tan)
Taw, Jennifer Morrison. Operations Other Than War: Implications for the U.S. Army. Santa Monica, Calif.: Rand Corporation, 1995. [RAND memorandum MR-566-A] (355.34 Taw)
Thigpen, Jerry L. AFSOC: The Air Force _s Newest Command. Carlisle Barracks, Pa.: U.S. Army War College, 1991. (356.167 Thi)
Thompson, Leroy. Ragged war: the story of unconventional and counter-revolutionary warfare. London : Arms and Armour Press, 1996. (355.02 Tho)
Tomhave, Steven F. The Impact of Congressional Legislation on United States Special Operations Capability. Carlisle Barracks, Pa.: Army War College, 1989. (356.167 Tom)
Trest, Warren. Wings of denial the Alabama Air National Guard _s covert role at the Bay of Pigs. Montgormery, AL : NewSouth Books, 2001. (972 Tre)
Treverton, Gregory. Covert Action: The Limits of Intervention in the Postwar World. New York: Basic Books, 1987. (355.0218 Tre)
U.S. National Security Policy and Strategy : documents and policy proposals. Ed. Sam Sarkesian with Robert Vitos. New York: Greenwood Press, 1988. (355.0335 U.S)
Contains documents pertaining to Special Operations activities.
Uncomfortable Wars: Toward a New Paradigm of Low Intensity Conflict. Ed. Max G. Mainwaring. Boulder, Colo.: Westview Press, 1991. (355.0218 Unc)
United States. Air Force. Special Operations Command. CSAR: A Special Operations Mission, White Paper. Hurlburt Field, Fla.: HQ AFSOC, April 1994. (356.167 Uni)
Combat search and rescue (CSAR).
---. Joint Special Operations Aviation Component Commander, White Paper. Hurlburt Field,

Fla.: HQ AFSOC, November 1993. (356.167 Uni)
---. National SOF Command and Training Center, White Paper. Hurlburt Field, Fla.: HQ AFSOC, October 1993. (356.167 Uni)
---. The Role of SOF in the Air Campaign, White Paper. Hurlburt Field, Fla.: HQ AFSOC, December 1993. (356.167 Uni)
United States. Defense Intelligence Agency. Terrorist Group Profiles. Washington, D.C.: U.S. Government Printing Office, 1988. (R 364.1 U.S)
Detailed information about key terrorist groups--membership strength, leaders, ideological orientation, targets, background and selected incident chronology.
Van Creveld, Martin. The Transformation of War. New York: Free Press, 1991. (355.0209 Van)
Vega, Luis. Guerrillas in Latin America: The Techniques of the Counter State. New York: Praeger, 1969. (355.4 Mar)
Vo-Nguyen Giap. People _s War, People _s Army: The Viet Cong Insurrection Manual for Underdeveloped Countries. New York: Praeger, 1962. (355.4 Vo)
Lays out Giap _s strategy for defeating _ imperialist occupation forces. _
War in Peace: Conventional and Guerrilla Warfare Since 1945. Ed. Sir Robert Thompson. New York: Harmony Books, 1982. (355.00904 War)
Watman, Kenneth. Airpower in U.S. Light Combat Operations. Santa Monica, Cailf.: Rand, 1994. (355.40973 Wat)
Wetterhahan, Ralph. The last battle : the Mayaguez incident and the end of the Vietnam war. New York : Carroll & Craf publishers, 2001. (959.704 W MCN)
White, Terry. Swords of Lighting: Special Forces and the Changing Face of Warfare. New York: Macmillan, 1992. (356.16 Whi)
Winning the Peace: The Strategic Implications of Military Civic Action. New York: Praeger, 1992. (355.34 Win)
Winters, Edward G., and Kent A. Paro. The Misuse of Special Operations Forces. Monterey, Calif.: Naval Postgraduate School December, 1994. (356.167 Win)
Through the use of four case studies illustrative of four types of error, this thesis demonstrates a systematic method of considering the proper employment of SOF.
Women, War, and Revolution. Ed. Carol R. Berkin and Clara M. Lovett. New York: Holm & Meier, 1980. (301.412 Wom)
Young, Darryl. The element of surprise : Navy SEALS in Vietnam. New York : Ivy Books, 1990. (959.70434 You)

## II. ELITE UNITS AND RAIDS

Adams, James. Secret Armies: Inside the Soviet, American and European Special Forces. New York: Atlantic Monthly, 1988. (356.167 Ada)
Ballard, Jack S. The Development and Employment of Fixed-Wing Gunships, 1962-1972. Washington, D.C.: Office of Air Force History, USAF, 1982. (959.704 Bal)
Beckwith, Charles A., and Donald Knox. Delta Force. San Diego, Calif.: Harcourt Brace Jovanovich, 1983. (955.054 Bec)
Col. Beckwith _s account of his struggles to create a special force along the lines of the British SAS.
Bergeron, Randy G. Air Force Special Operations Command in Operations Desert Shield and Desert Storm. Hurlburt Field, Fla.: HQ AFSOC, Historian _s Office, [n.d.]. (956.70442 Ber)
Bermudez, Joseph S. North Korean special forces. Annapolis, Md. : Naval Institute Press, 1998. (356.167 Ber)
Biggs, Bradley. The Triple Nickles : America _s first all black paratroop unit. Hamden, Conn.: Archon Books, 1986. (940.541 Big)
A brief account of the all-black airborne regiment raised in the U.S. Army WW II.
Bosiljevac, T. L. SEALs : UDT/SEAL operations in Vietnam. Boulder, Colo. : Paladin Press, 1990. (959.70433 Bos)
Boyatt, Mark D. Unconventional Operations Forces of Special Operations. Carlisle Barracks, Pa.: Army War College, 1993. (356.167 Boy)
Carew, Tom. Jihad! : the SAS secret war in Afghanistan. Edinburgh : Mainstream, 2000. (958.104 Car)
Carmody, Russell D. Theater Combat Search and Rescue. Ft. Leavenworth, Kan.: U.S. Army

Command and General Staff College, 1993. (356.16 Car)
Carroll, Douglas E. Special Forces Doctrine and Arms Operations Doctrine. Ft. Leavenworth, Kan.: U.S. Army Command and General Staff College, 1993. (356.167 Car)
Casper, Lawrence E. Falcon brigade: combat and command in Somalia and Haiti. Boulder, Colorado : Lynne Rienner Publishers, Inc., 2001. (967.7305 Cas)
Chinnery, Philip D. Any Time, Any Place: Fifty Years of the USAF Air Commando and Special Operations Forces, 1944-1994. Annapolis, Md.: Naval Institute Press, 1994. (356.167 Chi)
Churchill, Jan. Hit my smoke : forward Air controllers in Southeast Asia. Sunflower University Press, 1997. (358.42 Chu)
Churchill, Winston S. Their Finest Hour. Boston: Houghton Mifflin, 1949. (940.53 Chu)
Collins, J.M. Green Berets, SEALs and Spetsnaz. London: Pergamon, 1987. (356.167 Col)
A comparative study of American and Soviet special operations forces aimed at improving U.S. capacity. By the Congressional Research Service for the House Armed Services Committee.
---. Special Operations Forces: An Assessment, 1986-1993. Washington, D.C.: Library of Congress, Congressional Research Service, July 30, 1993. (356.167 Col)
Discusses operational readiness of U.S. special forces.
-----United States. Congress. Subcommittee on Armed Services. United States and Soviet Special Operations: A Study by the Congressional Research Service, Library of Congress. Washington, D.C.: GPO, 1987. (355.0218 Col)
Combat and survival : what it takes to fight and win. Westport, CT : Stuttman, c1991. (355.02 Com)
Constance, Harry. Good to go : the life and times of a decorated member of the U.S. Navy _s elite SEAL Team Two. New York : Morrow, c1997. (359.9 Con)
Craig, William T. Team sergeant : a special forces NCO at Lang Vei and beyond. New York : Ivy Books, 1998. (355.0092 Cra)
Craven, Wesley Frank, and James Lea Cate. The Army Air Forces in World War II. (940.544 Arm)
Material on combat air crew selection, training and operations in various elite forces and special operations.
Curtis, Thiery G. Special Operations Joint Training. Maxwell Air Force Base, Ala.: Air University Press, January 1993. (356.167 Cur)
Dank, Milton. The Glider Gang : an eyewitness history of World War II glider combat. New York: J.B. Lippincott, 1977. (940.54 Dan)
A brief history of American glider operations in WW II.
DeLong, Kent. Mogadishu!: Heroism and Tragedy. Wesport, Conn.: Praeger, 1994. (967.7305 DeL)
U.S. Army Rangers _ unsuccessful attempt to capture Somali warlord Mohammed Farrah Aidid, 3 Oct. 1993.
Devlin, Gerard M. Paratrooper: The Saga of U.S. Army and Marine Parachute and Glider Combat Troops During World War II. New York: St. Martin _s Press, 1979. (356.166 Dev)
---. Silent Wings: The Saga of the U.S. Army and Marine Corps Combat Glider Pilots During World War II. New York: St. Martin _s Press, 1985. (940.544 Dev)
Dobson, Christopher, and Ronald Payne. Counterattack: The West _s Battle Against the Terrorists. New York: Facts On File, 1982. (363.32 Dob)
Detailed descriptions of antiterrorist organizations.
Dockery, Kevin. SEALS in action. New York : Avon Books, 1991. (359.00973 Doc)
Donahue, James C. Mobile Guerrilla Force: With the Special Forces In War Zone D. Annapolis, Md.: Naval Institute Press, 1996. (959.70434 Don)
Dwyer, John B. Scouts and Raiders: The Navy _s First Special Warfare Commandos. Westport, Conn.: Praeger, 1993. (359.9 Dwy)
The Elite : Special Forces of the World. New York : Marshall Cavendish, 1987. (356.167 Eli)
Emerson, Steven. Secret Warriors: Inside the Covert Military Operations of the Reagan Era. New York: G.P. Putnam _s, 1986. (356.16 Eme)
A survey of special units and activities that burgeoned in the aftermath of the failure of the Iran hostage rescue raid in 1980 on through the covert operations renaissance of the Reagan era.
Eshel, David. Elite Fighting Units. New York: Arco Publishing, 1984. (355.35 Esh)

A well-illustrated, selective survey of elite forces and special operations since WW II, with emphasis on Great Britain, the U.S. and Israel.
---. The U.S. Rapid Deployment Forces. New York: Arco Publishing, 1985. (355.35 Esh)
Fane, Francis Douglas. The Naked Warriors: The Story of the U.S. Navy _sFrogmen. Annapolis, Md.: Naval Institute Press, 1995. (940.5451 Fan)
Farwell, Byron. The Gurkhas. New York: Norton, 1984. (356.1 Far)
Fitzgerald, Frances. Fire in the Lake : the Vietnamese & the Americans in Vietnam. Boston: Little, Brown, 1972. (320.95 Fit)
Includes a critique of U.S. Special Forces and Provincial reconnaissance units _ terror tactics.
Follet, Ken. On Wings of Eagles. New York: Morrow, 1993. (955.054 Fol)
Perot-financed rescue of two Americans from Iran.
From Troy to Entebbe : special operations in ancient and modern times. Lanham, Md. : University Press of America, 1996. (355.4 Fro)
Gallagher, Thomas. Assault In Norway: Sabotaging the Nazi Nuclear Bomb. New York: Harcourt Brace Jovanovich, 1975. (940.548 Gal)
An account of a raid on the Vermork plant in October 1942 by Norwegians trained by SOE.
Gleason, Robert L. Air Commando chronicles untold tales from Vietnam, Latin America, and back again. Manhattan, Kansas : Sunflower University, 2000. (358.4 Gle)
Glines, Carroll V. The Doolittle Raid: America _s Daring First Strike Against Japan. New York: Orion Books, 1988. (940.5425 Gli)
---. Doolittle _s Tokyo Raiders. New York: Van Nostrand, 1964. (940.54 Gli)
Gudmundsson, Bruce I. Stormtroop Tactics: Innovations In the German Army, 1914-1918. New York: Praeger, 1989. (940.41343 Gud)
Includes chapters on _ Special Assault Units _ and _ Mountain Warfare. _
Haas, Michael E. Air Commando! 1950-1975: Twenty-Five Years At the Tip of the Spear. Hurlburt Field, Fla.: HQ Air Force Special Operations Command, 1994. (356.167 Haa)
Hagedorn, Dan. Foreign Invaders: The Douglas Invader in Foreign Military and U.S. Clandestine Service. Leicester: Midland Publishing, 1994. (623.746042 Hag)
Halberstadt, Hans. Green Berets: Unconventional Warriors. Novato, Calif.: Presidio Press, 1988. (356.167 Hal)
Hall, George. Eglin: Fighters, Bombers, Special Ops. London: Osprey Publishing, 1990. (358.417 Hal)
Hamilton-Merritt, Jane. Tragic Mountains: The Hmong, the Americans, and the Secret Wars for Laos, 1942-1992. Bloomington: Indiana University Press, 1993. (959.70049 Ham)
Hardesty, Von. Red Phoenix: The Rise of Soviet Air Power. Washington, D.C.: Smithsonian Press, 1982. (940.544 Har)
A study of the Soviet air forces in WW II, including training, aces, etc.
Harrison, Derrick I. These Men Are Dangerous: The Special Air Service At War. London: Cassell, 1957. (940.548 Her)
Haugland, Vern. The Eagle _s War: The Saga of the Eagle Squadron Pilots, 1940-1945. New York: James Aronson, 1982. (940.544 Hau)
Heilbrunn, Otto. Warfare In the Enemy _s Rear. New York: Praeger, 1963. (355.4 Hei)
A survey history of special operations in WW II and in the Cold War.
Hickey, Michael. Out of the Sky: A History of Airborne Warfare. London: Mills and Brown, 1979. (358.4 Hic)
Hill, John A. Air Force Special Operations Forces: A Unique Application of Aero-space Power. Maxwell Air Force Base, Ala.: Air University Press, April 1993. (356.167 Hil)
Horner, David. SAS : phantoms of the jungle: a history of the Australian Special Air Service. Nashville, TN : The Battery Press, 1989. (355.3099 Hor)
Hoyt, Edwin P. Airborne: The History of American Parachute Forces. New York: Stein and Day, 1979. (356.166 Hoy)
---. The Kamikazes. New York: Arbor House, 1983. (940.544 Hoy)
A popular history of the special attack corps.
---. SEALs At War: The Story of U.S. Navy Special Warfare From the Frogmen To the SEALs. New York: Dell, 1993. (359.9 Hoy)
Inside Spetsnaz: Soviet Special Operations: A Critical Analysis. Ed. William Burgess. Novato,

Calif.: Presidio Press, 1990. (355.35 Ins)
Hutchins, Joel. Swimmers among the trees : SEALs in the Vietnam War. Novato, CA : Presidio, 1996. (959.70434 Hut)
Jackson, Robert. The Secret Squadrons, Special Duty Units of the RAF and USAAF In the Second World War. London: Robson Books, 1983. (940.54 Jac)
Jolly, Randy. Air Commandos: The Quiet Professionals: Air Force Special Operations Command. Garland, Tex.: Aero Graphics, 1994. (356.167 Jol)
_ A pictorial salute to the men and women of AFSOC. _
Katz, Samuel M. The night raiders : Israel _s naval commandos at war. New York : Pocket books, 1997. (356.186 Kat)
Keegan, John and Richard Homes. _ Irregulars. _ Soldiers: A History of Men In Battle. New York: Viking, 1986: 241-258. (355.009 Kee)
Kelly, Francis. U.S. Army Special Forces 1961-1971. Washington, D.C.: Dept. of the Army, 1973. (959.70434 Kel)
Kelly, Orr. Brave Men, Dark Waters: The Untold Story of the Navy SEALs. Novato, Calif.: Presidio Press, 1992. (359.9 Kel)
---. From a Dark Sky: The Story of U.S. Air Force Special Operations. Novato, Calif.: Presidio Press, 1996. (358.414 Kel)
---. Never Fight Fair!: Navy SEALs _ Stories of Combat and Adventure. Novato, Calif.: Presidio Press, 1995. (359.9 Kel)
Kernan, William F. The Holloway Report: Did It Reflect the Facts and Lessons Learned? Carlisle Barracks, Pa.: Army War College, 21 March 1987. (955.054 Ker)
A student assessment of the official Iranian hostage rescue mission report.
Kershaw, Michael M. The Integration of Special Operations and General Purpose Forces. Monterey Calif.: Naval Postgraduate School, 1994. (355.41 Ker)
Kissling, Herbert. An Air Commando and Special Operations Chronology, 1961-1991. Hurlburt Field, Fla.: 1st Special Operations Wing, 1991. (356.167 Kis)
Knight, David C. Shock Troops: The History of Elite and Special Forces. Greenwich, Conn.: Bison, 1983. (358.167 Kni)
A large-format, heavily illustrated wide-ranging survey, popular in style.
Koster, Michael G. Foreign Internal Defense: Does Air Force Special Operations Have What It Takes? Maxwell Air Force Base, Ala.: Air University Press, December 1993. (355.0215 Kos)
AFSOC ARI Command-Sponsored Research Fellow addresses AFSOC aviation support to developing countries _ defenses.
Krulak, Victor H. First to Fight: An Inside View of the U.S. Marine Corps. Annapolis, Md.: U.S. Naval Institute, 1984. (359.96 Kru)
Kupperman, Robert H., and Darrell M. Trent. Terrorism: Threat, Reality, Response. Stanford, Calif.: Hoover Institution Press, 1979. (364.131 Kup)
Extensive interthreading of corps d _elite and special operations with the complexities of terrorism, both cause and response.
Ladd, J.D. Commandos and Rangers of World War II. New York: St. Martin _s Press, 1978. (940.54 Lad)
Ladd, James. Inside the Commandos: A Pictorial History From World War Two to the Present. London: Arms and Armour, 1984. (355.4220941 Lad)
Landau, Alan M. Airborne Rangers. Osceola, Wis.: Motorbooks International, 1992. (356.167 Lan)
Lanning, Michael Lee. Inside the crosshairs : snipers in Vietnam. New York : Ivy Books, 1998. (959.704 Lan)
Leasor, James. Green Beach. New York: Morrow, 1975. (940.542 Lea)
Commando attack on Dieppe.
Lee, Alex. Force Recon Command: A Special Marine Unit in Vietnam, 1969-1970. Annapolis, Md.: Naval Institute Press, 1995. (959.70434 Lee)
Lloyd, Mark. Modern Combat Uniforms: A Survey of Military Personnel. Carrollton, Tex.: Squadron/Signal Publications, 1988. (R 390.4355 Llo)
Includes Special Forces.

---. Special Forces: The Changing Face of Warfare. London: Arms and Armour, 1995. (356.16 Llo)
Locher, James R., and Carl W. Stiner. United States Special Operations Forces: Posture Statement 2000. (356.16 Uni)
Lucas, James. Kommando: German Special Forces of World War II. New York: St. Martin _s Press, 1985. (940.542 Luc)
Lutwak (sic), Edward. A Systematic Review of _ Commando _ Special Operations, 1939-1980. Potomac, Md.: C & L Associates, 1982. (355.343 Lut)
Marcinko, Richard. Rogue Warrior, the real team. New York : Pocket Books, 1999. (359.909 Mar)
Marshall, S.L.A. Ambush. New York: Cowles, 1969. (959.7 Mar)
A compendium of unit actions in Vietnam, including a chapter of Special Forces _ Operation Blackjack 22.
McLean, Brian W. Joint Training for Night Air Warfare. Maxwell Air Force Base, Ala.: Air University Press, October 1992. (358.4142 McL)
Mesko, Jim. U.S. Infantry--Vietnam. Carrollton, Tex.: Squadron/Signal, 1983. (959.704 Mes)
Also included is U.S. Elite Forces--Vietnam by Leron Thompson.
Miles, Milton, and Daniel Hawthorne. A Different Kind of War: The Little Known Story of the Combined Guerrilla Forces Created in China by the U.S. Navy and the Chinese in World War II. Garden City, N.Y.: Doubleday, 1967. (940.5486 Mil)
An account by a principal of the Sino-American cooperation force--SACO, N.Y.
Millar, George. The Bruneval Raid: Flashpoint of the Radar War. London: Bodley Head, 1974. (940.54 Mil)
An account of a dramatic WW II raid on a secret German radar station in occupied France-a combined Allied effort of British paratroopers, the RAF commandos, and the French underground.
Miller, David. The new illustrated guide to weapons of the Elite Forces. New York: Smithmark Publishing, 1992. (623.44 Mil)
Momyer, William W. The Vietnamese Air Force, 1951-1975: An Analysis of Its Role in Combat, and, Fourteen Hours At Koh Tang. Washington, D.C.: U.S. Air Force, Office of A.F. History, 1986. (959.704 Mom)
Mayaguez Crisis, May 1975.
Murray, Raymond. The SAS in Ireland. Dublin, Ireland: Mercier Press, 1991. (941.60824 Mur)
Traces the history of the British Army Special Air Services Regiment in Ireland over the past twenty years.
Nadel, Joel. Special Men and Special Missions: Inside American Special Operations Forces, 1945 to the Present. London: Greenhill Books, 1994. (356.167 Nad)
Ogburn, Charles. The Marauders. New York: Harper, 1956. (940.54 Ogb)
A history of Merrill _s Marauders by a participant.
Olson, James S. Dictionary of the Vietnam War. Westport, Conn.: Greenwood, 1988. (R 959.7043 Dic)
O _Shaughnessy, Hugh. Grenada: Air Eyewitness Account of the U.S. Invasion and the Caribbean History That Provoked It. New York: Dodd, Mead, 1984. (972.984 O _S)
Palmer, Bruce J. The 25-Year War: America _s Military Role in Vietnam. New York: Simon and Schuster, 1984. (959.704 Pal)
Extensive references to U.S. and Vietnamese elite forces and special operations.
Patterson, Charles J., and G. Lee Tippin. The Heroes Who Fell From Grace: The True Story of Operation Lazarus, the Attempt to Free American POWs From Laos in 1982. Canton, Ohio: Daring Books, 1985. (959.704 Pat)
Payne, Anthony. Grenada: Revolution and Invasion. New York: St Martin _s Press, 1984. (972.984 Pay)
Philip, Craig. Inside the SAS. London: Bloomsbury, 1992. (356.167 Phi)
Phillips, William R. Night of the silver stars : the battle of Lang Vei. Annapolis, Md. : Naval Institute Press, 1997. (959.70434 Phi)
Pigeon, Robert L. et al. The Soldier of Fortune: the book of professional adventurers. New

York: Exeter Books, 1986. (355.0092 Sol)
A collection of articles from Soldier of Fortune magazine, including a section on _ Elite Men and Elite Units. _
Ravenstein, Charles A. Air Force Combat Wing: Lineage and Honors, Histories, 1947-1977. Washington, D.C.: U.S. Air Force, Office of A.F. History, 1984. (358.4 Rav) also in Reference
Includes data on special operations units dating from the Air Commandos of WW II.
Reynolds, David. Paras : an illustrated history of Britain _s airborne forces. Stroud : Sutton, 1998. (356.167 Rey)
Reynolds, Quenton. The Amazing Mr. Doolittle. New York: Appleton-Century-Crofts, 1953. (92 Doo)
Contains material on the Tokyo Raid of 1942.
Ronfeldt, David F. The Mitrione Kidnapping in Uruguay. Santa Monica, Calif.: Rand Corporation, 1987. [RAND note N-1571-DOS/DARPA/RC] (989.5065 Ron)
Rosholt, Malcolm. Days of the Ching Pao: A Photographic Record of the Flying Tigers--14th Air Force in China in World War II. N.p.: [?], 1978. (940.5449 Ros)
Rottman, Gordon L. U.S. Army Special Forces, 1952-84. London: Osprey, 1989. (356.167 Rot)
Rowan, Roy. The Four Days of Mayaguez. New York: Norton, 1975. (359.32 Row) Mayaquaz Incident, 1975.
Ryan, Paul B. The Iranian Rescue Mission: Why It Failed. Annapolis, Md.: U.S. Naval Institute, 1985. (955.054 Rya)
A post-mortem of Operation Eagle Claw.
Schemmer, Benjamin. The Raid. New York: Harper and Row, 1976. (959.704 Sch)
An account of the attempt of U.S. special forces elements under Col. _ Bull _ Simon to free U.S. prisoners of war at Son Tay, N. Vietnam, November 21, 1970.
Schofield, Carey. The Russian Elite: Inside Spetsnaz and the Airborne Forces. London: Greenhill Books, 1993. (356.167 Sch)
Simpson, Charles. Inside the Green Berets: The First Thirty Years. Novato, Calif.: Presidio Press, 1984. (356.167 Sim)
Smith, R. Harris. O.S.S.: The Secret History of America _s First Central Intelligence Agency. Berkeley: University of California Press, 1981. (940.54 Smi)
Special Forces Operational Techniques. Washington, D.C.: HQ Department of the Army, 1988. (356.167 Spe)
Stranton, Shelby L. Rangers At War: Combat Recon in Vietnam. New York: Crown, 1992. (959.70434 Sta)
U.S. Army Rangers of the Long Range Reconnaissance Patrols (the _ Lerps _ ) were selected for extremely dangerous scouting and raiding missions.
---. Green Berets At War: U.S. Army Special Forces in Southeast Asia, 1956-1975. London: Arms and Armour Press, 1986. (356.167 Sta)
A detailed account.
Stevenson, William. Zanek! A Chronicle of the Israeli Air Force. New York: Viking, 1971. (358.4 Ste)
A popular view of the Israeli air force, the central corps d _elite in the Israeli defense force.
Strekhnin, Yuriy. Commandos From the Sea: Soviet Naval Spetsnaz in World War II. Annapolis, Md.: Naval Institute Press, 1996. (940.54594 Str)
Summers, Harry G. Vietnam War Almanac. New York: Facts On File, 1985. (R 959.704 Sum)
Extensive details on special forces and operations.
Thompson, Leroy. The Rescuers: The World _s Top Antiterrorist Units. Boulder, Colo.: Paladin Press, 1986. (356.167 Tho)
An overview of antiterrorist operations, units, and equipment, with an evaluation of preeminent corps d _elite, an appraisal of weapons and technical equipment, and lists of units and terrorist groups.
---. SAS: Great Britain _s Elite Special Air Service. Oscela, Wis.: Motorbooks International, 1994. (356.167 Tho)
---. Uniforms of the Soldiers of Fortune. London: Blandford Press, 1985. (355.35 Tho)
---. US Special Forces, 1941-1987. London: Blandford Press, 1987. (356.167 Tho)

True Stories of the Elite Forces. New York: Carroll S. Graf Publishers, 1995. (356.167 Tru)
Firsthand accounts of some of the successes of elite units.
The United States Air Force in Southeast Asia, 1961-1973: An Illustrated Account. Ed. Carl Berger. Washington, D.C.: U.S. Air Force, Office of A.F. History, 1984. (959.704 Uni)
Extensive references to special operations, including training and tactics.
United States. Department of Defense. Rescue Mission Report. Washington, D.C.: The Department, August 23, 1980. (955.054 Uni)
The unclassified version of the Iranian hostage rescue mission report, also referred to as the Holloway Report.
United States Special Operations Command history. MacDill AFB, FL : USSOCOM History and Research Office, 1998. (356.16 Uni)
United States Special Operations Command 10th Anniversary history. MacDill AFB, FL : U.S. Special Operations Command, 1997. (356.16 Uni)
Van Wagner, R. D. Any place, any time, any where : the 1st Air Commandos in WWII. Atglen, PA : Schiffer Pub., 1998. (940.54497 Van)
Vandenbroucke, Lucien S. Perilous Options: Special Operations as an Instrument of U.S. Foreign Policy. New York: Oxford University Press, 1993. (973.92 Van)
The author examines the use and misuse of special ops through an in-depth analysis of four operations--the Bay of Pigs operation, the Son Tay raid to rescue POW _s in North Vietnam, the Mayaquez operation, and the Iran hostage rescue missions
Veith, George J. Code-name Bright Light : the untold story of U.S. POW rescue efforts during the Vietnam war. New York : Free Press, 1998. (959.70437 Vei)
Wade, Leigh. Tan Phu, Special Forces Team A-23 in combat. New York : Ivy Books, 1997. (959.704 Wad)
Waller, Douglas C. The Commandos: The Inside Story of America _s Secret Soldiers. New York: Simon & Schuster, 1994. (356.167 Wal)
A popularized overview by a Newsweek journalist.
Walmer, Max. An Illustrated Guide to Modern Elite Forces. New York: Arco Publishing, 1984. (356.16 Wal)
An unreferenced handbook of 30 corps d _elite of all continents except Antarctica and South America.
---. An Illustrated Guide to Weapons of the Special Forces: Full-Color Directory of the Guns and Missiles Used By the World _s Elite Forces. New York: Prentice Hall, 1989. (623.44 Wal)
Walsh, Michael J. SEAL! : from Vietnam _s PHOENIX program to Central America _s drug wars : twenty-six years with a special operations warrior. New York :Pocket Books, 1994. (359.9 Wal)
Whitcomb, Darrel D. The rescue of Bat 21. Annapolis, Md. : Naval Institute Press, 1998. (959.704 Whi)
Whitehead, William. Echoes of Disaster: Dieppe, 1942. New York: St. Martin _s Press, 1980. (940.542 Whi)
Account of the controversial, large-scale raid/reconnaissance force in August 1942 against the strongest Nazi fortifications on the continent.
Whitlow, Robert H. U.S. Marines in Vietnam: The Advisory & Combat Assistance Era, 1954-1964. Washington, D.C.: History and Museums Division, Headquarters, U.S. Marine Corps, 1977. (959.704 Whi)
Young, Darryl. SEALs, UDT, frogmen : men under pressure. New York : Ivy Books, 1994. (359.9 You)

## III. SPECIAL OPERATIONS IN CONVENTIONAL WAR

Adkin, Mark. Urgent Fury: The Battle for Grenada. Lexington, Mass.: D.C. Heath, 1989. (972.9845 Adk)
Adleman, Robert H. The Champagne Campaign. Boston: Little, Brown, 1969. (940.54 Adl)
A survey of Operation ANVIL-DRAGON, the invasion of southern France in August 1944, including commando, airborne, and 1st U.S. - Canadian Special Service Force involvement.
Armstrong, John Alexander. Soviet Partisans in World War II. Madison: University of Wisconsin Press, 1964. (940.54 Arm)
Arthur, Anthony. Bushmaster: America _ s Jungle Warriors of World War II. New York: St.

Martin _s Press, 1987. (940.5412 Art)
Bank, Aaron. From O.S.S. to Green Berets. Novato, Calif.: Presidio Press, 1986. (356.167 Ban)
A memoir of a senior U.S. Army Special Forces officer from WW II through Vietnam.
Baron, Richard W., et al. Raid! The Untold Story of Patton _s Secret Mission. New York: G.P. Putnam _s, 1981. (940.54 Bar)
Based on interviews of veterans of the Hammelburg raid, a special operation assigned to a standard force.
Bidwell, Shelford. The Chindit War: Stillwell, Wingate, and the Campaign in Burma, 1944. New York: Macmillan, 1979. (940.542 Bid)
Readable and personal account of events in Burma, political and military.
Bowden, Mark. Black Hawk down : a story of modern war. New York : Atlantic Monthly Press, 1999. (967.73 Bow)
Cohen, Stan. Destination, Tokyo: A Pictorial History of Doolittle _s Tokyo Raid, April 18, 1942. Missoula, Mont.: Pictorial Histories Publishing Co., 1983. (940.5425 Coh)
Cook, Graeme. Commandos in Action. New York: Taplinger Publishing Co., 1973. (940.5421 Coo)
Cruickshank, Charles G. Deception in World War II. Oxford: Oxford University Press, 1979. (940.541 Cru)
A study of the _ London Control Section _ which oversaw deception efforts covering major invasions of Western Europe.
Davis, Larry. Gunships: A Pictorial History of Spooky. Carrollton, Tex.: Squadron/ Signal Publications, 1982. (R 358.43 Dav)
Derry, Sam. The Rome Escape Line: The Story of the British Organization in Rome for Assisting Escaped Prisoners-of-War, 1943-44. New York: Norton, 1960. (940.54 Der)
Dunlop, Richard. Behind Japanese Lines With the O.S.S. in Burma. Chicago: Rand McNally, 1979. (940.53 Dun)
Dwyer, John B. Commandos from the sea : the history of amphibious special warfare in World War II and the Korean War. Boulder, Colol : Paladin Press, 1998. (940.54597 Dwy)
Ellington, Sidney T. Special Operations in Littoral Warfare. Monterey, Calif.: Naval Postgraduate School, 1995. (359.423 Ell)
Eshel, David. Daring to Win: Special Forces At War. London: Arms and Armour, 1992. (973.92 Esh)
Eudes, Dominique. The Kapetanios: Partisans and Civil War in Greece, 1943-1949. New York: Monthly Review Press, 1973. (940.53495 Eud)
Evanhoe, Ed. Darkmoon: Eighth Army Special Operations in the Korean War. Annapolis, Md.: Naval Institute Press, 1995. (951.9042 Eva)
Fondacaro, Steve A. A Strategic Analysis of U.S. Special Operations During the Korean Conflict, 1950-1953. Fort Leavenworth, Kan.: U.S. Army Command and General Staff College, 1988. (951.9092 Fon)
Foot, Michael Richard D. SOE in France: An Account of the Work of the British Special Operations Executive in France, 1940-1944. Frederick, Md.: University Publications of America, 1984. (940.5486 Foo)
Ford, Kirk. OSS and the Yugoslav Resistance, 1943-1945. College Station: Texas A&M University Press, 1992. (940.53497 For)
Haas, Michael E. Apollo _s warriors : US Air Force special operations during the Cold War. Maxwell Air Force Base, AL : Air University Press, 1997. (358.4 Haa)
---. In the devil _s shadow: UN special operations during the Korean War. Annapolis, Md: Naval Institute Press, 2000. (951.90424 Haa)
Harkins, Philip. Blackburn _s Headhunters. New York: W.W. Norton, 1955. (940.54 Har)
At the fall of Bataan, Lt. Donald Blackburn escaped from the Japanese and organized a highly successful guerrilla army of Filipinos and Americans.
Heimark, Bruce H. The OSS Norwegian Special Operations Group in World War II. Westport, Conn.: Praeger, 1994. (940.54867 Hei)
Hogan, David W. U.S. Army Special Operations in World War II. Washington, D.C.: Center for Military History, Department of the Army, 1992. (940.5427 Hog)
Howe, Ellic. The Black Game: British Subversive Operations Against the Germans During the

Second World War. London: M. Joseph, 1982. (940.5488 How)
Hunt, Ray C. Behind Japanese Lines: An American Guerrilla in the Philippines. Lexington, Ky.: University Press of Kentucky, 1986. (940.548 Hun)
Jackson, Robert. The Secret Squadrons: Special Duty Units of the RAF and USAF in the Second World War. London: Robson Books, 1983. (940.54 Jac)
Jones, Reginald Victor. The Wizard War: British Scientific Intelligence, 1939-1945. New York: Coward, 1978. (940.54 Jon)
A participant scientist _s account of the development of various electronic warfare systems in WW II with detailed perspectives on links between technical intelligence and special operations, e.g. the Bruneval raid.
Kinzey, Bert. The Fury of Desert Storm: The Air Campaign. Blue Ridge Summit, Pa.: TAB Books, 1991. (358.4183 Kin)
Ladd, James D. Clandestine Warfare: Weapons and Equipment of the SOE and OSS. New York: Blandford Press, 1988. (940.5486 Lad)
---. Commandos and Rangers of World War II. New York: St. Martin _s Press, 1978. (940.54 Lad)
Leary, William. Perilous Missions: Civil Air Transport and CIA Covert Operationsin Asia. Huntsville: University of Alabama Press, 1984. (358.46 Lea)
Lewis, S.J. Jedburgh Team Operations in Support of the 12th Army Group, August1944. Fort Leavenworth, Kan.: Combat Studies Institute, U.S. Army Command and General Staff College, 1991. (940.5421 Lew)
Lindsay, Franklin. Beacons in the Night: With the OSS and Tito _s Partisans in Wartime Yugoslavia. Stanford, Calif.: Stanford University Press, 1993. (940.54 Lin)
Lloyd Owen, David L. Providence Their Guide: A Personal Account of the Long Range Desert Group, 1940-45. Nashville, Tenn.: Battery Press, 1981. (940.5412 Llo)
Lorain, Pierre. Clandestine Operations: the Arms and Techniques of the Resistance, 1941-1944. New York: Macmillan, 1983. (940.5486 Lor)
Macksey, Kenneth. The Partisans of Europe in the Second World War. New York: Stein and Day, 1975. (940.534 Mac)
Malcom, Ben S. White Tigers: My Secret War in North Korea. Washington, D.C.: Brassey _s, 1995. (951.9042 Mal)
Mason, Herbert A. Operation Thursday: Birth of the Air Commando. Washington, D.C.: Office of Air Force History, 1994. (940.542 Mas)
Milazzo, Matteo J. The Chetnik Movement & the Yugoslav Resistance. Baltimore: Johns Hopkins University Press, 1975. (940.53497 Mil)
Moore, Bernard V. The Secret Air War Over France: USAAF Special Operations Units in the French Campaign of 1944. Maxwell Air Force Base, Ala.: Air University Press, 1993. (940.5442 Moo)
_ A historical case study of the role of Air Force special operations forces in high-intensity conflict. _
Musicant, Ivan. The Banana Wars: A History of Military Intervention From the Spanish-American War to the Invasion of Grenada. New York: Macmillan, 1990. (327.7308 Mus)
Napier, John Hawkins. The Air Commandos in Vietnam, November 5, 1961 to February 7, 1965. Auburn, Ala.: Auburn University, 1967. (940.542 Nap)
Neave, Airey. The Escape Room. New York: Doubleday, 1970. (940.534 Nea)
World War II underground movements.
O _Shaughnessy, Hugh. Grenada: An Eyewitness Account of the U.S. Invasion and the Caribbean History That Provoked It. New York: Dodd, Mead, 1984. (972.984 O _S)
Parnell, Ben. Carpetbaggers: America _s Secret War in Europe. Austin, Tex.: Eakin Press, 1993. (940.54 Par)
Support for underground activities.
Pash, Boris T. The Alsos Mission. New York: Award House, 1969. (940.54 Pas)
Col. Pash headed a special American task force of Intelligence commandos to determine how close Hitler was to unleashing atomic warfare.
Pawle, Gerald. The Secret War, 1939-1945. New York: W. Sloan, 1957. (940.54 Paw)
A personal account of involvement in the development of weapons for special operations in

Britain in WW II.
Payne, Anthony. Grenada: Revolution and Invasion. London: Croom Helm, 1984. (972.984 Pay)
Polidoro, Michael A. The Use of Patrol Craft in Low-Intensity Conflict Opeations: An Alternative Model for the Employment of the Cyclone-Class (PC-1). Monterey, Calif.: Naval Postgraduate School, 1995. (359.413 Pol)
Reynolds, Quenton. The Amazing Mr. Doolittle. New York: Appleton-Crofts, 1953. (92 Doo)
Contains material on the Tokyo Raid of 1942.
Riley, Craig Allen. The Role of Special Operations Forces in Operations Against Theater Missles. Monterey, Calif.: Naval Postgraduate School, 1996. (358.174 Ril)
Rout, Leslie. The Shadow War: German Espionage and United States Counterespionage in Latin America During World War II. Frederick, Md.: University Publications of America, 1986. (940.5485 Rou)
Russell, Lee. Grenada 1983. London: Osprey Publishing, 1985. (972.9845 Rus)
Ryan, Cornelius. The Longest Day. New York: Simon and Schuster, 1959. (940.54 Rya)
A popular history of D-Day, including details of various special units _ activities on the 6th of June 1944.
Schwab, Gerald. OSS agents in Hitler _s heartland : destination Innsbruck. Westport, Conn : Praeger, 1996. (940.54867 Sch)
The Secrets War: The Office of Strategic Services in World War II. Washington, D.C.: National Archives and Records Administration, 1992. (940.54867 Sec)
Shoemaker, Lloyd R. The Escape Factory: The Story of MIS-X. New York: St. Martin _s Press, 1990. (940.54 Sho)
Smith, Richard Harris. O.S.S.: The Secret History of America _s First Central Intelligence Agency. Berkeley: University of California Press, 1972. (940.54 Smi)
Special Operations in U.S. Strategy. Ed. Frank R. Barnett. Washington, D.C.: National Defense University Press in cooperation with National Strategy Information Center, 1984. (355.0335 Spe)
Spencer, Otha C. Flying the Hump: Memories of an Air War. College Station: Texas A&M University Press, 1994. (940.54437 Spe)
When the occupying Japanese cut off China from outside contact during WW II, the Americans quickly established the _Hump _, an airlift of troops and supplies over the Himalayas designed to keep Chiang Kaishek _s army in the fight.
Stanton, Shelby L. The Rise and Fall of an American Army: U.S. Ground Forces in Vietnam, 1965-1973. Novato, Calif.: Presidio Press, 1985. (959.704 Sta)
Extensive detailing on corps d _elite and related operations.
Suhl, Yuri. They Fought Back: The Story of Jewish Resistance in Nazi Europe. New York: Schocken Books, 1975. (940.5315 Suh)
Tourison, Sedwick D. Secret Army, Secret War: Washington _s Tragic Spy Operation in North Vietnam. Annapolis, Md.: Naval Institute Press, 1995. (959.70438 Tou)
Warner, Philip. Secret Forces of World War II. Chelsea, Mich.: Scarborough House, 1991. (940.54124 War)
Warren, Harris Gaylord. Special Operations: AAF Aid to European Resistance Movements, 1943-1945. Washington, D.C.: AAF Historical Office, HQ Army Air Forces, 1947. (940.534 War)
Zich, Arthur. The Rising Sun. Alexandria, Va.: Time-Life Books, 1977. (940.5426 Zic)

## IV. SPECIAL OPERATIONS AND REVOLUTIONARY WAR

Arostegui, Martin C. Twilight warriors : inside the world _s special forces. New York : St. Martin _s Paperbacks, 1998. (356.167 Aro)
Asprey, Robert. War in the Shadows: Guerrilla past and present. New York: William Morrow, 1994. (355.0218 Asp)
A revised and updated edition outlining 2,000 years of the guerrilla at war from ancient Persia to the present. A basic point of departure.
Bierman, John. Fire in the Night Wingate of Burma, Ethiopia, and Zion. New York : Random House, 1999. (940.5423 Bie)

Casper, Lawrence E. Falcon brigade: combat and command in Somalia and Haiti. Boulder, Colorado, 2001. (967.7305 Cas)
Coleman, J. D. Incursion : from America _s choke hold on the NVA lifelines to the sacking of the Cambodian sanctuaries. New York : St. Martin _s Press, 1991. (959.704 Col)
Clayton, Anthony. Counter-Insurgency in Kenya: A Study of Military Operations Against Mau Mau 1952-1960. Manhattan, Kan : University Press, 1984. (967.62 Cla)
Conboy, Kenneth J. Spies and commandos : how America lost the secret war in North Vietnam. Lawrence, KS : University Press of Kansas, 2000. (959.70438 Con)
Clutterbuck, Richard L. The Long, Long War: Counterinsurgency in Malaya and Vietnam. New York: Praeger, 1966. (959.5 Clu)
Collins, John M. America _s Small Wars: Lessons For the Future. Washington, D.C.: Brassey _s, 1991. (355.03357 Col)
Cox, Steven J. Role of SOF in Paramilitary Operations. Monterey, Calif.: Naval Postgraduate School, 1995. (355.0218 Cox)
Dean, David J. The Air Force Role in Low-Intensity Conflict. Maxwell Air Force Base, Ala.: Air University Press, 1986. (358.414 Dea)
---. Airpower in Small Wars: The British Air Control Experience. Maxwell Air Force Base, Ala.: Air University Press, 1985. (358.41441 Dea)
Drumm, Robert H., Jr. Saint, Sinner, or Soldier: Liberation Theology and Low Intensity Conflict. Ft. Leavenworth, Kan.: U.S. Army and General Staff College, 1991. (230.2 Dru)
Evans, Ernest. Wars Without Splendor: U.S. Military and Low-Level Conflict. Westport, Conn.: Greenwood Press, 1987. (355.0332 Eva)
Fall, Bernard. _ The Theory and Practice of Insurgency and Counterinsurgency. _ Last Reflections On a War. New York: Doubleday, 1967: 209-223. (956.7 Fal)
Fall, a French journalist who wrote extensively on the 1st and 2nd Indochina Wars, was sensitive to the political nature of small wars, but his support of the Lansdale approach was falling on deaf ears when he was killed in 1965.
Gallagher, James J. Low-Intensity Conflict: A Guide for Tactics, Techniques and Procedures. Harrisburg, Pa.: Stackpole Books, 1992. (355.0218 Gal)
Galula, David. Counterinsurgency Warfare: Theory and Practice. New York: Praeger, 1964. (355.4 Gal)
The author was a retired French officer and an eyewitness to low-intensity and limited war in several areas. His synthesis of _ la guerre revolutionaire _ with emerging American counterinsurgency doctrine provides useful perspectives on special operations and forces doctrine.
Glick, Edward Bernard. Peaceful Conflict: The Non-Military Use of the Military. Harrisburg, Pa.: Stackpole Books, 1967. (355. Gli)
The Grenada Papers. Ed. Paul Seabury and Walter A. McDougall. San Francisco, Calif.: Institute for Contemporary Studies, 1984. (972.9845 Gre)
Grinter, Lawrence E. Realities of Revolutionary Violence in Southeast Asia: Challenges and Responses. Maxwell Air Force Base, Ala.: Air University Press, 1990. (959.9046 Gri)
Grivas, George. General Grivas on Guerrilla Warfare. New York: Praeger, 1962. (355.425 Gri)
An essay on insurgency by a Greek officer who served in both insurgent and counter-insurgent roles and headed the Greek nationalist EOKA underground on Cyprus.
Guerrilla Warfare. Ed. John Pimlott. London: Hamlyn, 1985. (355.02 Gue)
Guerrilla Warfare and Counterinsurgency: U.S.-Soviet Policy in the Third World. Ed. Richard H. Shultz, Jr., et al. Lexington, Mass.: Lexington Books, 1989. (355.0218 Gue)
Hanson, Gay M. Who Are the Soldiers of the Revolution? Monterey, Calif.: Naval Postgraduate School, 1996. (303.62 Han)
Herrington, Stuart A. Silence Was a Weapon: The Vietnam War in the Villages: A Personal Perspective. Novato, Calif.: Presidio Press, 1982. (959.704 Her)
Hosmer, Stephen T. Constraints on U.S. Military Strategies in Past Third World Conflicts. Santa Monica, Calif.: Rand Corporation, 1984. [RAND note N-2180-AF] (355.0335 Hos)
How Latin American Insurgents Fight. Fort Clayton: HQ Dept. of the Army, 193rd Infantry Brigade, 1986. (355.0218 How)
Johnson, Haynes. The Bay of Pigs. New York: Norton, 1964. (972.91 Joh)

Kissick, Luther C. Guerrilla One, the 74th Fighter Squadron Behind Enemy Lines in China, 1942- 45. Manhattan, Kan.: Sunflower University Press, 1983. (940.54 Kis)
Landau, Saul. The Guerrilla Wars of Central America: Nicaragua, El Salvador, and Guatemala. New York: St. Martin _s Press, 1993. (972.8053 Lan)
Author looks at differences and similarities between these wars, each having its roots in regional inequalities and fueled by U.S. financial and military intervention.
Laos: War and Revolution. Ed. Nina S. Adams and Alfred W. McCoy. New York: Harper & Row, 1970. (959.404 Lao)
Lawrence, Thomas Edward. The Seven Pillars of Wisdom. New York: Doubleday, 1938. (940.4 Law)
In WW I, Lawrence worked for British Intelligence organizing a revolt of Arab tribesman against the Turks, and acquired a legendary reputation. This book is an account of this campaign and the guerrilla tactics employed.
Locke, Charles E., Jr. The Heirs of Angkor: An Analysis of Khmer Rouge Viability. Monterey, Calif.: Naval Postgraduate School, 1995. (956.6 Loc)
Lorell, Mark A. Airpower in Peripheral Conflict: The French Experience in Africa. Santa Monica, Calif.: Rand Corporation, 1989. [RAND report R-3660-AF] (355.00944 Lor)
Low-Intensity Conflict and Modern Technology. Ed. David Dean. Maxwell Air Force Base, Ala.: Air University Press, 1986. (355.021 Low)
Marine Corps Gazette. The Guerrilla and How to Fight Him: Selections From the Marine Corps Gazette. New York: Praeger, 1962. (355.4 Mar)
Marks, Thomas A. Maoist Insurgency Since Vietnam. London: Frank Cass, 1996. (959.05 Mar)
McCuen, John J. The Art of Counter-Revolutionary War: The Strategy of Counter-Insurgency. Harrisburg, Pa.: Stackpole Books, 1966. (355.4 McC)
Meyer, Karl. The Cuban Invasion: The Chronicle of a Disaster. New York: Praeger, 1962. (972.91 Mey)
Modern Guerrilla Warfare: Fighting Communist Guerrilla Movements, 1941-1961. Ed. Franklin Mark Osanka. New York: Free Press, 1962. (355.4 Osa)
A compendium of essays on various aspects of insurgency and counter-insurgency as American involvement in Vietnam increased. Dated, yet extensive and useful.
Nasution, Abdul Harris. Fundamentals of Guerrilla Warfare. New York: Praeger, 1965. (355.4 Nas)
Paget, Julian. Counterinsurgency Operations: Techniques of Guerrilla Warfare. New York: Walker, 1967. (355.4 Pag)
References special operations and forces as linked to the Special Branch _s Special Operations Volunteer Force in Malaya and Kenya.
Parker, James E. Codename Mule: Fighting the Secret War in Laos for the CIA. Annapolis, Md.: Naval Institute Press, 1995. (959.70434 Par)
Petterson, Eric M. Acceleration of Foreign Military Sales Resupply to Third World Nations Involved in Counterinsurgency Operations. Maxwell Air Force Base, Ala.: Air University Press, 1987. (341.728 Pet)
Plaster, John L. SOG : a photo history of the secret wars. Boulder, Colo : Paladin Press, 2000. (959.704 Pla)
---. SOG: the secret wars of America _s commandos in Vietnam. New York : Simon & Schuster, 1997. (959.704 Pla)
Powers, Frances. Operation Overflight : the U2 spy pilot tells his story for the first time. New York: Holt, Rinehart & Winston, 1970. (973.921 Pow)
Prado Salmon, Gary. The Defeat of Che Guevara: Military Response to Guerrilla Challenge in Bolivia. New York: Praeger, 1990. (984.05 Pra)
Pustay, John C. Counterinsurgency Warfare. New York: Free Press, 1965. (355.4 Pus)
Includes data on U.S. Army and Air Force special operations elements as the war in Vietnam escalated.
Race, Jeffrey. War Comes to Long An: Revolutionary Conflict in a Vietnamese Province. Berkeley: University of California Press, 1972. (959.70431 Rac)
Responding to Low-Intensity Conflict Challenges. Maxwell Air Force Base, Ala.: Air University Press, 1990. (355.0215 Res)

_ Revolution Beyond Our Borders _ : Sandinista Intervention in Central America. Washington, D.C.: U.S. Department of State, Bureau of Public Affairs, Office of Public Communications, 1985. (320.97285 Rev)
The Roots of Counter-Insurgency: Armies and Guerrilla Warfare, 1900-1945. Ed. Ian F.W. Beckett. London: Blandford Press, 1988. (909.82 Roo)
Sarkesian, Sam C. Unconventional Conflicts in a New Security Era: Lessons From Malaya and Vietnam. Westport, Conn.: Greenwood Press, 1993. (355.0218 Sar)
Schemmer, Benjamin F. The Raid. New York: Harper and Row, 1976. (959.704 Sch)
An account of the ill-fated Son Tay raid by the editor of Armed Forces Journal International, a major advocate of the expansion of special/covert operations in the Reagan years.
Simons, William E. Scenarios, Targets, and Planning Factors for Projecting Air-Delivered Firepower in the Third World. Santa Monica, Calif.: Rand Corporation, 1988. [RAND note N-2425-PA&E/USDP] (358.4148 Sim)
Small Wars Manual, U.S. Marine Corps, 1940. Manhattan, Kan.: Sunflower University Press, [n.d.]. (355.02184 Sma)
A great read especially for anyone hooked on the history of small-wars tactical operations.
Some Observations on Islamic Revolutions. Maxwell Air Force Base, Ala.: Air University Press, 1985. (320.54 War)
Special Operations in U.S. Strategy. Ed. Frank R. Barnett. Washington, D.C.: National Defense University Press in cooperation with National Strategy Information Center, 1984. (355.0335 Spe)
Taber, Robert. The War of the Flea: A Study of Guerrilla Warfare, Theory and Practice. New York: Lyle Stuart, 1965. (355.4 Tab)
A well-known piece on revolutionary warfare.
Thompson, Robert Grainger. Defeating Communist Insurgency: The Lessons of Malaya and Vietnam. New York: Praeger, 1966. (355.4 Tho)
Trinquier, Roger. Modern Warfare: A French View of Counterinsurgency. New York: Praeger, 1964. (355.4 Tri)
Case study on Algeria. Contains some rather extraordinary opinions on how to deal with insurgents and terrorist infrastructures.
Valeriano, Napoleon D. and T.R. Bohannon. Counter-Guerrilla Operations: The Philippine Experience. New York: Praeger, 1966. (355.4 Val)
A history and analysis of American-supported Philippine counterinsurgency operations of the late 1940s and 1950s, including the role of special units.
West, Francis J. The Village. Madison: University of Wisconsin Press, 1985. (959.704 Wes)
A vivid and unbiased portrait of one Vietnamese hamlet in the grip of war--where a handful of American Marines and Vietnamese militia lived and died together trying to defend it.
Willenson, Kim. _ Secret Wars. _ The Bad War: An Oral History of the Vietnam War. New York: New American Library, 1987: 202-223. (959.704 Wil)
Interviews with ex-CIA Director William Colby, Col. William Corson, Gen. Bruce Palmer, Frank Snepp, Jeff Stein and Col. John Waghelstein, dealing with special operations from the early 1950s onward.
Wyden, Peter. Bay of Pigs: The Untold Story. New York: Simon and Schuster, 1979. (972.91 Wyd)

## V. TERROR/COUNTERTERROR OPERATIONS

Adams, James. The Financing of Terror: Behind the PLO, IRA, Red Brigades, and M-19 Stand the Paymasters: How the Groups That Are Terrorizing the World Get the Money to Do It. New York: Simon and Schuster, 1986. (338.433 Ada)
American Society of International Law. Legal Aspects of International Terrorism. Ed. Alona E. Evans, John F. Murphy. Lexington, Mass.: Lexington Books, 1978. (341.77 Ame)
Anderson, Sean. Historical Dictionary of Terrorism. Metuchen, N.J.: Scarecrow Press, 1994. (909 And)
Arnold, Terrell E. The Violence Formula: Why People Lend Sympathy and Support to Terrorism. Lexington, Mass.: Lexington Books, 1988. (322.42 Arn)
Bell, J. Bowyer. A Time of Terror: How Democratic Societies Respond to Revolutionary Violence. New York: Basic Books, 1978. (301.633 Bel)

Written under the auspices of the Institute of War and Peace Studies, Columbia University.
---. Transnational Terror. Washington: American Enterprise Institute for Public Policy Research, 1975. (364.15 Bel)
Beyond the Iran-Contra Crisis: The Shape of U.S. Anti-Terrorism Policy in the Post-Reagan Era. Ed. Neil C. Livingstone and Terrell E. Arnold. Lexington, Mass.: Lexington Books, 1988. (327.73 Bey)
Bodansky, Yossef. Bin Laden: the man who declared war on America. Rocklin, Calif : Forum, 1999. (953.8 Bod)
Boyd, Curtis D. Terrorism As a Psychological Operation: A Comparative Analysis of the Zionist and the Palestine Terrorist Campaigns. Monterey, Calif: Naval Postgraduate School, 1994. (303.625 Boy)
Cassese, Antonio. Terrorism, Politics, and Law: The Achille Lauro Affair. Princeton, N.J.: Princeton University Press, 1989. (364.1552 Cas)
Celmer, Marc A. Terrorism, U.S. Strategy, and Reagan Policies. New York: Greenwood Press, 1987. (363.32 Cel)
Chomsky, Noam. The Culture of Terrorism. Boston: South End Press, 1988. (327.73 Cho)
Deals with the U.S. _s government and military policies in the aftermath of the Iran-Contra Affair.
Cline, Ray S. Terrorism : the Soviet Connection. New York: Crane Russak, 1984. (303.625 Cli)
Clutterbuck, Richard L. Guerrillas and Terrorists. Chicago: University Press, 1980. (393.62 Clu)
---. Living With Terrorism. London: Faber & Faber, 1975. (364.1 Clu)
The mechanics of terrorist actions--bombs, kidnapping, hijacking of aircraft, etc.
---. Terrorism and Guerrilla Warfare. New York: Routledge, 1990. (303.625 Clu)
Combating the Terrorists. Ed. H.H. Tucker. New York: Facts On File, 1988. (363.32 Com)
Conference on Terrorism and Political Crimes. International Terrorism and Political Crimes. Ed. M. Cherif Bassiouni. Springfield, Ill.: Thomas, 1975. (341.77 Con)
Contemporary Terrorism. Ed. William Gutteridge for the Institute for the Study of Conflict. New York: Facts On File, 1986. (364.13 Con)
Control of Terrorism: International Documents. Ed. Yonah Alexander, Marjorie Ann Browne, Allan S. Nanes. New York: Crane, Russak, 1979. (341.77 Con)
The Deadly Sin of Terrorism: Its Effect on Democracy and Civil Liberty in Six Countries. Ed. David A. Charters. Westport, Conn.: Greenwood, 1994. (303.625 Dea)
DeLeon, Peter. The Threat of Nuclear Terrorism: Reexamination. Santa Monica, Calif.: Rand Corporation, 1988. [RAND note N-2706] (363.1799 DeL)
Demaris, Ovid. Brothers in Blood: The International Terrorist Network. New York: Scribner, 1977. (364.1 Dem)
Dewar, Michael. Weapons and Equipment of Counterterrorism. New York: Sterling, 1987. (623.3 Dew)
Dimensions of Irish Terrorism. The International Library of Terrorism 2. New York: G.K. Hall, 1994. (303.625 Dim)
Dobson, Christopher. The Never-Ending War: Terrorism in the 80s. New York: Facts On File, 1987. (303.625 Dob)
Dobson, Christopher and Ronald Payne. Counterattack: The West _s Battle Against the Terrorist. New York: Facts On File, 1982. (363.32 Dob)
A survey of major antiterrorist circles, forces, operations, and the efforts taken in commercial circles against terrorism.
---. The Terrorists: Their Weapons, Leaders and Tactics. New York: Facts On File, 1972. (303.625 Dob)
Emerson, Steven. The Fall of Pan Am 103. New York: Putnam, 1990. (363.124 Eme)
Encyclopedia of world terrorism. Armonk, N.Y. : Sharpe Reference, 1997. (R 303.625 Enc)
Erickson, Richard J. Legitimate Use of Military Force Against State-Sponsored International Terrorism. Maxwell Air Force Base, Ala.: Air University Press, 1989. (341.772 Eri)
Extremist Groups: An International Compilation of Terrorist Organizations, Violent Political Groups, and Issue-Oriented Militant Movements. [Chicago]: The University of Illinois at Chicago, 1996. (R 364.1 Ext)

European Terrorism. New York: G.K. Hall, Maxwell Macmillan International, 1994. (303.625 Eur)
Fighting Back: Winning the War Against Terrorism. Ed. Neil C. Livingstone and Terrell E. Arnold. Lexington, Mass.: Lexington Books, 1986. (363.32 Fig)
Goldstein, Frank L. _ International Terrorism in the Twenty-First Century. _ Global Security Concerns: Anticipating the Twenty-First Century. Ed. Karl P. Magyar. Maxwell Air Force Base, Ala.: Air University Press, March 1996. (355.02709 Glo)
The Guerrilla--And How to Fight Him. Ed. T.N. Green. New York: Praeger, 1962. (355.4 Mar)
Hall, Sam. Counter-Terrorist. New York: D.I. Fine, 1987. (355.35 Hal)
Hanle, D.J. Terrorism: The Newest Taste of Warfare. New York: Brassey _s, 1990. (303.625 Han)
Hoffman, Bruce. _ Holy Terror _ : The Implications of Terrorism Motivated By a Religious Imperative. Santa Monica, Calif.: Rand Corporation, 1993. [RAND paper p-7834] (303.625 Hof)
Hydra of Carnage: The International Linkage of Terrorism and Other Low-Intensity Operations The Witnesses Speak. Ed. Uri Ra _anan, et al. Lexington, Mass.: Lexington Books, 1986. (303.625 Hyd)
Inside Terrorist Organizations. Ed. David C. Rapoport. New York: Columbia University Press, 1988. (303.625 Ins)
International Terrorism: Policy Implications. Ed. Susan Flood. Chicago, Ill.: Office of International Criminal Justice, University of Illinois at Chicago, 1991. (363.32 Int)
Jenkins, Brian M. Should Our Arsenal Against Terrorism Include Assassination? Santa Monica, Calif.: Rand Corporation, 1987. [RAND paper P-7303] (327.73 Jen)
Joes, Anthony James. Guerrilla conflict before the Cold War. Westport, Conn. : Praeger, 1996. (355.425 Joe)
--- Guerrilla warfare : a historical biographical, and bibliographical sourcebook. Westport, Conn. : Greenwood Press, 1996. (355.424 Joe)
Katz, Robert. Days of Wrath: The Ordeal of Aldo Moro, the Kidnapping, the Execution, the Aftermath. New York: Doubleday, 1980. (364.154 Kat)
Knott, Stephen F. Secret and Sanctioned: Covert Operations and the American Presidency. New York: Oxford University Press, 1996. (327.1273 Kno)
A study to broaden the understanding of two hundred years of American reliance on covert activity.
Kupperman, Robert H. Final Warning: Averting Disaster in the New Age of Terrorism. New York: Doubleday, 1989. (363.32 Kup)
---. Terrorism: Threat, Reality, Response. Stanford, Calif.: Hoover Institution Press, 1979. (364.131 Kup)
Lake, Anthony. Six nightmares : real threats in a dangerous world & how American can meet them. Boston : Little Brown, 2000. (363.32 Lak)
Laqueur, Walter. Terrorism. Boston: Little, Brown, 1977. (301.63 Laq)
Levitt, Geoffrey M. Democracies Against Terror: The Western Response To State-Supported Terrorism. New York: Praeger, 1988. (363.32 Lev)
Littleton, Matthew J. Information Age Terrorism: Toward Cyperterror. Monterey, Calif.: Naval Postgraduate School, 1995. (303.625 Lit)
Livingstone, Neil C. The Cult of Counterterrorism: The Weird World of Spooks, Counterterrorists, Adventurers, and Not Quite Professionals. Lexington, Mass.: Lexington Books, 1989. (363.32 Liv)
Livingstone, Neil C. and Terrell Arnold. Beyond the Iran-Contra Crisis: The Shape of U.S. Anti- Terrorism Policy in the Post-Reagan Era. Lexington, Mass.: D.C. Heath, 1988. (327.73 Bey)
Mallin, Jay. Terror and Urban Guerrillas: A Study of Basic Documents. Miami: University of Miami Press, 1971. (321 Mal)
Marrs, Robert W. Nuclear Terrorism: Rethinking the Unthinkable. Monterey, Calif.: Naval Postgraduate School, 1994. (363.1799 Mar)
Martin, David C. Best Laid Plans: the inside story of America _s War Against Terrorism. New York: Harper and Row, 1988. (363.32 Mar)

Melman, Yossi. The Master Terrorist: The True Story of Abu-Nidal. New York: Adam Books, 1986. (303.625 Mel)
Mickolus, Edward F., comp. The Literature of Terrorism: A Selectively Annotated Bibliography. Westport, Conn.: Greenwood Press, 1980. (016.30362 Mic)
Middle East Terrorism: Current Threats and Future Prospects. The International Library of Terrorism 5. New York: G.K. Hall, 1994. (303.625 Mid)
Miller, Abraham H. Terrorism and Hostage Negotiations. Boulder, Colo.: Westview Press, 1980. (364.154 Mil)
The Morality of Terrorism: Religious and Secular Justifications. Ed. David C. Rapoport and Yonah Alexander. New York: Pergamon Press, 1982. (303.62 Mor)
Murphy, John Francis. Punishing International Terrorists: The Legal Framework for Policy Initiatives. Totowa, N.J.: Rowman & Allanheld, 1985. (364.1 Mur)
Nacos, Brigitte Lebens. Terrorism and the media : from the Iran hostage crisis to the World Trade Center bombing. New York : Columbia University Press, 1994. (303.625 Nac)
Netanyahu, Binyamin. Fighting Terrorism: How Democracies Can Defeat Domestic and International Terrorism. New York: Farrar, Straus Giroux, 1995. (363.32 Net)
Norton, Augustus R. International Terrorism: An Annotated Bibliography and Research Guide. Boulder, Colo.: Westview Press, 1980. (016.30362 Nor)
Nuclear Terrorism: Defining the Threat. Ed. Paul Leventhal and Yonah Alexander. Washington: Pergamon-Brassey _s, 1986. (363.32 Nuc)
O _Ballance, Edgar. Language of Violence: The Blood Politics of Terrorism. San Rafael, Calif.: Presidio Press, 1979. (904.7 O _B)
Concerns terrorism in the Near East, the Fedayeen, and Jewish-Arab relations.
---. Terror in Ireland: The Heritage of Hate. Novato, Calif.: Presidio Press, 1981. (941.508 O _B)
O _Neill, Bard E. Insurgency and Terrorism: Inside Modern Revolutionary Warfare. New York: Brassey _s, 1990. (355.0218 O _N)
Origins of Terrorism: Psychologies, Ideologies, Theologies, States of Mind. Ed. Walter Reich. New York: Woodrow Wilson International Center for Scholars and Cambridge University Press, 1990. (303.625 Ori)
A blend of theory with specific facts and narrative accounts of dealing with terrorism.
Perspectives on Terrorism. Ed. Lawrence Friedman and Yonah Alexander. Wilmington, Del.: Scholarly Resources, 1983. (303.625 Per)
Political Terrorism. Ed. Lester A Sobel. New York: Facts On File, 1978. (322.42 Pol)
A history of terrorism in world politics.
The Politics of Terrorism. Ed. Michael Stohl. 3rd ed. New York: M. Dekker, 1988. (322.42 Pol)
Reeve, Simon. The new jackals : Ramzi Yousef, Osama bin Lden and the future of terrorism. Boston : Northeastern University Press, 1999. (364.1 Ree)
Riley, Kevin Jack. Domestic Terrorism: A National Assessment of State and Local Preparedness. Santa Monica, Calif.: Rand Corporation, 1995. (363.32 Ril)
Rosenberg, Tina. Children of Cain: Violence and the Violent in Latin America. New York: Morrow, 1991. (303.625 Ros)
Rubenstein, Richard E. Alchemists of Revolution: Terrorism in the Modern World. New York: Basic Books, 1987. (303.62509 Rub)
Schlahek, Donna M. International Terrorism: An Introduction to Concepts and Actors. Lexington, Mass.: Lexington Books, 1988. (303.625 Sch)
Segaller, Stephen. Invisible Armies: Terrorism: Into the 1990s. San Diego: Harcourt Brace Jovanovich, 1987. (364.13 Seg)
Shafritz, Jay. Almanac of Modern Terrorism. New York: Facts On File, 1991. (303.625 Sha)
Silj, Alessandro. Never Again Without A Rifle: The Origins of Italian Terrorism. New York: Karz, 1979. (322.42 Sil)
Simon, Jeffrey D. The Terrorist Trap: America _s Experience With Terrorism. Bloomington: Indiana University Press, 1994. (363.32 Sim)
Sloan, Stephen. Beating International Terrorism: An Action Strategy for Preemption and Punishment. Maxwell Air Force Base, Ala.: Air University Press, 1986. (363.32 Slo)
Sper, Mary K. Towards Understanding Terrorism: A Theoretical Examination of Internal Cohesion in Terrorist Groups and the Negative Dynamic of Violence. Monterey, Calif.:

Naval Postgraduate School, 1995. (303.625 Spe)
Sterling, Claire. The Terror Network: The Secret War of International Terrorism. New York: Holt, Rinehart, and Winston, 1981. (303.62 Ste)
Taheri, Amir. Holy Terror: Inside the World of Islamic Terror. Bethesda, Md.: Adler and Adler, 1987. (303.625 Tah)
Taillon, J. Paul de B. Evolution of special forces in counter-terrorism. Westport, Conn : Praeger, 2001. (356.16 Tai)
Taylor, Maxwell. The Terrorist. Washington, D.C.: Brassey _s Defence, 1988. (303.625 Tay)
---. Terrorist Lives. Washington, D.C.: Brassey _s Defence, 1994. (363.32 Tay)
Technology and Terrorism. Portland, Ore.: F. Cass, 1993. (363.32 Tec)
Terrorism and Low Intensity Conflict. Santa Monica, Calif.: Rand Corporation, 1991. [RAND bibliography SB-1060] (R 322.32 Ter)
Terrorism: British Perspective. The International Library of Terrorism 1. New York: G.K. Hall, 1994. (363.32 Ter)
Terrorism in Africa. The International Library of Terrorism 4. New York: G.K. Hall, 1994. (303.625 Ter)
Terrorism in Context. University Park, Pa.: Pennsylvania State University Press, 1995. (363.32 Ter)
The Terrorism Reader: A Historical Anthology. Ed. Walter Laqueur and Yonah Alexander. New York: NAL Penguin, 1987. (904.7 Ter)
Terrorism: Theory and Practice. Ed. Yon Alexander, David Carlton, and Paul Wilkinson. Boulder, Colo.: Westview Press, 1979. (301.633 Ter)
The Threat of Terrorism. Ed. Juliet Lodge. Boulder, Colo.: Westview Press, 1988. (363.32 Thr)
Turner, Stansfield. Terrorism and Democracy. Boston: Houghton Mifflin, 1991. (955.054 Tur)
United States. Defense Intelligence Agency. Terrorist Group Profiles. Washington, D.C.: U.S. Government Pring Office, 1988. (R 364.1 U.S)
Vega, Luis. Guerrillas in Latin America: The Technique of the Counter State. New York: Praeger, 1969. (355.4 Mer)
Victims of Terrorism. Ed. Frank M. Ochbert and David A. Soskis. Boulder, Colo.: Westview Press, 1982. (362.88 Vic)
Violent Persuasions: The Politics and Imagery of Terrorism. Ed. David J. Brown and Robert Merrill. Seattle: Bay Press, 1993. (303.625 Vio)
A collaboration of political scientists, activists, and artists serving as a guidebook to the multiple and sometimes conflicting meanings of world terrorism.
Wilkinson, Paul. Political terrorism. New York: Macmillan, 1974. (322.42 Wil)
---. Terrorism and the Liberal State. New York: Wiley, 1977. (322.42 Wil)
Yedinak, Steven M. Hard to forget : an American with the Mobile Guerrilla Force in Vietnam. New York : Ivy Books, 1998. (959.704 Yed)

## VI. BIOGRAPHY/AUTOBIOGRAPHY

Aderholt, Harry C. Air Commando One : Heinie Aderholt and America _s secret air wars. Washington, D.C. : Smithsonian Institution Press, 2000. (92 Ade)
Altieri, James. The Spearheaders: A Personal History of Darby _s Rangers. Washington D.C.: Zenger Publishers, 1979. (940.54 Alt)
An autobiographical history of the Rangers in WW II.
Bank, Aaron. From O.S.S. to Green Berets. Novato, Calif.: Presidio Press, 1986. (356.167 Ban)
A memoir of a senior U.S. Army Special Forces officer from WW II through Vietnam.
Beals, Carleton. Great Guerrilla Warriors. Englewood Cliffs, N.J.: Prentice Hall, 1970. (909.82 Bea)
Betser, Moshe. Secret soldier : the true life story of Israel _s greatest commando. New York : Atlantic Monthly Press, 1996. (356.167 Bet)
Bierman, Smith. Fire in the night Wingate of Burma, Ethiopia, and Zion. New York : Random House, 1999. (940.5423 Bie)
Blair, Clay. Ridgeway _s Paratroopers: The American Airborne in World War II. New York: Dial Press, 1985. (940.541 Bla)
Ridgeway headed the 101st Airborne Division in the European theater in WW II, commanded the 8th Army in Korea in its darkest hour, and went on to be Army Chief of Staff and NATO

commander.
Brome, Vincent. The Way Back. New York: W.W. Norton, 1958. (940.54 Bro)
The story of Pat O _Leary, one of the most celebrated and mysterious secret operations of World War II.
Chevrillon, Claire. Code Name Christine Clouet: A Woman in the French Resistance. College Station, Tex.: A&M University Press, 1995. (940.53443 Che)
Clarke, A.F.N. Contact. London: Pan Books, 1983. (941.608 Cla)
Memoir by a British parachute regiment veteran of 1973 and 1976 tours in Ulster.
Cohen, William S. Men of Zeal: A Candid Inside Story of the Iran-Contra Hearings. New York: Viking, 1988. (973.927 Coh)
Darby, William Orlando. We Led the Way : Darby _s Ranger. San Rafael, Calif.: Presidio Press, 1980. (940.541 Dar)
A co-founder of the U.S. Army _s WW II Ranger force, Darby led the largest contingent in combat, which suffered the highest loss rate of an American corps d _ elite in the 20th century. Darby was killed in action while serving with the 10th Mountain Division.
Ellis, Robert B. See Naples and Die: A World War II Memoir of a United States Army Ski Trooper in the Mountains of Italy. Jefferson, N.C.: McFarland, 1996. (940.54817 Ell)
Fall, Bernard B. Street Without Joy. Harrisburg, Pa.: Stackpole Books, 1964. (959.7 Fal)
Classic case study on Vietnam.
Foley, Dennis. Special Men: A LRP _s Recollections. New York: Ivy Books, 1994. (959.70438 Fol)
Garner, Joe R. Code Name Copperhead: My True-Life Exploits As a Special Forces Soldier. New York: Simon & Schuster, 1994. (356.167 Gar)
Gavin, James M. On to Berlin: Battles of an Airborne Commander, 1943-1946. New York: Viking Press, 1987. (940.54 Gav)
A war memoir by a young cavalry captain, one of many who built the American airborne program from scratch during the major pre-war build-up and rose to command the 82nd Airborne Division in Europe.
Geyer, Georgie Anne. Guerrilla Prince: The Untold Story of Fidel Castro. Boston: Little, Brown, 1991. (972.91064 Gey)
Gormly, Robert A. Combat swimmer : memoirs of Navy SEAL. New York : Dutton, 1998. (959.704 Gor)
Goulden, Joseph C. The Death Merchant: The Rise and Fall of Edwin P. Wilson. New York: Simon & Schuster, 1984. (364.131 Gou)
Detailed, well-researched account of the career of an international arms dealer and his dealings with the likes of Libya _s Qaddafi, former CIA agents, Green Berets, and the indirect cooperation of American politicians.
Grivas, George. General Grivas on Guerrilla Warfare. New York: Praeger, 1964. (355.425 Gri)
Guevara, Ernest (Che). Che Guevara on Guerrilla Warfare. New York: Praeger, 1961. (355.4 Gue)
---. The Complete Bolivian Diaries of Che Guevara and Other Captured Documents. Ed. Daniel James. New York: Stein & Day, 1968. (984 Jam)
Henderson, Charles. Marine sniper : 93 confirmed kills : the true story of gunnery Sergeant Carols Hathcock. Canton, Ohio : Daring Pub. Group, 1990. (959.70433 Hen)
Ho, Chi Minh. On Revolution; Selected Writings, 1920-66. New York: Praeger, 1967. (959.7 Ho)
Hough, Richard. Mountbatten: Hero of Our Time. London: Weidenfeld & Nicholson, 1980. (92 Mou)
A brief biography of Admiral of the Fleet Lord Louis Mountbatten who headed combined operations, 1941-43.
Hunters and shooters : an oral history of the U.S. Navy SEALs in Vietnam. New York : W. Morrow and Co., 1995. (959.70434 Hun)
King, Stella. _ Jacqueline _ : Pioneer Heroine of the Resistance. New York: Sterling, 1990. (92 Rud)
Biography of Yvonne Rudellat, first trained female agent landed in France by the Special Operations Executive (S.O.E.), and the only woman officially nominated for the Military

Cross.
Kyle, James H. Guts to Try: The Untold Story of the Iran Hostage Mission By the On-Scene Desert Commander. New York: Orion, 1990. (955.054 Kyl)
Lawrence, Thomas Edward. The selected letters. Ed. Malcolm Brown. New York: Norton, 1989. (92 Law)
_ Lawrence of Arabia _ of WW I British Intelligence fame whose guerrilla tactics pitted the Arabs against the Turks.
---. The Seven Pillars of Wisdom. New York: Doubleday, 1938. (940.4 Law)
An account of the Arab-Turk campaign and the guerrilla theory and tactics employed.
Lawson, Ted. Thirty Seconds Over Tokyo. New York: Random House, 1943. (940.54 Law)
Autobiographical account of the _ Doolittle Raid, _ a special operation in essence, aimed at enhancing civilian morale and demonstrating aggressiveness when conventional operations were going badly. Navy and Army Air Corps elements combined to launch an attack on Japanese cities in a high-risk operation in April 1942. Most crews survived, and Lawson _s account was the basis of a major motion picture.
MacCloskey, Monro. Secret Air Missions. New York: Richard Rosen, 1969. (940.54 Mac)
A collection of letters and a personal narrative by the commander of a squadron of the 15th U.S. Air Force detailed to support clandestine operations in the Mediterranean in WW II.
MacDonald, Peter. Giap: The Victor in Vietnam. New York: Norton, 1993. (92 GIA)
A new biography of a brilliant guerrilla warfare strategist.
Marcinko, Richard. Rogue Warrior. New York: Pocket Books, 1992. (359.0092 Mar)
Autobiography of the founder of SEAL Team Six.
Mayer, Allan J. Gaston _s War: A True Story of a Hero of the Resistance in World War II. Novato, Calif.: Presidio Press, 1988. (940.53492 May)
Meyer, Peter. Defiant Patriot: The Life and Exploits of Lt. Colonel Oliver L. North. New York: St. Martin _s Press, 1987. (92 Nor)
Queen, Richard. Inside and Out: Hostage to Iran, Hostage to Myself. New York: Putnam, 1981. (955.054 Que)
Ramsey, Edwin Price. Lieutenant Ramsey _s War: From Horse Soldier to Guerrilla Commander. Washington, D.C.: Brassey _s, 1996. (940.53599 Ram)
Reynolds, Quenton. The Amazing Mr. Doolittle. New York: Appleton-Century-Crofts, 1953. (92 Doo)
Contains information on the Tokyo Raid of 1942.
Roske, Ralph Joseph. Lincoln _s Commando: The Biography of Commander William B. Cushing, U.S. Navy. Annapolis: Naval Institute Press, 1995. (973.757 Ros)
Russell, Charles W. The Memoirs of Colonel John S. Mosby. Indiana University Press, 1996. (973.7455 Mos)
Samson, Jack. Chennault. New York: Doubleday, 1987. (358.4 San)
Selser, Gregorio. Sandino. New York: Monthly Review Press, 1981. (972.85051 Sei)
Smythe, Donald. Guerrilla Warrior: The Early Life of John J. Pershing. New York: Scribner, 1973. (355.3 Smy)
Special operations recipients of the Medal of Honor and the Victoria Cross. MacDill Air Force Base, FL : United States Special Operations Command, 1997. (355.1342 Spe)
Steinman, Ron. The soldiers _ story : Vietnam in their own words. New York : TV Books, 1999. (959.704 Ste)
Taruc, Luis. He Who Rides the Tiger: The Story of an Asian Guerrilla Leader. New York: Frederick A. Praeger, 1967. (364.13 Tar)
Troy, Thomas F. Donovan and the CIA: A History of the Establishment of the Central Intelligence Agency. Frederick, Md.: Aletheia Books, 1981. (327.12 Tro)
---. Wild Bill and Intrepid: Donovan, Stephenson, and the Origin of CIA. New Haven, Yale University Press, 1996. (327.1273 Tro)
United States Air Force Oral History Interview: Col. Philip G. Cochran, 20-21 Oct 1975, 11 Nov 1975. Washington, D.C.: Office of Air Force History, USAF, 1975. (358.4 Uni)
United States Air Force Oral History Interview: Maj. Gen. John R. Alison, 22-28 April 1979. Washington, D.C.: Albert F. Simpson Historical Center, Office of Air Force History, USAF, (1979?). (358.4 Uni)

Wilson, Jeremy. Lawrence of Arabia: The Authorized Biography of T.E. Lawrence. New York: Collier Books, 1991. (940.415 Wil)
Womack, John. Zapata and the Mexican Revolution. New York: Knopf, 1969. (972.08 Wom)

## VII. PSYCHOLOGICAL WARFARE

The Art and Science of Psychological Operations: Case Studies of Military Applications. Army pamphlet #525-7-2. Washington, D.C.: U.S. Goverenment Printing Office, 1976. (355.3434 Ame)
Buhite, Russell D. Lives At Risk: Hostages and Victims in America Foreign Policy. Wilmington, Del.: Scholarly Resources, 1995. (327.73 Buh)
Chandler, Robert W. War of Ideas: The U.S. Propaganda Campaign Vietnam. Boulder, Colo.: Westview Press, 1981. (959.70438 Cha)
Cruickshank, Charles Greig. Deception in World War II. New York: Oxford University Press, 1979. (940.541 Cru)
---. The Fourth Arm: Psychological Warfare 1938-1945. London: Davis-Poynter, 1977. (940.54886 Cru)
Derry, Archie. Emergency in Malaya: The Psychological Dimension. Latimer, UK: Psychological Operations Section, Joint Warfare Wing, National Defence College, 1982. (959.504 Der)
German Psychological Warfare. Ed. Ladislas Farago. New York: Arno Press, 1972. (355.3434 Far)
Hazan, Barukh. Soviet Impregnational Propaganda. Ann Arbor, Mich.: Ardis Publishers, 1982. (947.085 Ha)
Hicks, Randolph D. Undercover Operations and Persuasion. Springfield, Ill.: C.C. Thomas, 1973. (363.232 Hic)
Johnson, Richard Denis. Seeds of victory : psychological warfare and propaganda . Atglen, PA : Schiffer Pub., 1997. (956.70442 Joh)
Lerner, Daniel. Psychological Warfare Against Nazi Germany; The Sykewar Campaign, D-Day to VE-Day. Cambridge, Mass.: M.I.T. Press, 1971. (940.54886 Ler)
Lescault, Maurice A. The Power of persuasion : Army PSYOP control and execution entering the third wave. Judge Advocate General _s School, United States Army, 1996. (355.3434 Les)
Linebarger, Paul. Psychological Warfare. New York: Arno Press, 1972. (355.3434 Lin)
MacCloskey, Monro. Alert the Fifth Force: Counterinsurgency, Unconventional Warfare, and Psychological Operations of the United States Air Force in Special Air Warfare. New York: R. Rosen Press, [1969]. (358.414 Mac)
Owen, David. Battle of Wits: A History of Psychology and Deception in Modern Warfare. London: Leo Cooper, 1978. (355.343 Owe)
Pease, Stephen E. Psywar: Psychological Warfare in Korea 1950-1953. Harrisburg, Pa.: Stackpole Books, 1992. (951.9042 Pea)
Petty, Richard E. Communication and Persuasion: Central and Peripheral Routes to Attitude Change. New York: Springer-Verlag, 1986. (302.24 Pet)
Psychological Operations and Political Warfare in Long-Term Strategic Planning. Ed. Janos Radvanyi. New York: Praeger, 1990. (327.14 Psy)
Psychological Operations: Principles and Case Studies. Maxwell Air Force Base, Ala.: Air University Press, 1996. (355.3434 Psy)
Psychological Operations: The Soviet Challenge. Ed. Joseph Gordon. Boulder, Colo.: Westview Press, 1988. (327 Psy)
Psychological Warfare and Propaganda: Irgun Documentation. Ed. Eli Tavin and Yonah Alexander. Wilmington, Del.: Scholarly Resources, 1982. (956.9404 Psy)
A Psychological Warfare Casebook. Comp. William E. Daugherty. Baltimore: Md.: Johns Hopkins University Press, 1958. (355.4 Daughtery)
Collection of information relating to all phases of psychological warfare--a handbook, history, how-to case histories, and articles by 73 experts in the field.
Qualter, Terence H. Propaganda and Psychological Warfare. New York: Random House, 1962. (301.154 Qua)
Readings in Psychological Operations. Ed. Frank L. Goldstein. Hurlburt Field, Fla.: USAF

Special Operations School, 1988. (355.343 Rea)
A collection of articles revealing what the _ best and the brightest _ feel is key to both offensive and defensive PSYOPS.
Richardson, F.M. Fighting Spirit, a Study of Psychological Factors in War. New York: Crane Russak, 1978. (355.123 Ric)
Roetter, Charles. The Art of Psychological Operations, 1914-1945. New York: Stein & Day, 1974. (940.488 Roe)
Simpson, Christopher. Science of Coercion: Communication Research and Psychological Warfare, 1945-1960. New York: Oxford University Press, 1994. (355.3434 Sim)
Examination of the role of the CIA, Pentagon, and other U.S. security agencies in the evolution of modern communication studies.
Torres, Herminio. Managing Meaning: The Role of Psychological Operations and Public Diplomacy in a National Information Warfare Strategy. Monterey, Calif.: Naval Postgraduate School, 1995. (355.3434 Tor)
Volkogonov, Dmitrii Antonovich. The Psychological War. Moscow: Progress Publishers, 1986. (355.3434 Vol)
White, John Baker. The Big Lie. New York: Crowell, 1955. (940.54 Whi)
How the great campaigns of World War II were influenced by psychological warfare.

## VIII. CIVIL-MILITARY RELATIONS

The Armed forces in contemporary Asian societies. Boulder, Colo. : Westview Press, 1986. (306.27 Arm)
Avant, Deborah D. Political institutions and military change : lessons from peripheral wars. Ithaca : Cornell University Press, 1994. (322.5 Ava)
Berghahn, Volker Rolf. Militarism : the history of an international debate, 1861-1979. New York : St. Martin _s Press, 1982. (355.021 Ber)
Civil affairs in Operations Desert Shield, Desert Storm, and provide comfort, 1990-1991 : some views of the operators about mobilization. Langley Air Force Base, VA : Army-Air Force Center for Low Intensity Conflict, 1993. (956.7043 Civ)
Cochran, Charles L. Civil-military relations; changing concepts in the seventies. New York : Free Press, 1974. (350.0895 Coc)
Edmonds, Martin. Armed services and society. Boulder : Westview Press, 1990. (306.27 Edm)
From massacres to genocide : the media, public policy, and humanitarian crises. Washington, D.C. : Brookings Institution, 1996. (363.34526 Fro)
Haulman, Daniel L. The United States Air Force and humanitarian airlift operations, 1947-1994. Washington, D.C. : Air Force History and Museums Program, 1998. (R 363.34 Hau)
Hendrickson, David C. Reforming defense : the state of American civil-military relations. Baltimore : Johns Hopkins University Press, 1988. (355.00973 Hen)
Huntington, Samuel P. The soldier and the state; the theory and politics of civil-military relations. Cambridge, Belknap Press of Harvard University Press, 1957. (342.73 Hun)
Mitchell, Janice L. Special operations forces as humanitarians? - you bet!. Newport, R.I. : Naval War College, 1993. (356.167 Mit)
Palmer, Dave Richard. 1794 : America, its army, and the birth of the nation. Novato, CA : Presidio, 1994. (973.43 Pal)
Rizer, Kenneth R. Military resistance to humanitarian war in Kosovo and beyond : an ideological explanation. Maxwell AFB, AL : Air University Press, 2000. (355.033 Riz)
Rouquie, Alain. The military and the state in Latin America. Berkeley : University of California Press, 1987. (322.5 Rou)
Seiple, Chris. Square-dancing into the future ; the U.S. military/NGO relationship and the CMOC in times of humanitarian intervention. Monterey, CA : Naval Postgraduate School, 1995. (361.6 Sei)
---.The U.S. military/NGO relationship in humanitarian interventions. Carlisle Barracks, PA : Peacekeeping Institute, Center for Strategic Leadership, U.S. Army War College, 1996. (361.6 Sei)
Somalia good intentions, deadly results. Phildelphia, PA : KR Video, 1997. (Video 967.7305 Som)

Snow, Donald M. From Lexington to Desert Storm : war and politics in the American experience. Armonk, N.Y. : M.E. Sharpe, 1994. (306.27 Sno)
Toner, James Hugh. True faith and allegiance : the burden of military ethics. Lexington : University Press of Kentucky, 1995. (174.9355 Ton)
U.S. civil-military relations. Washington, D.C. : Center for Strategic and International Studies, 1995. (322.5 U.S.)
Weiss, Thomas George. Humanitarian challenges and intervention : world politics and the dilemmas of help. Boulder, Colo. : Westview Press, 1996. (362.87052 Wei)
Winning the peace : the strategic implications of military civic action. New York : Praeger, 1992. (355.34 Win)

## IX. GENERAL WAR STUDIES

### SURVEY WORKS

Addington, Larry H. Patterns of War Since the Eighteenth Century. Bloomington: Indiana University Press, 1984. (355.009 Add)
Bado, Christopher. Intergration of Special Operations and Conventional Forces in Unconventional Warfare. Monterey, Calif.: Naval Postgraduate School, 1996. (355.02 Bad)
Brodie, Bernard. From Crossbow to H-Bomb. Bloomington: Indiana University Press, 1973. (355.009 Bro)
Chandler, Robert W. New face of war : weapons of mass destruction and the revitalization of America _ s transoceanic military strategy. McLean, Va. : Amcoda Press, 1998. (355.03307 Cha)
---. Tomorrow _s war, today _s decisions. McLean, Va. : AMCODA Press, 1996. (355.02 Cha)
Howard, Michael Eliot. War in European History. New York: Oxford University Press, 1976. (355.02 How)
Jomini, Antoine Henri, baron de. The Art of War. Novato, Calif.: Presidio Press, 1992. (355.02 Jom)
Jones, Archer. The Art of War in the Western World. Urbana: University of Illinois Press, 1987. (355.009 Jon)
Mandeles, Mark david. Managing _ command and control _ in the Persian Gulf War. Westport, Conn. : Praeger, 1996. (956.704 Man)
Preston, Richard A., et al. Men in Arms: A History of Warfare and Its Interrelationships With Western Society. New York: Holt, Rinehart, and Winston, 1979. (909 Pre)
Ropp, Theodore. War in the Modern World. Westport, Conn.: Greenwood Press, 1981. (355.009 Rop)
United States Special Operations Command. United States Special Operations Forces: 2000 Posture Statement. Washington, D.C.: Assistant Secretary of Defense for Special Operations and Low-Intensity Conflict, 1999. (356.16 Uni)

### AMERICAN MILITARY STUDIES

Drew, Dennis M. The Eagle _s Talons: The American Experience At War. Maxwell Air Force Base, Ala.: Air University Press, 1988. (355.00973 Dre)
The Future of Air Power in the Aftermath of the Gulf War. Ed. Richard H. Schultz and Robert L. Pfaltzgraff. Maxwell Air Force Base, Ala.: Air University Press, July 1992. (358.403 Fut)
Includes a chapter by Gen. Larry D. Welch, USAF, Retired, on _ Air Power in Low- and Mid-Intensity Conflict. _
Millett, Allan Reed. For the Common Defense: A Military History of the United States. New York: Free Press, 1984. (973 Mil)
Perret, Geoffrey. A Country Made By War: From the Revolution to Vietnam: The Story of America _s Rise to Power. New York: Random House, 1989. (306.27 Per)
Special Operations in Peace and War. N.p.: U.S. Special Operations Command, 1996. (356.167 Spe)
Toffler, Alvin. War and anti-war. New York : Warner Books, 1993. (355.02 Tof)

Walker, Greg. At the hurricane _s eye : U.S. Special Forces from Vietnam to Desert Storm. New York : Ivy Books, 1994. (356.167 Wal)
Weigley, Russell Frank. The American Way of War: A History of United States Military Strategy and Policy. New York: Macmillan, 1973. (355.42 Wei)

### MILITARY THEORY

Clausewitz, Carl von. On War. (Various editions shelved at 355 Cla)
Doughty, Robert Allan. The Seeds of Disaster: The Development of French Army Doctrine, 1919-1939. Hamden, Conn.: Archon Books, 1985. (355.00944 Dou)
Drew, Dennis M. Making Strategy: An Introduction to National Security Processes and Problems. Maxwell Air Force Base, Ala.: Air University Press, 1988. (355.03 Dre)
Liddel Hart, Basil Henry. Strategy. 2nd rev. ed. New York: Meridian, 1991. (355.4 Lid)
Makers of Modern Strategy: From Machiavelli to the Nuclear Age. Princeton, N.J.: Princeton University Press, 1986. (355.02 Mak)
Mets, David R. Land-Based Air Power in Third World Crises. Maxwell Air Force Base, Ala.: Air University Press, July 1986. (358.403 Met)
Sun-Tzu. The Art of War. New York: Oxford University Press, 1971. (355.02 Sun)
(also available as a sound recording at cassette 355.02 Sun)

### SPECIAL TOPICS

Avoiding War: Problems of Crisis Management. Ed. Alexander L. George. Boulder, Colo.: Westview Press, 1991. (327.16 Avo)
Blank, Stephen J., et al. Conflict, Culture, and History: Regional Dimensions. Maxwell Air Force Base, Ala.: Air University Press, January 1993. (303.6 Con)
Brodie, Bernard. War and Politics. New York: Macmillan, 1973. (327 Bro)
Douhet, Giulio. The Command of the Air. Washington, D.C.: Office of Air Force History, 1983. (358.4 Dou)
Karnow, Stanley. Vietnam, a History. New York: Viking Press, 1983. (959.704 Kar)
Summers, Harry G. On Strategy: The Vietnam War in Context. Carlisle Barracks, Pa.: Strategic Studies Institute, U.S. Army War College, 1981. (959.704 Sum) (Also available as a sound recording at Cassette 959.704 Sum.)
Van Creveld, Martin L. Command in War. Cambridge, Mass.: Harvard University Press, 1985. (355.33 Van)
Watts, Barry D. The Foundations of U.S. Air Doctrine: The Problem of Friction in War. Maxwell Air Force Base, Ala.: Air University Press, 1984. (358.4 Wat)

## X. DOCTRINE

Air Force Doctrine Document 35, Special Operations, 16 January 1995.
Air Force Doctrine Document 36, Foreign Internal Defense, 6 January 1995.
Air Force Manual 1-1, Basic Aerospace Doctrine of the United States Air Force.
Field Manual 100-20/Air Force Pamphlet, Military Operations in Low-Intensity Conflict. A multi-service publication that discusses the insurgency-counterinsurgency environment and describes U.S. military support of counterinsurgency through FID.
Joint Publication 1, Joint Warfare of the U.S. Armed Forces.
Joint Publication 3-05, Doctrine for Joint Special Operations. Describes, among other things, principal special operations missions and collateral activities. Includes discussion on special operations involvement in FID.
Joint Publication 3-07, Doctrine for Military Operations Other Than War. Sets forth the principals governing the joint conduct of U.S. foreign internal defense. Outlines basic military capabilities for FID and provides commanders guidance on how to organize, plan, and train for the employment of U.S. forces in support of counterinsurgency and miltinational operations.
Joint Publications 3-07.3, ITTP for Peacekeeping Operations.
Joint Publication 3-07.4, Joint Counter Drug Operations.
Joint Publication 3-07.5, Joint Doctrine for Contingency Operations.
Joint Publication 3-50.2, Doctrine for Joint Combat and Search and Rescue.

## XI. SPECIAL OPERATIONS IN THE 21st CENTURY

Adams, Thomas K. US special operations forces in action : the challenge of unconventional warfare. London ; Portland, OR : Frank Cass, 1998. (355.343 Ada)
Global Security Concerns: Anticipating the Twenty-First Century. Maxwell Air Force Base, Ala.: Air University Press, 1996. (355.02709 Glo)
Hakala, Jeffrey W. Combat Simulation Modeling in Naval Special Warfare Mission Planning. Monterey, Calif.: Naval Postgraduate School, 1995. (355.48 Hak)
Libicki, Martin C. What Is Information Warfare? Washington, D.C.: Center for Advanced Concepts and Technology, Institute for National Strategic Studies, National Defense University, 1995. (355.343 Lib)
Paschall, R. LIC 2010: Special Operations and Unconventional Warfare in the Next Century. London: Brassey _s 1990. (355.0218 Pas)
Security implications of SDI : will we be more secure in 2010? Washington, DC : National Defense University Press, 1990. (358.1 Sec)
Security studies for the 21st century. Washington : Brassey _s, 1997. (327.172 Sec)

## XII. SPECIAL OPERATIONS ELECTRONIC SOURCES

*Special Operations Bibliography:*
**carlisle-www.army.mil/library/bibs/special.htm**
This bibliography identifies selected books, documents, and periodical articles which present the
history, development, and current status of special operations.
*Operations other than war (OOTW):*
**carlisle-www.army.mil/library/bibs/ootw.htm**
This bibliography covers materials that address military operations other than war, to include civil assistance, short duration interventions, and post-combat restoration.
*Air Commandos & Special Operations:*
**home.earthlink.net/~aircommando1/**
Home page for the Air Commando Association. This site provides many links to information on
aircraft and units, both past and present.
*The USAF Special Operations School:*
**www.hurlburt.af.mil/usafsos/**
An excellent site, rich in both graphics and information. This site provides background information on the school, such as its history, the current commandant, and scheduled class dates. Additionally, it allows visitors to browse the school curriculum, view _ Commando Edge _ and course allocation & registration.
*U.S. Army Special Forces: The Quiet Professionals:*
**users.aol.com/armysof1/SpecialForces.html**
This site is just plain great! Scored well in all categories and received the _USA TODAY ONLINE Hot Site Award _ &and for good reason. This site is well designed with appropriate and stimulating pictures. It addresses topics related to Army Special Forces, including the history, mythology, organization, assessment process, mission and technology. Really, an allencompassing
primer for those who need some brushing up.
*US Army Special Forces.net*
**www.specialforces.net/army/special_forces/SFlinks.htm**
U.S. Army Special Forces _ De Oppresso Liber _ - This site provides information from Tom Hunter _s U.S. Special Operations to the story behind the Green Beret. This site contains link

to the locator of the Special Forces and Special Operators.
*The Library of Congress Country Studies:*
**lcweb2.loc.gov/frd/cs/cshome.html**
A continuing series of books prepared by the Federal Research Division of the Library of Congress under the Country Studies/Area Handbook Program sponsored by the Department of the Army. This online series presently contains studies of 85 countries. Countries that were previously in multi-country volumes are now available individually.
*The Harbor Site:*
**http://grunt.space.swri.edu/harbor.htm**
This section contains stories, essays, pictures, maps, and other material related to U.S. Army Special Forces, SOG (Special Operations Group), Marine Corps Reconnaissance Units, Navy SEAL, and other small unit, independent action forces that operated in Vietnam.
*Global Univision, Incorporated:*
**www.globalunivision.com/**
Global Univision is a company that utilizes Doctors, Nurses, Physician _s Assistants and Paramedics like any other medical company. However, all these people have Special Operations experience from the U.S. or other nations _ elite services.
*Special Operations.Com:*
**www.specialoperations.com/**
This is a very informative site with plenty of information not easily researched. It has a very extensive list of past special operation mission code names and a brief description of the corresponding operation. SpecialOperations.com provides resources ranging from special operations weapons history to special ops humor, current news and terrorism. The site also has a section dealing with vets _ resources.
*Foreign Military Studies Office:*
**call.army.mil/**
FMSO researches, writes & publishes material taken from unclassified sources regarding selected
foreign armed forces. It also studies civil-military and transnational security issues affecting the U.S. military.
*SpecWarNet:*
**www.specwarnet.com/**
Sections includes : Special forces, counter-terrorism, Taclink\SWAT, iSpec and Equipmennt. Thirty new news links in the USAF section as well as new material and a Pave Low page.
SOF History
**www.sofhistory.com/**
Web site is dedicated to the collection, preservation, and passing along of the rich history of the
U.S. Special operation forces (SOF) active, reserve, and retired communities.
January, 2002

# Doctrine for Joint Psychological Operations

## Joint Publication 3-53 September 2003

PREFACE

**1. Scope**
This publication addresses military psychological operations planning and execution in support of joint, multinational, and interagency efforts across the range of military operations.

**2. Purpose**
This publication has been prepared under the direction of the Chairman of the Joint Chiefs of Staff. It sets forth doctrine to govern the joint activities and performance of the Armed Forces of the United States in joint operations and provides the doctrinal basis for US military involvement in multinational and interagency operations. It provides military guidance for the exercise of authority by combatant commanders and other joint force commanders (JFCs) and prescribes doctrine for joint operations and training. It provides military guidance for use by the Armed Forces in preparing their appropriate plans. It is not the intent of this publication to restrict the authority of the JFC from organizing the force and executing the mission in a manner the JFC deems most appropriate to ensure unity of effort in the accomplishment of the overall mission.

**3. Application**
a. Doctrine and guidance established in this publication apply to the commanders of combatant commands, subunified commands, joint task forces, and subordinate components of these commands. These principles and guidance also may apply when significant forces of one Service are attached to forces of another Service or when significant forces of one Service support forces of another Service.
b. The guidance in this publication is authoritative; as such, this doctrine will be followed except when, in the judgment of the commander, exceptional circumstances dictate otherwise. If conflicts arise between the contents of this publication and the contents of Service publications, this publication will take precedence for the activities of joint forces unless the Chairman of the Joint Chiefs of Staff, normally in coordination with the other members of the Joint Chiefs of Staff, has provided more current and specific guidance. Commanders of forces operating as part of a multinational (alliance or coalition) military command should follow multinational doctrine and procedures ratified by the United States. For doctrine and procedures not ratified by the United States, commanders should evaluate and follow the multinational command's doctrine and procedures, where applicable and consistent with US law, regulations, and doctrine. For the Chairman of the Joint Chiefs of Staff:
JAMES A. HAWKINS
Major General, USAF
Vice Director, Joint Staff

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**COMMANDER'S OVERVIEW**

Provides an Overview of Psychological Operations
Discusses Organizational Responsibilities for Psychological Operations
Explains Command Relationships
Discusses Psychological Operations Planning in Support of the Joint Force Campaign
Highlights the Psychological Operations Approval Process
Discusses Psychological Operations Across the Range of Military

## Operations

## Overview

***The purpose of psychological operations(PSYOP) is to induce or reinforce foreign attitudes and behavior favorable tothe originator's objectives.There are three categories of military PSYOP: strategic, operational, and tactical.***

Psychological operations (PSYOP) are planned operations to convey selected information and indicators to foreign audiences to influence the emotions, motives, objective reasoning, and ultimately the behavior of foreign governments, organizations, groups, and individuals. PSYOP are a vital part of the broad range of US diplomatic, informational, military, and economic activities. PSYOP characteristically are delivered as information for effect, used during peacetime and conflict, to inform and influence. When properly employed, PSYOP can save lives of friendly and/or adversary forces by reducing adversaries' will to fight. By lowering adversary morale and reducing their efficiency, PSYOP can also discourage aggressive actions and create dissidence and disaffection within their ranks, ultimately inducing surrender. PSYOP are an integral part of military operations and, as such, are an inherent responsibility of all military commanders. There are three categories of military PSYOP, strategic, operational, and tactical, which are used to establish and reinforce foreign perceptions of US military, political, and economic power and resolve. Strategic PSYOP are international information activities conducted by US Government (USG) agencies to influence foreign attitudes, perceptions, and behavior in favor of US goals and objectives during peacetime and in times of conflict. These programs are conducted predominantly outside the military arena but can utilize Department of Defense (DOD) assets. Operational



PSYOP are conducted across the range of military operations, including during peacetime, in a defined operational area to promote the effectiveness of the joint force commander's (JFC's) campaigns and strategies. Tactical PSYOP are conducted in the area assigned a tactical commander across the range of military operations to support the tactical mission against opposing forces. During peacetime, the Secretary of Defense (or designated representative) translates national security policy into military policy. Because the execution of policy routinely contains an informational element and desires behavior favorable to its intent, there is an inherent psychological dimension. During war, policy flows directly from the President, as the Commander in Chief of the Armed Forces of the United States, and the Secretary of Defense through the Chairman of the Joint Chiefs of Staff to the combatant commanders. The combatant commander is responsible for the centralized direction and conduct of PSYOP within the command's area of responsibility.

PSYOP units support the JFC and contribute to all aspects of joint operations by performing the following missions:

Advising the supported commander through the targeting process regarding targeting restrictions, psychological actions, and psychological enabling actions to be executed by the military force. Influencing foreign populations by expressing information through selected conduits to influence attitudes and behavior and to obtain compliance or noninterference with friendly military operations. Providing public information to foreign populations to support humanitarian activities, ease suffering, and restore or maintain civil order.

Serving as the supported commander's voice to foreign populations by conveying the JFC's intent.

Countering adversary propaganda, misinformation, disinformation, and opposing information to correctly portray friendly intent and actions, while denying others the ability to polarize public opinion and affect the political will of the United States and its multinational partners within an operational area.

*The President andSecretary of Defense issue national security policy through directives and statements.PSYOP supports joint force commander missions.*


Organizational Responsibilities for Psychological Operations The Secretary of Defense participates in the establishment of national security policy and objectives and provides strategic PSYOP advice to USG agencies and allies. The Under Secretary of Defense for Policy (USD [P]) approves all PSYOP programs unless the authority is delegated to the
Assistant Secretary of Defense (Special Operations/Low Intensity Conflict) (ASD[SO/LIC]), and delegates product approval and dissemination authority to the appropriate level for peace, contingency, or war. The ASD(SO/LIC) acts as principal staff assistant and advisor to the Secretary of Defense, the Deputy Secretary of Defense,
and the USD (P) on PSYOP matters; coordinates PSYOP policy, plans, and programs with other USG departments and agencies; develops PSYOP policy for the Department of Defense; reviews and approves all PSYOP plans and programs delegated by the USD(P); and evaluates the effectiveness of DOD PSYOP plans and programs. The Chairman of the Joint Chiefs of Staff advises the President, Secretary of Defense, and National Security Council on all matters regarding PSYOP forces, capabilities, programs, and missions.

When directed by the Secretary of Defense, the Commander, US Special Operations Command transfers PSYOP forces by attachment to geographic combatant commanders. When these forces are transferred, the command relationship of the gaining commander (and the losing commander will relinquish) over those forces must be specified; in most cases that will be operational control.

PSYOP forces, organized as a joint psychological operations task force (JPOTF), normally serve as a subordinate joint command of a joint force. The JPOTF exercises command and control of those PSYOP assets assigned, attached, or in support from the Services components and, when applicable, from other nations. Further, although tactical PSYOP units are usually assigned to maneuver commanders, the JPOTF normally has coordinating authority with tactical forces for developing, producing, and disseminating PSYOP products.

*Organizational responsibilities for PSYOP involve many parts of the Department of Defense. Unless otherwise directed by the Secretary of Defense, the Commander, US Special OperationsCommand exercisescombatant command(command authority) over all assigned military PSYOP forces.*

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*The scale of operations generally will dictate the organization of PSYOP forces. Effective use of PSYOP increases the potential for operational success. The Chairman of the Joint Chiefs of Staff's execute order (authorized by the Secretary of Defense) should designate who has authority for PSYOP product approval and PSYOP product dissemination.*

As a crisis begins to develop, one of the first elements deployed to a supported commander is the PSYOP assessment team (POAT). The POAT provides staff support to the operations directorate (J-3) of the joint force. The POAT assesses the situation, confers with the commander, develops the PSYOP objectives, and recommends an appropriate combination of personnel, equipment, and support provided by Service components to accomplish the mission. If the POAT assesses that significant PSYOP forces are required to support the JFC's objectives, the POAT recommends to the JFC that a JPOTF or PSYOP support element be established.

PSYOP are involved in all three types of planning processes for joint operations: campaign, deliberate, and crisis action. Experience has repeatedly demonstrated that PSYOP planners must be involved throughout the planning process and that bringing PSYOP in early to the process can significantly improve the PSYOP contribution to the overall operation. The overall function of PSYOP is to cause selected foreign audiences to take actions favorable to the objectives of the United States and its allies or coalition partners. PSYOP forces are the only DOD asset given the authority to influence foreign target audiences (TAs) directly through the use of radio, print, and other media. PSYOP personnel specifically advise the supported commander on methods to capitalize on the psychological impacts of every aspect of force employment to achieve the overall campaign objectives. Their duties are wide-ranging but include, as a minimum, advising on the psychological impacts of planned operations, the identification of foreign TAs, and any psychological weaknesses. The Secretary of Defense normally delegates PSYOP product approval to the supported combatant commander. This does not mean that the supported combatant commander also has been delegated approval for PSYOP product dissemination. In some cases, PSYOP products may be politically sensitive and may require separate approval for dissemination. The supported combatant commander may, in turn, delegate PSYOP product approval to a joint task force (JTF) commander but not lower without approval of the Secretary of Defense.

In all PSYOP activities, commanders must be aware of two levels of product approval. PSYOP objectives and themes frame the products Psychological Operations Planning in Support of the Joint Campaign

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that reach foreign TAs and reflect national and theater policy and strategy. Approval of themes and messages is reserved by USG policy at Office of the Secretary of Defense-levels where the interagency process can address PSYOP products with a broad range of considerations. Commanders subordinate to JTF commanders can modify approved products, within the guidelines issued by higher headquarters, to better target local foreign TAs. Military operations other than war (MOOTW) not involving the use or threat of force that can be supported by joint PSYOP include foreign humanitarian assistance, nation assistance, foreign internal defense, consequence management, and DOD support to counterdrug operations. These military activities provide training and in-theater access to allow for the facilitation and use of PSYOP during the transition to war. Nonlethal activities such as PSYOP can be decisive in MOOTW involving the use or threat of force. Joint PSYOP are capable of supporting operations conducted during MOOTW, to include strikes and raids, combatting terrorism, foreign internal defense, enforcement of sanctions and maritime intercept operations, peace operations (e.g., peace enforcement operations), noncombatant evacuation operations or flexible deterrent options as directed. During war prehostilities, PSYOP can provide powerful operational leverage in support of flexible deterrent options. Among their potential contributions, PSYOP can be employed to gather critical information, undermine a potential opponent's will or capacity to wage war, or enhance the capabilities of multinational forces.

During war, PSYOP at the strategic, operational, and tactical level may enhance the success of operations at all echelons. PSYOP are operations planned to convey selected information and indicators to influence the emotions, motives, objective reasoning, and ultimately the behavior of foreign governments, organizations, groups, and individuals. To accomplish this goal, PSYOP must have a clearly defined mission, the ability to analyze and evaluate targets and their effects, a reliable media transmission, and a rapid ability to implement their activities. PSYOP depend on communications to ensure proper execution of the mission and objectives. This is accomplished by command and control, preplanning, and support from all levels of the chain of command.

*PSYOP support joint and multinational operations and designated government agencies.*
Psychological Operations Across the Range of Military Operations
CONCLUSION

# CHAPTER I
## PSYCHOLOGICAL OPERATIONS: AN OVERVIEW
I-1

> "In this war, which was total in every sense of the word, we have seen many great changes in military science. It seems to me that not the least of these was the development of psychological warfare as a specific and effective weapon." -- General of the Army Dwight D. Eisenhower

1. General
a. The employment of any instrument of national power, particularly the military instrument, has always had a psychological dimension. Foreign perceptions of US military capabilities are fundamental to strategic deterrence. The effectiveness of deterrence hinges on US ability to influence the perceptions of others.

Psychological operations (PSYOP) are planned operations to convey selected information and indicators to foreign audiences to influence their emotions, motives, objective reasoning, and ultimately the behavior of foreign governments, organizations, groups, and individuals. The purpose of PSYOP are to induce or reinforce foreign attitudes and behavior favorable to the originator's objectives. PSYOP are a vital part of the broad range of US diplomatic, informational, military, and economic activities. PSYOP characteristically are delivered as information for effect, used during peacetime and conflict, to inform and influence.

When properly employed, PSYOP can save lives of friendly and/or adversary forces by reducing adversaries' will to fight. By lowering adversary morale and reducing their efficiency, PSYOP can also discourage aggressive actions and create dissidence and disaffection within their ranks, ultimately inducing surrender.

b. The President and Secretary of Defense issue national security policy through directives and statements. During peacetime, the Secretary of Defense (or designated representative) translates national security policy into military policy. Because the execution of policy routinely contains an informational element and desires behavior favorable to its intent, there is an inherent psychological dimension. During war, policy flows directly from the President, as the Commander in Chief of the Armed Forces of the United States, and the Secretary of Defense through the Chairman of the Joint Chiefs of Staff (CJCS) to the combatant commanders. The combatant commander is responsible for the centralized direction and conduct of PSYOP within the command's area of responsibility (AOR). Early and full PSYOP support to the supported commander is critical throughout the crisis action planning process. "[Members of the Joint Psychological

Operations Task Force (JPOTF) of the Joint Task Force (JTF) NOBLE ANVIL] . . . Psychological Operations (PSYOP) played a key role throughout Operation ALLIED FORCE. Your efforts at influencing diverse groups ranging from Serb military and police forces in Kosovo, to the civilian population in Belgrade and in small towns and villages throughout the remainder of Serbia, to Kosovar Albanian refugees in camps in Albania and Macedonia, were truly impressive. Although difficult to measure, I truly believe your efforts had a significant impact on the success of the operation.



During the 78-day air campaign, the JPOTF developed over 40 different leaflets. More than 104.5 million leaflets were dropped throughout Serbia over the course of the campaign. The JPOTF also produced radio and television programming in Serbian and Albanian which was broadcast by EC-130E Commando Solo aircraft. The format for the program, modeled after National Public Radio's programming, set a high standard for honesty and objectivity and provided a valuable antidote to Serb propaganda. . . .

Your efforts, combined with other elements of the JTF, helped to save lives and to prevail in this conflict."
J.O. Ellis, Admiral, United States Navy Commander, Joint Task Force NOBLE ANVIL

2. Statutes and Policy

Several Presidential Security Directives and Executive Orders apply to PSYOP. Additionally, regulatory guidance pertaining to the conduct of PSYOP is promulgated by the Department of Defense (DOD).

*Specific Executive and departmental citations are listed in Appendix C, "References."*

3. Treaties and Agreements

Bilateral defense treaties usually have agreements concerning the conduct of PSYOP by the signatories. Use of PSYOP also may be regulated under status-of-forces agreements. A current list of treaties and other international agreements in force is found in Department of State Publication 9434, *Treaties In Force*.

4. Military Psychological Operations

a. PSYOP are an integral part of military operations and, as such, are an inherent responsibility of all military commanders. They have been used throughout history to influence foreign groups and leaders. Modern PSYOP are enhanced by the expansion of mass communications capabilities. Nations may multiply the effects of their military capabilities by communicating directly to their intended targets promises or threats of force or retaliation, conditions of surrender, safe passage for deserters, invitations to sabotage, support to resistance groups, and other messages. The effectiveness of this communication depends on the perception of the communicator's credibility and capability to carry out promises or threatened actions. It is important not to confuse psychological impact with PSYOP. Actions such as shows of force or limited strikes may have a psychological impact, but they are not PSYOP unless the primary purpose is to influence the emotions, motives, objective reasoning, decision making, or behavior of the foreign target audience (TA).



TRUTH IS THE BEST PROPAGANDA

". . . While B-52s rain terror from the skies, an elaborate psychological operation is fighting for the hearts and minds of Afghans, trying to turn them against Osama bin Laden. American armies have used PSYOP [psychological operations] since the Revolutionary War (leaflets were passed out to British soldiers at the battle of Bunker Hill promising free land if they defected). It has a reputation as a black art, the stuff of

Tokyo Rose and Nazi propaganda, but today's psywarriors act more like Madison Avenue ad executives — except they wear combat fatigues and jump out of planes.

Four PSYOP specialists, for example, parachuted in with Army Rangers who raided a Taliban compound and air base Oct. 19; they heralded the arrival of US forces by spreading leaflets with the picture of a New York firefighter raising an American flag. Psywarriors have found that 'the truth is the best propaganda,' says COL [Colonel] James Treadwell, the 4th [Psychological Operations] Group's commander. Otherwise, 'you lose credibility,' he explains, and the audience tunes out. Leaflets have explained how to use relief food packets and warned civilians to stay away from combat zones. Commando Solo's broadcasts mix world news stories with sales pitches. A recent show [broadcast], for example, reported on United Nations efforts to organize Taliban opposition groups and ended with the plea: 'this must happen for there to finally be peace in Afghanistan.' . . . . "

SOURCE: Douglas Waller, TIME.com, December 10, 2001

b. Every activity of the force has psychological implications that may be leveraged in the battle to influence a foreign TA. If communicated to the potential opponent, such things as the arrival of the force in the operational area, the multinational nature of the force, its combat power, technological sophistication, level of training, and preparation of US and multinational forces can break the adversary's will to fight.

c. Categories of military PSYOP are shown in Figure I-1.

d. Military PSYOP constitute a systematic process of conveying messages to selected foreign groups to promote particular themes that result in desired foreign attitudes and behaviors. PSYOP are used to establish and reinforce foreign perceptions of US military, political, and economic power and resolve.

5. Policies and Strategies

a. PSYOP in support of US national policies and strategies to resolve conflicts, deter hostile action, and attain objectives in crises or open hostilities are designed to influence foreign groups and leaders so that their behaviors and actions will promote the attainment of US national goals.



b. Strategic-level US Government (USG) departments and agencies conduct international information activities to influence foreign attitudes, perceptions, and behavior in favor of US goals and objectives. These activities predominantly take place outside the military arena but can use DOD assets and receive support from military PSYOP forces. Strategic PSYOP play an important role in theater security cooperation (TSC) agreements by supporting US country team initiatives such as counterdrug and mine awareness programs.

c. Operational-level PSYOP are designed to strengthen US and multinational capabilities to conduct military operations in the operational area and accomplish particular missions across the range of military operations. Along with other military operations, PSYOP may be used independently or as an integral part of other operations throughout the operational area. Operational-level PSYOP also play an important role in supporting military-to-military programs as part of TSC agreements. These initiatives have promoted military professionalization and human rights programs within host nation militaries, as well as many other programs designed to improve civil-military relations.

d. Tactical-level PSYOP outline how military force will be employed against opposing forces to attain tactical objectives. PSYOP are conducted as an integral part of multinational, joint, and single-Service operations.

*For details concerning PSYOP support to multinational operations, refer to Chapter VI, "Psychological Operations Across the Range of Military Operations."*
Figure I-1. Categories of Military Psychological Operations

## CATEGORIES OF MILITARY PSYCHOLOGICAL OPERATIONS

Strategic Psychological
Operations (PSYOP)
International information activities
conducted by US Government
agencies to influence foreign
attitudes, perceptions, and behavior
in favor of US goals and objectives
during peacetime and in times of
conflict. These programs are
conducted predominantly outside
the military arena but can utilize
Department of Defense assets.
Military PSYOP with potential
strategic impact must be
coordinated with national efforts.
Operational PSYOP
Conducted across the range of
military operations, including during
peacetime, in a defined operational
area to promote the effectiveness of
the joint force commander's
campaigns and strategies.
Tactical PSYOP
Conducted in the area assigned a
tactical commander
to support the
tactical mission against opposing
forces.
across the range
of military operations



6. Missions
a. PSYOP units support the joint force commander (JFC) and contribute to all aspects of joint operations by performing the following missions:

(1) Advising the supported commander through the targeting process regarding targeting restrictions, psychological actions, and psychological enabling actions to be executed by the military force.
(2) Influencing foreign populations by expressing information through selected conduits to influence attitudes and behavior and to obtain compliance or non-interference with friendly military operations.
(3) Providing public information to foreign populations to support humanitarian activities, ease suffering, and restore or maintain civil order.
(4) Serving as the supported commander's voice to foreign populations by conveying the JFC's intent.

(5) Countering adversary propaganda, misinformation, disinformation, and opposing information to correctly portray friendly intent and actions, while denying others the ability to polarize public opinion and affect the political will of the United States and its multinational partners within an operational area.
(6) The above missions highlight the fact that PSYOP are a force multiplier and one of the most effective nonlethal weapons available to a JFC.

7. Principles of Joint Psychological Operations

"If you are going to win any battle, you have to do one thing. You have to make the mind run the body. Never let the body tell the mind what to do . . . the body is never tired if the mind is not tired."
General George S. Patton, US Army

a. PSYOP Methodology. Although the complexity of the methodology varies with the foreign TAs, basic considerations for development of all PSYOP are the same. The following are essential to successful PSYOP:

(1) PSYOP Core Task. The PSYOP core task must be clearly defined in terms that correspond to the supported commander's vision of how the campaign or operation will proceed.
(2) PSYOP Approval Process. The PSYOP approval process must be clarified in the initial planning, and modified as required to facilitate the process. (See Chapter V, "Psychological Operations Approval Process.")



(3) Early Planning. Early planning and employment of PSYOP are critical in maximizing their impact upon the foreign TA.
(4) PSYOP Themes, Activities, and Symbols. PSYOP themes, activities, and symbols should be based on a thorough analysis of targets, including friendly and adversary PSYOP capabilities, strengths, and weaknesses.
(5) Impact of Military Operations. All military force presence and actions should be thoroughly evaluated for their psychological implications and, where necessary, supported by deliberate PSYOP to offset potentially negative effects and reinforce positive effects.
(6) Media Selection. The medium or media selected for transmission or dissemination should be relevant, reliable, and readily accessible by the intended foreign TAs. The potential for adverse environmental consequences should also be weighed as planners select the appropriate medium or media.
(7) Timeliness. Timely exploitation of PSYOP themes is critical. The PSYOP process is interactive, the dynamics of which force the executor to perform an action, assess a reaction, and implement an appropriate counteraction. The PSYOP approval process is rooted in DOD policy to ensure adequate oversight of this potential activity. A streamlined and responsive approval process will facilitate the flexibility a commander requires.
(8) Continuous Assessment. Where possible, the results of PSYOP should be continually evaluated for relevance to the mission and to national and military goals. As with initial planning actions, decisions to terminate or revise PSYOP programs must be linked to careful analysis of all-source intelligence.
(9) Measure of Effectiveness. A PSYOP measure of effectiveness (MOE) provides asystematic means of assessing and reporting the impact a PSYOP program (series of PSYOP products and actions) has on specific foreign TAs. PSYOP MOE, as all MOE, change from mission to mission and encompass a wide range of factors that are fundamental to the overall effect of PSYOP. PSYOP impact indicators collectively provide an indication of the overall effectiveness of the PSYOP task. Development of MOE and their associated impact indicators (derived from measurable supporting PSYOP objectives) must be done during the planning process. By determining the measure in the Soldiers erect the antenna of the Special

Operations Media System-Broadcast (SOMS-B) capable of providing local radio and television support including editing of radio and audiovisual products.



planning process, PSYOP planners ensure that organic assets and PSYOP enablers, such as intelligence, are identified to assist in evaluating MOEs for the execution of PSYOP. Evaluating the effectiveness of PSYOP may take weeks or longer given the inherent difficulties and complexity of determining cause and effect relationships with respect to human behavior.

b. Psychological Impact. The psychological dimension affects those fighting the battle, their military leaders and staffs, the political leaders, and the civilian population. Within the battlespace, US forces want to face an adversary that is both unsure about its cause and capabilities and sure about its impending defeat — an adversary who, even if unwilling to surrender, has little will to engage in combat.

"To seduce the enemy's soldiers from their allegiance and encourage them to surrender is of especial service, for an adversary is more hurt by desertion than by slaughter."

Flavius Vegetius Renatus,
The Military Institutions of the Romans, c. 378 AD

c. Support Requirements. Support requirements for successful PSYOP are shown in Figure I-2 and discussed below.

(1) Intelligence Support

(a) Intelligence. Intelligence support for military PSYOP requires detailed information concerning the target identity, location, vulnerabilities, accessibility, and the political, economic, social, cultural, religious, and historic conditions within the operational area. Intelligence also supports the detection and analysis of adversary propaganda programs in support of PSYOP counterpropaganda activities. Collection should be from all available sources and agencies and is based upon thorough mission and requirements planning. Developing a well-planned collection management architecture ensures that the requisite intelligence is available to support the development of PSYOP.

For further details concerning intelligence support to PSYOP, refer to Chapter VII, "Psychological Operations Enablers."

(b) Counterintelligence. Counterintelligence support for military PSYOP consists of identifying, exploiting, deterring, or neutralizing foreign intelligence service targeting of PSYOP plans, operations, personnel, and equipment, especially at the operational and tactical levels. Upon execution of PSYOP, counterintelligence and human intelligence (HUMINT) operations can provide feedback on its effect.

(2) Command, Control, Communications, and Computer Systems (C4S). Military C4S are vital to planning, mounting, and sustaining successful joint PSYOP. The Services must design C4S that provide interoperable, rapid, reliable, and secure exchange of information throughout the chain of command.



*For further details concerning C4S, refer to Chapter VII, "Psychological Operations Enablers."*

(3) Logistic Support. Support of joint PSYOP places unique additional demands on Service and theater logistic systems. Although the majority of PSYOP sustainment requirements are satisfied by standard Service support systems, PSYOP-specific equipment is generally low-density items requiring careful

management. To ensure continuous sustainment and support of PSYOP, commanders, planners, and logisticians must plan for and coordinate the effective procurement and distribution of operating supplies, repair parts, and major end items for PSYOP-specific equipment. Distribution of these assets to PSYOP forces may pose problems that are dictated by the nature of the operation, the existing transportation infrastructure, and rates of consumption. Before any PSYOP plan is executed, all aspects of logistic supportability must be considered and coordinated. Emphasis also should be placed on locating and using equipment and supplies already available in theater; i.e., printing presses and radio and/or television (TV) broadcast transmitters.

*For further details concerning logistic support to PSYOP, refer to Chapter VII, "Psychological Operations Enablers."*

Figure I-2. Psychological Operations Support Requirements

PSYCHOLOGICAL OPERATIONS SUPPORT REQUIREMENTS

Intelligence
Intelligence support to PSYOP includes current and accurate intelligence for PSYOP analysis and assessment, as well as counterintelligence detection, deterrence, or neutralization of foreign intelligence targeting

Command, Control, Communications, and Computer Systems
Provide interoperable, rapid, reliable, and secure exchange of information

Logistics
All aspects of logistic supportability must be considered and coordinated





8. Psychological Operations Relationships

a. PSYOP Relationship to Public Affairs (PA)

> "One cannot wage war under present conditions without the support of public opinion, which is tremendously molded by the press and other forms of propaganda."
>
> General Douglas MacArthur, US Army

(1) PSYOP are used to influence the attitudes, opinions, and behaviors of foreign TAs in a manner favorable to US objectives.

(2) Military PA are the public information, command/internal information, and community relations activities directed toward both the external and internal audience with interest in the Department of Defense. PA provide accurate and timely information without attempting to influence or sway the audience. As open sources to foreign countries and the United States, PA channels can be used to disseminate international information. To maintain the credibility of military PA, care must be taken to protect against slanting or manipulating such PA channels. PA channels can be used to provide facts that will counter foreign propaganda, including disinformation, directed at the United States.

(a) PA operations and activities shall not focus on directing or manipulating public actions or opinion.

(b) PA and PSYOP products should provide a timely flow of information to external and internal audience. Based on policy, PA and PSYOP must be separate and distinct even though they reinforce each other and involve close cooperation and coordination. Each function requires distinct efforts to plan, resource, and

execute as part of the commander's operation plan (OPLAN). It is critically important that PA and PSYOP coordinate with each other to maintain credibility with their respective audiences. Therefore, PSYOP representatives should coordinate with command PA offices supporting the joint information bureau and PA representatives present within joint planning organizations such as the joint planning group, operations planning group, or information operations (IO) working group to integrate operational activities while strictly maintaining autonomy.
(c) PA and PSYOP products must be coordinated and deconflicted early in the planning process and during execution. Although PA and PSYOP generated information may be different, they must not contradict one another or their credibility will be lost. Although each has specific audiences, information often will overlap between audiences. This overlap makes deconfliction crucial. Under no circumstances will personnel working in PA functions or activities engage in PSYOP activities. Commanders will establish separate agencies and facilities for PA and PSYOP activities, with PA being the commander's primary contact with the media.


*For further details concerning PA, refer to Joint Publication (JP) 3-61,* Doctrine for Public Affairs in Joint Operations.

b. PSYOP Relationship to Military Deception and Operations Security (OPSEC). PSYOP convey information not only to intended PSYOP foreign TAs but also to foreign intelligence services and their customers. Therefore, PSYOP messages must be coordinated with counterintelligence planners and operators, with military deception planners, and with OPSEC planners to ensure that essential secrecy is realized, counterintelligence operations are not compromised, and messages reinforce the desired outcomes of counterintelligence and deception as well as PSYOP plans. Additionally, PSYOP can be executed to support deception actions or vice versa.

(1) Military Deception Operations
(a) PSYOP normally are directed toward a TA whereas military deception operations normally target specific individuals, i.e., adversary decision makers. An individual targeted by military deception also may be part of a target group. Groups that might be suitable for targeting by PSYOP in support of military deception include adversary command groups, planning staffs, specific factions within staffs, nonmilitary interest groups who can influence military policies and decisions, and intelligence systems analysts.
(b) PSYOP can magnify the effects of and reinforce military deception plans through the skillful use of associated truths. Dedicated PSYOP dissemination assets can discreetly convey intended information to selected foreign TAs through appropriate "key communicator" back channel networks. PSYOP convey information not only to the intended foreign TAs but also to foreign intelligence systems. This provides the opportunity for mutual support if military deception and PSYOP are carefully coordinated.
(c) PSYOP units plan and conduct counterpropaganda operations that can complement and enhance military deception operations. Counterpropaganda operations are those PSYOP activities that identify adversary propaganda, contribute to situational awareness, and serve to expose adversary attempts to influence friendly populations and military forces.
(2) Operations Security
(a) PSYOP integrate with OPSEC to assist in denying critical information about friendly forces to an adversary.
(b) Planning for, preparing for, and conducting PSYOP and psychological actions must be accomplished to maintain essential secrecy for the commander's intent and to gain and maintain essential secrecy for OPSEC-sensitive PSYOP courses of action (COAs).

*For further details concerning military deception and OPSEC, refer to JP 3-58,* Joint Doctrine for Military Deception*, and JP 3-54,* Joint Doctrine for Operations Security*, respectively.*

9. Psychological Operations Integration with Information Operations

a. General

(1) IO exploit the opportunities and vulnerabilities inherent in dependence on information supporting military activities. IO should be conducted in concert with operations conducted by general-purpose military forces to provide a fully integrated warfighting capability. In peacetime, IO support national objectives primarily by influencing foreign perceptions and decision making. In crisis and hostilities, IO can be used as a flexible deterrent option to communicate national interest and demonstrate resolve. In conflict, IO can be applied to achieve physical and psychological results in support of military objectives. IO contribute by taking advantage of information technology, exploiting the growing worldwide dependence upon automated information systems and near real time global dissemination of information, to affect adversary decision cycles with the goal of achieving information superiority.

(2) IO contribute by both defending military decision making from adversary attacks and degrading an adversary's decision-making capability, thereby producing a relative information advantage. IO also contribute by shaping adversary perceptions and behavior.

b. Core Capabilities. IO core capabilities are employed by DOD components to influence foreign decision makers or groups while protecting friendly decision making. PSYOP, military deception, and OPSEC are three core capabilities associated with influencing foreign decision making. Electronic warfare (EW) and computer network operations (CNO) are concerned with affecting or defending the electromagnetic spectrum, information systems, and information that support decision makers, weapon systems, command and control (C2) and automated responses. Integration of all of these core capabilities is critical to mission accomplishment.

c. Integration

(1) As one of the core capabilities of IO, PSYOP must be integrated with the other IO capabilities providing mutual benefits for both. PSYOP are used to conduct counterpropaganda,

## KEY TERM

INFORMATION OPERATIONS:

*Actions taken to affect adversary information and information systems while defending one's own information and information systems. Also called IO.*



induce or reinforce attitudes and behavior to friendly objectives, and discourage support for adversaries and their goals. As an integrated part of the IO plan PSYOP can:

(a) Integrate with IO capabilities by either providing or withholding information for adversary analysis.
(b) Be used to attack adversary legitimacy and credibility.
(c) Build and sustain support among selected foreign TAs.
(d) Shift loyalty of adversary forces.
(e) Help promote the cessation of hostilities.
(f) Undermine adversary confidence.
(g) Persuade isolated and bypassed adversary forces to surrender.

(2) PSYOP are an integrated part of IO through effective analysis of adversary propaganda and information efforts to:

(a) Counter and diminish adversary propaganda efforts.
(b) Discourage adversary offensive operations.
(c) Assist host/foreign nation in providing information and support to its civilian populace.

(d) Reduce or neutralize support of adversary operations.
(e) Reorient or educate the selected foreign TAs in liberated or occupied territory.
(f) Support command information programs.
d. Psychological Operations and the Information Operations Cell
(1) PSYOP is a critical core capability of IO. They are conducted to influence foreign TAs. PSYOP are also an important contributor when conducting interagency coordination for joint operations involving the influence of foreign TAs.
(2) The coordination of IO elements is critical to successful execution of IO.
(3) The JFC's staff, which includes the IO cell, develops and promulgates guidance/ plans for IO that are passed to the components and supporting organizations and agencies for detailed mission planning and decentralized execution. The IO cell integrates the broad range

 of potential IO actions and activities that help contribute to the JFC's desired end state in an operational area.

(4) The IO cell is comprised of representatives from each staff element, component, and supporting agency responsible for integrating IO capabilities and related activities.
(a) PSYOP representatives to the IO cell are integral members of the cell.
(b) The duties PSYOP representatives perform in the IO cell are in addition to the ones they perform, for example in a joint psychological operations task force (JPOTF).
(c) In the IO cell, PSYOP representatives integrate, coordinate, deconflict, and synchronize the use of PSYOP with IO capabilities and related activities. They also advise and/ or recommend on multinational information activities within a JFC's operational area, that may support IO.
(d) It is important to note that these representatives integrate the PSYOP supporting plans with the overall IO strategy.
(e) A PSYOP representative must be prepared, at the direction of the JFC or Director of the Joint Staff, to assume duties as chief of the IO cell.

*For further detail concerning IO, refer to JP 3-13,* Joint Doctrine for Information Operations*, Department of Defense Directive (DODD) S3600.1,* Information Operations (IO) (U)*, and Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3210.01A (S),* Joint Information

## Operations Policy (U).

e. Information Operations Support to a Joint Psychological Operations Task Force
(1) The IO cell supports the JFC's JPOTF by performing the following tasks:
(a) The cell supports improved PSYOP product development by obtaining critical personality profiling data and human factor analysis data for PSYOP use and obtains special information not usually available through DOD intelligence systems for PSYOP use upon request. It also can augment dissemination of PSYOP products and programs via non-standard dissemination assets or platforms, and provide responsive access and use of classified and compartmented information and programs for PSYOP forces as required.
(b) The cell facilitates PSYOP communications, distribution, and dissemination through joint restricted frequency list deconfliction, frequency spectrum analysis, media analysis, propagation analysis, and modeling, and helps in the facilitation of PSYOP contingency planning by coordinating resources to support the PSYOP scheme of maneuver. Additionally, it facilitates the PSYOP product approval process as part of an IO program and foreign TA polling, post-test analysis, and impact assessment of PSYOP programs, and establishes systems for adversary propaganda collection, reporting, and analysis to facilitate PSYOP counterpropaganda programs.

(c) The cell coordinates and synchronizes PSYOP with IO capabilities and related activities and other aspects of joint force operations and assists in the collection and analysis of impact indicators and MOE of PSYOP plans and programs. Furthermore, it assists in coordination and synchronization with strategic information operations, programs, or activities, and helps coordinate PSYOP requirements for support from other government agencies at the strategic level.
(d) The cell ensures the integration of PSYOP with military deception, EW, CNO, OPSEC, and related activities of PA and civil-military operations (CMO). The cell also ensures the joint targeting coordination board (JTCB) supports the JFC PSYOP objectives.
(e) The cell makes sure that the JTCB has the support of PSYOP subject matter experts.
(2) If military potential is to be maximized, PSYOP and IO cannot be conducted in a vacuum; rather, they must be woven into the strategies and operations across the range of military operations to include integrating them with joint, multinational, and interagency operations.

PSYCHOLOGICAL OPERATIONS IMPACT

Millions of PSYOP [psychological operations] leaflets were dropped [during Operations DESERT SHIELD and DESERT STORM]; they called on the Iraqis not only to surrender, but also warned them to stay away from their equipment because it was the target of Coalition air strikes. Most leaflets were dropped by MC-130s. F-16s and other aircraft flew several missions a day carrying the MK 129 leaflet container, showering the Iraqi troops with messages and warnings. USMC [United States Marine Corps] A-6s dropped another version of the leaflet in Kuwait. UH-1Ns used loudspeakers and Arab linguists to convince Iraqi soldiers to surrender along the Kuwait border. One leaflet depicted a mosque and a schoolyard, in which Saddam Hussein had liberally interspersed tanks, AAA [antiaircraft artillery] guns, and other military equipment. The message to the Iraqi soldier was that Saddam Hussein was deliberately endangering their religion and families. The detonation of several 15,000-pound bombs, which were dropped from MC-130 special operations planes, also seemed to have a psychological effect on Iraqi troops. Senior Iraqi officer EPWs [enemy prisoners of war] frequently commented that their troops also were terrified of B-52s, and could clearly see and hear their strikes, even when miles away.

SOURCE: Final Report to Congress
Conduct of the Persian Gulf War, April 1992

# CHAPTER II
## ORGANIZATIONAL RESPONSIBILITIES FOR PSYCHOLOGICAL OPERATIONS

"For a strong adversary (corps) the opposition of twenty-four squadrons and twelve guns ought not to have appeared very serious, but in war the psychological factors are often decisive. An adversary who feels inferior is in reality so."--- Field Marshal Carl Gustav Baron von Mannerheim

The Memoirs of Field Marshal Mannerheim, 1953

### 1. Responsibilities

The following responsibilities are outlined in DODD S3321.1, *Overt Peacetime Psychological Operations Conducted by the Military Services in Contingencies Short of Declared War*:

a. The Secretary of Defense:
(1) Participates in the establishment of national security policy and objectives.

(2) Recommends to the President the mobilization of Reserve Components (RC) assets, as necessary, and provides strategic PSYOP advice to USG agencies and allies.
b. The Under Secretary of Defense for Policy (USD[P]):
(1) Approves all PSYOP programs not delegated to the Assistant Secretary of Defense (Special Operations/Low Intensity Conflict) (ASD [SO/LIC]).
(2) Delegates product approval and dissemination authority to the appropriate level for peace, contingency, or war.
c. The ASD(SO/LIC):
(1) Acts as principal staff assistant and advisor to the Secretary of Defense, Deputy Secretary of Defense, and USD(P) on PSYOP matters.
(2) Represents the Secretary of Defense in interagency forums and coordinates PSYOP policy, plans, and programs with other USG departments and agencies.
(3) Provides guidance on the planning and conduct of PSYOP activities and their integration into USG activities during peacetime, and more specific guidance for the planning and conduct of these activities across the range of military operations.
(4) Develops PSYOP policy for the Department of Defense.




(5) Reviews and approves all DOD PSYOP programs delegated by USD(P).
(6) Evaluates the effectiveness of DOD PSYOP programs.
d. The Assistant Secretary of Defense (International Security Affairs) reviews all DOD PSYOP plans and programs and provides recommendations to the ASD(SO/LIC) on the development of specific PSYOP programs affecting the geographic combatant commanders.
e. The Assistant Secretary of Defense for Command, Control, Communications, and Intelligence and the Assistant Secretary of Defense for Public Affairs review all DOD PSYOP plans and programs and provide recommendations to the ASD(SO/LIC) on the development of specific PSYOP programs affecting their responsible areas.
f. The DOD General Counsel conducts legal reviews of all proposed PSYOP programs.
g. The Chairman of the Joint Chiefs of Staff:
(1) Advises the President, Secretary of Defense, and National Security Council on all matters regarding PSYOP forces, capabilities, programs, and tasks.
(2) Represents the Secretary of Defense on the North Atlantic Treaty Organization PSYOP Working Group and in other multinational military forums.
(3) Coordinates and directs the preparation of multinational PSYOP plans and US participation in multinational military PSYOP training programs.
(4) Provides PSYOP representation to the interagency organizations and their working groups.
(5) Provides the general policy and establishes production priorities for the PSYOP Studies Program.
(6) Provides the guidance for PSYOP conducted by the combatant commanders.
(7) Prepares strategic plans and issues policy for the use of military PSYOP across the range of military operations.
(8) Reviews the PSYOP plans and programs of the combatant commanders to ensure they are adequate, feasible, and consistent with USG and DOD policy.
(9) Provides PSYOP plans and programs to the Office of the Secretary of Defense for eview and approval.
(10) Reviews the peacetime psychological operations plans and programs of the combatant commanders.





(11) Establishes in conjunction with the Commander, US Special Operations Command (USSOCOM) joint doctrine for PSYOP.

(12) Provides a joint, prioritized statement of military requirements for PSYOP capabilities to meet the needs of the Secretary of Defense, the Service Chiefs, combatant ommanders, and the Chairman of the Joint Chiefs of Staff.
(13) Provides an integrated statement of joint PSYOP training requirements and ensures that these requirements are appropriately addressed.
(14) Apportions PSYOP forces to the combatant commands through the Joint Strategic Capabilities Plan (JSCP).
(15) Prepares integrated logistic and mobilization guidance for PSYOP capabilities.
(16) Provides a unified, prioritized list of PSYOP intelligence and counterintelligence requirements to meet the needs of the combatant commanders, Joint Staff, and Services
(17) Ensures integration of PSYOP activities into the CJCS Exercise Program and Joint Experimentation Program.
(18) Incorporates PSYOP instruction into joint professional military education programs.
(19) Ensures integration of PSYOP activities into military planning for TSC activities, contingency operations, and war.
(20) Ensures integration of PSYOP activities into the preparation and review of joint OPLANs that conform to policy guidance from the President and Secretary of Defense.
h. Geographic combatant commanders have the following responsibilities in addition to those listed in Annex D, JSCP and those listed for all military commanders:
(1) Designate specific staff responsibility for maintaining a PSYOP planning element, coordinating PSYOP actions, and ensuring that regional plans, activities, and operations support national psychological objectives.
(2) Develop intelligence and counterintelligence requirements necessary to perform PSYOP analysis, planning, and execution.
(3) Plan, support, and conduct in peacetime and during conflict PSYOP activities in support of theater military missions and US national and regional objectives. Peacetime PSYOP must be coordinated with the chiefs of US Diplomatic Missions within the combatant commander's geographic AOR.



(4) Prepare PSYOP plans and, upon approval, conduct theater PSYOP to support the execution of operations.
(5) Foster cooperative PSYOP policies among multinational military forces and regional security organizations.
(6) Ensure advance contingency planning for use of non-DOD informational and related capabilities in DOD PSYOP.
(7) Establish a PSYOP reporting system to provide relevant information about PSYOP adversary activity, apparent impact of friendly PSYOP activities, and any anticipated changes to ongoing PSYOP activities.
(8) Integrates PSYOP activities into the preparation and review of joint OPLANs.
i. Combatant Commanders (less Commander, USSOCOM) have the following responsibilities in addition to those listed for all military commanders:
(1) Ensure that staffs and organizations within their commands have sufficient representation and working proficiency in the planning and conduct of joint PSYOP. This includes requesting liaison officers from other USG agencies when appropriate.
(2) Develop plans and programs, in coordination with the Joint Staff and the USSOCOM, to support PSYOP requirements identified by supported geographic combatant commanders, and develop and submit to the Chairman of the Joint Chiefs of Staff additional PSYOP requirements necessary to support geographic combatant commanders.
(3) When directed by the Secretary of Defense, accept the attachment of PSYOP forces from the Commander, USSOCOM. Employ these forces as directed.
j. Commander, USSOCOM. The Commander, USSOCOM's responsibilities for the development of strategy, doctrine, and tactics for joint PSYOP are interrelated with those of the Service Chiefs. The Commander, USSOCOM exercises combatant command (command authority) (COCOM) of all active and

reserve US Army PSYOP forces. The Commander, USSOCOM has the following responsibilities in addition to those detailed in Annex D, JSCP:

(1) Prepares program and budget to fund approved PSYOP programs. In fulfilling this responsibility, the Commander, USSOCOM coordinates with the Chairman of the Joint Chiefs of Staff, Service Chiefs, and the other combatant commanders to ensure that all PSYOP and support requirements are addressed.
(2) Provides trained and ready PSYOP forces to support the Secretary of Defense and the other combatant commanders with strategic, operational, and tactical PSYOP support.



(3) Acts as CJCS Executive Agent for the programming, training, and equipping of joint PSYOP forces.
(4) Prepares and provides assigned PSYOP forces to the other combatant commanders, when directed by the Secretary of Defense.
(5) Supports the other combatant commanders' PSYOP requirements.
(6) Provides the special operations (SO)-peculiar resources necessary to sustain the forces, capabilities, and support programs. This includes identification of PSYOP future concepts, technology development, and acquisition of PSYOP systems.
(7) Provides training to foreign military personnel, when directed.
(8) Recommends PSYOP policy guidance to the Chairman of the Joint Chiefs of Staff, Service Chiefs, and US military commanders, as required.
(9) Validates and develops priorities for PSYOP training, intelligence, and military requirements and provides these to the Chairman of the Joint Chiefs of Staff to support Service, combatant command, and Joint Staff responsibilities as they relate to PSYOP.
(10) Provides visibility of PSYOP issues, activities, tasks, and capabilities to the Chairman f the Joint Chiefs of Staff, Service Chiefs, and commanders at other US military command levels.
(11) Coordinates with the Commander, US Joint Forces Command (USJFCOM) to integrate PSYOP activities into joint training and experimentation plans and programs.
(12) Acts as the lead agent for joint PSYOP doctrine development.
(13) Develops PSYOP concepts to support national security objectives, reviews Service PSYOP doctrine development for consistency with joint doctrine, and ensures that joint and Service PSYOP training supports national objectives.
(14) Participates with assigned PSYOP forces in CJCS and combatant command exercises to develop joint tactics, techniques, and procedures for PSYOP forces.
(15) Manages the PSYOP Studies Program and coordinates PSYOP input to the Defense Intelligence Production schedule.
(16) Ensures that PSYOP forces are trained to plan and conduct PSYOP in regions to which they are apportioned.
(17) Provides for employment of RC PSYOP forces in planning, developing concepts, and participating in joint training exercises and contingency operations.



(18) Coordinates with the Service Chiefs for planning and providing combat support, combat service support, and sustainment of PSYOP forces assigned to the other combatant commanders for conduct of PSYOP.

k. The Military Departments and Services:

(1) Provide civilian and military personnel with appropriate PSYOP training and planning skills.

(2) Provide capabilities organic to Service forces to execute PSYOP actions and dedicated PSYOP forces and equipment.
(3) Develop Service PSYOP doctrine relating to the primary functions assigned to the particular Service.
(4) Provide PSYOP forces or detachments (not assigned to the Commander, USSOCOM) to combatant commanders for service in foreign countries.
(5) Provide departmental intelligence and counterintelligence assets that are trained, equipped, and organized to support planning and conduct PSYOP.
(6) Incorporate PSYOP instruction into Service training and education programs.

*For further detail concerning Service PSYOP capabilities, refer to Appendix A, "Department of Defense Psychological Operations Capabilities."*

l. The Chief of Staff, US Army, in addition to responsibilities delineated as Chief of a Service, trains foreign personnel in PSYOP, when required.
m. Joint task force (JTF) commanders have the following responsibilities in addition to those listed for all military commanders:
(1) Coordinate all JTF PSYOP efforts with appropriate US and multinational authorities in the joint operations area, and incorporate PSYOP in JTF plans.
(2) Maintain up-to-date PSYOP estimates for designated operational areas.
(3) Monitor and review component PSYOP plans, including coordination of the development of appropriate PSYOP force capability.
(4) When directed, accept the attachment of and employ PSYOP forces from the combatant commander.

II-7

Organizational Responsibilities for Psychological Operations

n. The Director, Defense Intelligence Agency:
(1) Establishes and implements a plan to satisfy PSYOP intelligence and counterintelligence requirements.
(2) Assists in the preparation of PSYOP intelligence and counterintelligence estimates and appraisals of foreign groups designated by USD(P), Chairman of the Joint Chiefs of Staff, Service Chiefs, Commander, USSOCOM, and other combatant commanders.
(3) Provides PSYOP training for intelligence analysts to ensure a capability to respond to intelligence production requirements in support of PSYOP programs.
(4) Recommends PSYOP opportunities in support of US policy.
(5) Provides indications of potential vulnerability to hostile PSYOP or foreign intelligence services.
o. The Director, Defense Information Systems Agency provides computer systems support of the PSYOP automated system (POAS) and will support the communications and information systems requirements for the transmission of PSYOP products from the continental United States (CONUS) production facilities to overseas PSYOP forces.
p. The Director, National Security Agency/Chief, Central Security Service, provides intelligence information to satisfy intelligence collection requirements.
q. All military commanders, when appropriate:
(1) Include PSYOP planning in the preparation of plans for all military actions across the range of military operations.
(2) Consider the psychological effects and implications of all COAs during joint operation planning.
(3) Include PSYOP forces in the planning and conduct of all military exercises.
2. United States Forces Commanders Serving in Multinational Commands
a. Implement multinational PSYOP plans to the extent consistent with international law, including the law of armed conflict, and treaty obligations in relations with the government and civilian population of countries where US forces are assigned.
b. Request guidance from the Secretary of Defense on implementation of multinational policies and objectives, as appropriate.

c. Coordinate joint PSYOP planning with appropriate multinational commanders and national forces of host countries.

*For further details concerning multinational operations, refer to Chapter VI, "Psychological Operations Across the Range of Military Operations."*

3. Other United States Government Agencies
a. During peacetime, the Department of State provides overall direction, coordination, and supervision of interdepartmental activities overseas. In peacetime operations or in conflict, the Department of State may restrict PSYOP messages and themes used within specific countries or areas.
b. The Central Intelligence Agency, Department of State, the Broadcasting Board of Governors, Department of Treasury, Department of Justice, and other agencies impacted by military PSYOP, including peacetime PSYOP activities, may review plans to ensure consistency of effort.
Reachback, support near real time video, audio, and data over the Ethernet from Ft. Bragg to a SOMS-B site at Bagram, Afghanistan provided through JITI and DVDS transmission.

# CHAPTER III
## COMMAND RELATIONSHIPS


> "As the excited passions of hostile people are of themselves a powerful enemy, both the general and his government should use their best efforts to allay them."
> -----Lieutenant General Antoine-Henri Baron de Jomini

Summary of the Art of War, 1838

1. General
a. Unless otherwise directed by the Secretary of Defense, the Commander, USSOCOM exercises COCOM over all assigned military PSYOP forces. When directed by the Secretary of Defense, the Commander, USSOCOM transfers PSYOP forces to geographic combatant commanders. When these forces are transferred, the command relationship of the gaining commander (and the losing commander will relinquish) over those forces must be specified; in most cases that will be operational control (OPCON). Upon transfer of those forces,combatant commander responsibilities commence as described in Figure

III-1.

b. Because of the strategic and operational importance of the PSYOP contribution to the combatant commander's strategic concept, centralized planning of PSYOP should be focused at that level. Likewise, when the combatant commander activates a subordinate joint force, PSYOP planners should be on the subordinate JFC's staff. The supported combatant commander may obtain, through the Secretary of Defense, required PSYOP forces in the same manner that other forces are obtained.

Figure III-1. Combatant Commander Responsibilities

## COMBATANT COMMANDER RESPONSIBILITIES

Ascertain
PSYOP Force
Requirements
Give Authoritative
Direction to Subordinate
Commands and
Psychological Operations
(PSYOP) Forces
Establish
the Chain of Command
for PSYOP Forces
Operating Within The
Operational Area
Exercise
or Delegate
Operational Control
of PSYOP Forces
Task, Organize, and
Employ PSYOP Forces
to Accomplish Assigned
Missions



c. PSYOP forces, organized as a joint PSYOP task force, normally serve as a subordinate joint command of a joint force. The JPOTF exercises C2 of those PSYOP forces assigned, attached, or in support from the Services components and, when applicable, from other nations. Further, although tactical PSYOP units are usually assigned to maneuver commanders, the JPOTF normally has coordinating authority with tactical forces for developing, producing, and disseminating PSYOP products. This procedure allows PSYOP forces to meet the maneuver commander's requirements more effectively, while ensuring continuity with the objectives and intent of the combatant commander, or JTF commander. The JPOTF works closely with the US country team, other USG officials, allies and coalition officials, and international organizations. Finally, it coordinates strategic-level PSYOP requirements with the combatant commander.

d. The combatant commander may attach PSYOP forces to a subordinate joint force commander, normally a JPOTF or joint special operations task force (JSOTF) commander. This prevents the development of conflicting PSYOP programs and messages, and facilitates a more rapid approval process and product responsiveness. PSYOP planners will identify foreign TAs and PSYOP objectives, themes, symbols, activities, and products that support the JFC's campaign plan. PSYOP have significant impact on the JFC objectives as they involve the need to mobilize the civilian population, while simultaneously isolating the adversary, taking away its ability to muster popular support. Subordinate commanders will identify requirements for PSYOP forces to the JFC. Depending on mission requirements, PSYOP staff support may be provided to the commander of a subunified command, JTF, or component command to enhance planning and coordinating capability.

2. Organizing Psychological Operations Forces

a. The scale of operations generally will dictate the organization of PSYOP forces. This organization will vary with the nature of the mission, availability and operational requirements; and the supported commander's assessment of the PSYOP mission requirements.

b. As a crisis begins to develop, one of the first elements deployed to a supported commander is the PSYOP assessment team (POAT). The POAT provides staff support to the operations directorate (J-3) of the joint force. This small, tailored team (approximately 4-12 personnel) should consist of PSYOP distribution/dissemination and logistic planners, capable of assessing the needs and requirements for a JPOTF. It should deploy with organic communications and vehicles. The POAT assesses the situation, confers with the commander, develops the PSYOP objectives, and recommends an appropriate combination of personnel, equipment, and support provided by Service components to accomplish the mission. If the POAT can accomplish necessary planning and assist commanders in executing PSYOP activities, no further PSYOP forces are likely to be required. The POAT also coordinates with other USG agencies with related missions.

c. If the POAT assesses that significant PSYOP forces are required to support the JFC objectives, the POAT recommends to the JFC that a JPOTF or PSYOP support element (PSE) be established.



(1) The decision on whether or not to activate a JPOTF is determined by the following factors:

(a) Requirement for C2 of PSYOP product production elements in the operational area.

(b) Geographical size of the operational area requires dispersed operations.

(c) Number and types of supported units exceed the capability of a PSE to advise and assist.

(d) Number and types of PSYOP units and/or assets to be coordinated exceed the C2 capability of a PSE.

(2) A PSE is a tailored element that can provide limited PSYOP. PSEs do not contain organic C2 capability; therefore, command relationships must be clearly defined. The size, composition, and capability of the PSE are determined by the requirements of the supported commander. A PSE is not designed to provide full-spectrum PSYOP capability; reachback is critical for its mission success.

(3) The regional PSYOP battalion normally provides C2 assets and product development capability. The regionally oriented battalion is augmented by production assets (audio-visual studios, printing presses, and other related equipment), and dissemination assets (radio stations and radios, TV stations and TVs, tactical PSYOP teams [loudspeakers]), including RC, enemy prisoner of war (EPW)/civilian internee (CI)/dislocated civilian (DC), and tactical units, as required.

(4) Retention of OPCON of the JPOTF by the JFC and integration of its functions into the J-3 structure optimizes interaction with other operational activities and streamlines the approval and oversight process (see Figure III-2). Because all products used throughout the joint force must be consistent, they are developed in one product development cell. Retaining OPCON at the joint force headquarters allows the most effective use of scarce PSYOP-trained personnel and linguists while ensuring access of PSYOP products to all subordinate commands. (5) Tactical dissemination assets, primarily tactical PSYOP teams and liaison teams, may be attached in CONUS to deploying units, attached in theater based on mission requirements, or deployed with the JPOTF and remain in support of the entire joint force. When attached to a maneuver unit, tactical PSYOP forces normally are placed under the OPCON of the maneuver unit commander.

(6) Factors that will affect the size and composition of the PSYOP force include, but are not limited to, the following:

(a) Scope and duration of the PSYOP objectives.



(b) Requirements for liaison and coordination with other USG and host nation (HN) agencies.

(c) Requirements for sustaining and coordinating with supported units.

(d) Policy, funding, and foreign or HN sensitivities and their effect on other combatant command and supporting component objectives.

(e) Foreign intelligence and security service threats emanating from within the host country or from the target country.

d. The senior PSYOP officer in the operational area, normally the JPOTF commander, also may serve as the de facto joint force PSYOP officer. If the situation can be handled by augmenting the JFC's staff, the

joint force PSYOP officer will ensure that component staffs are aware of the PSYOP products available. Working through the various component operations staffs, the joint force PSYOP officer will ensure continuity of psychological objectives, and themes to stress and avoid.
Figure III-2. Joint Force Organizational Options

## JOINT FORCE ORGANIZATIONAL OPTIONS

*JCMOTF*
*JFACC*
*JFLCC*
*JFMCC*
*JFSOCC*
*JPOTF*
*JSOTF*
*JTF*
*Joint Civil-Military Operations Task Force*
*Joint Force Air Component Commander*
*Joint Force Land Component Commander*
*Joint Force Maritime Component Commander*
*Joint Force Special Operations Component Commander*
*Joint Psychological Operations Task Force*
*Joint Task Force*
*Joint Special Operations Task Force*
*Operational Control*
*JTF*
*Theater*
*Special*
*Operations*
*Command*
*Navy*
*Component*
*Air Force*
*Component*
*Navy*
*Component*
*Marine*
*Corps*
*Component*
*Air Force*
*Component*
*JFSOCC*
*JPOTF JCMOTF*
*JFLCC JFMCC*
*JSOTF*
*Marine*
*Corps*
*Component*
*Army*
*Component*
*Geographic Combatant Commander*
*ArmyComponent JFACC*

III-5

Command Relationships

e. When deployed in support of joint force operations, COMMANDO SOLO normally remains under the OPCON of the commander, JSOTF while the Navy's transportable amplitude modulation (AM) and frequency modulation (FM) radio broadcast system (TARBS) normally remains under the OPCON of the Navy component commander. Coordinating authority is granted between the COMMANDO SOLO element, the TARBS element, and the JPOTF to facilitate PSYOP dissemination.

". . . PSYOP [psychological operations] and COMMANDO SOLO. We have an EC-130 aircraft that is rigged out as a broadcasting studio. And it broadcasts — . . we were broadcasting in Afghanti — in the various languages with Afghan music intermittently to put on a five-hour radio program covering all of Afghanistan in theater. We were running two five-hour broadcasts per day out of this aircraft, short wave and AM. The leaflet drops — . . . from 14 October to 21 October, the B-52s, which obviously dropped other things, dropped over 10 million leaflets across Afghanistan. And our MC-130s also were dropping leaflets there. The 4th PSYOP Group [Airborne] that you mentioned is down at Fort Bragg, North Carolina, and it's a very unique operation of video, graphics arts, printed media, some very good professionals down there that work on the PSYOP themes that are approved here at national policy, at the State Department, et cetera." --------Mr. Robert Andrews, Principal Duty Assistant Secretary of Defense (Special Operations and Low-Intensity Conflict) Defense LINK News Transcript, December 12, 2001

f. During full mobilization, the entire US military PSYOP capability becomes available for employment by the supported combatant commander. PSYOP units apportioned for theater planning purposes and available for employment are identified in Annex D to the JSCP.
g. Operations may require use of RC PSYOP forces. Early identification of PSYOP requirements is necessary to facilitate RC activation, processing, and training. Required EC-130E COMMANDO SOLO from the 193rd Special Operations Wing, Pennsylvania Air National Guard, supporting Operation ENDURING FREEDOM.

Chapter III
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RC PSYOP forces must be included in the time-phased force and deployment data (TPFDD), along with Active Component (AC) PSYOP forces; otherwise, data essential for Joint Operation Planning and Execution System (JOPES) will not be available and deployment of forces required for the operations may be delayed.
h. The high demand for PSYOP forces to support worldwide operations make reachback a critical component for PSYOP success. Reachback assets must be considered whenever planning is conducted to minimize transportation requirements and provide flexibility to support future operations. Improvements in technology will continue to increase the ability of PSYOP to support multiple geographic areas with limited assets.

*For further details concerning JOPES, refer to Chairman of the Joint Chiefs of Staff Manual (CJCSM) 3122.01,* Joint Operation Planning and Execution System Vol I: (Planning Policies and Procedures)*, and CJCSM 3122.03A,* Joint Operation Planning and Execution System Vol II: (Planning Formats and Guidance).

CHAPTER IV

PSYCHOLOGICAL OPERATIONS PLANNING IN SUPPORT OF THE JOINT FORCE CAMPAIGN
IV-1

"The real target in war is the mind of the enemy command, not the bodies of his troops. If we operate against his troops it is fundamentally for the effect that action will produce on the mind and will of the commander; indeed, the trend of warfare and the development of new weapons — aircraft and tanks — promise to give us increased and more direct opportunities of striking at this psychological target." -Captain Sir Basil Liddell Hart Thoughts on War, 1944

1. Objectives of Joint Psychological Operations
a. General. The campaign planning process represents the art of linking major operations, battles, and engagements in an operational design to accomplish theater strategic objectives. Combatant commanders translate national and theater strategy into strategic and operational concepts through the development of campaign plans. These plans represent their strategic view of related operations necessary to attain theater strategic objectives. Campaign planning can begin before or during deliberate planning, but it is not completed until after crisis action planning, thus combining both planning processes. PSYOP are involved in all three types of planning processes for joint operations: campaign, deliberate, and crisis action. Experience has repeatedly demonstrated that PSYOP planners must be involved throughout the planning process and that bringing PSYOP in early to the process can significantly improve the PSYOP contribution to the overall operation.
b. The general objectives of joint PSYOP are shown in Figure IV-1.
2. Planning Skills To plan for the effective employment of PSYOP, JFCs and their staffs must possess a thorough knowledge of national security policy and objectives, as well as national and theater military objectives. In addition, PSYOP planners must possess joint operation-planning skills, with knowledge of PSYOP doctrine, tactics, techniques, procedures, and force structure; and a thorough understanding of the customs, mores, and values of the foreign TA. They must be able to develop three distinct types of documents: military plans and orders that synchronize the activities of military units; develop operations of persuasion that cause selected foreign TAs to behave in ways that support the commander's objectives; and an external information plan or proposal to clarify information, synchronize military PSYOP with national information programs, and leverage national resources to facilitate the actions of the supported commander. They must be able to explain how other IO capabilities and related activities support PSYOP.

IV-2
Chapter IV
JP 3-53

OPERATION ALLIED FORCE

On 10 June 1999, NATO [North Atlantic Treaty Organization] suspended the air campaign following confirmation that the full withdrawal of Yugoslavian security forces from Kosovo had begun. NATO had prevailed in its first protracted endeavor outside the shadows of the Cold War. Psychological operations [PSYOP] had proven to play a key role in setting the conditions for this victory. During the 78-day bombing campaign, a total of 104.5 million leaflets were dropped over Belgrade, Kosovo and other major urban and rural areas throughout the country. The thousands of Yugoslav Federal Army (VJ) soldiers within Kosovo, as well as the civilian population throughout Serbia, were routinely targeted by PSYOP products. In addition to the millions of leaflets dropped, thousands of posters, handbills and newspapers were also produced by tactical PSYOP forces in Albania. From the refugee camps in Albania and Macedonia to the citizens of Belgrade and Kosovo, PSYOP products were widely disseminated to inform and influence the Serbian and Kosovar Albanian populations. Figure IV-1. Joint Psychological Operations General Objectives

# JOINT PSYCHOLOGICAL OPERATIONS GENERAL OBJECTIVES

Support
and enhance
foreign humanitarian
assistance, foreign
internal defense, and/or
foreign nation
assistance military
operations
Facilitate
reorganization and
control of occupied
or liberated areas in
conjunction with
civil-military
operations
Reduce efficiency
of opposing forces
Further US and/or
multinational effort by
modifying, changing,
or reinforcing attitudes
and behavior of
selected foreign
Obtain the
cooperation of
allies and neutrals
in any
psychological
operations effort

IV-3

## Psychological Operations Planning in Support of the Joint Force Campaign

In addition to the printed products created to support Operation ALLIED FORCE, daily radio and television programs were broadcast from 1 April until the final broadcast on 27 June 1999. NATO's Allied Voice Radio and Television brought current world news and information about the situation in Kosovo to listeners throughout Yugoslavia. In areas where national media assets had been destroyed, and particularly in the face of heavily censored, state-run media, Allied Voice Radio and Television provided the Supreme Allied Commander Europe (SACEUR) with a powerful communications asset to reach the Yugoslav people. Additionally, the production of the daily radio and television program was a significant accomplishment for the soldiers of the 4th Psychological Operations Group (Airborne). The success of the Reachback concept permitted the program to be written, translated, and recorded at Fort Bragg, then sent forward via secure communications to Germany where it was assembled into a 60-minute or 90-minute broadcast. Daily Allied Voice Radio and Television programs, which aired less than 24 hours after recording at Fort Bragg, validated the Reachback concept and demonstrated the responsiveness and advanced capabilities of PSYOP. . . . the contributions of PSYOP during the war in Kosovo made one thing clear: PSYOP will continue to be a weapon of first choice as a combat and diplomatic multiplier and a combat reducer for future military operations. SOURCE: Psychological Operations Support
to Operation ALLIED FORCE

## 3. Psychological Operations Concepts

"If we do go to war, psychological operations are going to be absolutely a critical, critical part of any campaign that we must get involved in." General H. Norman Schwarzkopf III Commander in Chief, US Central Command, 1988 to 1991

Operation DESERT SHIELD

Effective use of PSYOP increases the potential for operational success. As plans are developed the following concepts must be kept in mind:

a. Persuasive Communications. All communications that systemically convey information with the intent of affecting the perceptions and behaviors of the foreign TA are persuasive communications. These communications will interact with individual beliefs to change or reinforce attitudes and behaviors.
b. Command Disruption. Disruption of C4S not only directly interferes with the capabilities of an adversary to succeed in combat but also can have serious impact upon the morale, cohesion, discipline, and public support essential to efficient operations.



c. Counterinformation. Competing parties systematically can deny opponents information they require to formulate decisions. The DOD Information Security Program establishes procedures to protect classified information, and the OPSEC program establishes measures to deny unclassified but sensitive indicators of friendly activities, capabilities, and intentions.
d. Intelligence Shaping. It is possible to systematically convey or deny data to opposing intelligence systems with the objective of causing opposing analysts to derive desired judgments. These judgments interact with the perceptions of opposing planners and decision makers to influence estimates upon which capabilities, intentions, and actions are based.
4. Psychological Operations Functions "U.S. planes are dropping leaflets as well as bombs and humanitarian rations over Afghanistan in hopes of winning support inside the country for its anti-terrorist campaign, Defense Secretary Donald Rumsfeld said Monday. 'We're working to make clear to the Afghan people that we support them, and we're working to free them from the Taliban and their foreign terrorist allies,' Rumsfeld said. In addition, he said, the United States has begun broadcasting its message to people on the ground, he said, but said U.S. planes were not yet dropping radios to help them hear the message. 'The partnership of nations is here to assist the people of Afghanistan,' the leaflets said. They are accompanied by a photo of a Western soldier shaking hands with an Afghan civilian. Another leaflet lists the frequencies on which U.S. broadcasts can be heard and broadcast times." [See Figure IV-2, The leaflets were not produced in English. The English examples are used in the figure for clarity and understanding by the users of JP 3-53, Doctrine for Joint Psychological Operations.] CNN.com, War Against Terror, 15 October 2001
a. The overall function of PSYOP is to cause selected foreign audiences to take actions favorable to the objectives of the United States and its allies or coalition partners. PSYOP forces are the only DOD asset given the authority to influence foreign TAs directly through the use of radio, print, and other media. PSYOP personnel specifically advise the supported commander on methods to capitalize on the psychological impacts of every aspect of force employment to achieve the overall campaign objectives. Their duties are wide-ranging but include, as a minimum, advising on the psychological impacts of planned operations, and the identification of foreign TAs and any psychological weaknesses. PSYOP staff officers assist in integrating and coordinating psychological activities to ensure unity of effort and thematic consistency within the operational area. PSYOP officers often can provide input most effectively by participating in the targeting process through the JTCB of the supported combatant command or JTF. At the JTCB, members discuss target priorities, recommend engagement methods and timings, discuss consequences and collateral damage issues, and recommend approval or disapproval for decision. Although the time frame is operationally dependent, the doctrinal tasks or functions of PSYOP units are enduring.

PSYOP units have functions that must be considered, regardless of mission, level of conflict, range of military operations, or situation. The following paragraphs explain each function.



b. Provide Command and Control for Psychological Operations. A PSYOP commander performs C2 functions by arranging personnel, equipment, communications, computers, facilities, and procedures when planning, directing, coordinating, and controlling PSYOP forces and operations. PSYOP C2 always is austere and the commander uses the resources of the supported command to the maximum extent possible. The intelligence function is inherent to C2 but unique in PSYOP. PSYOP forces possess limited capabilities to collect, process, integrate, analyze, evaluate, and interpret PSYOP-relevant intelligence information for PSYOP Figure IV-2. Examples of United States Psychological Operations Leaflets Produced and Disseminated in Afghanistan in Support of Operation ENDURING FREEDOM



forces and for use by supported geographic combatant commands, JTFs, component commands, other government agencies, and other intelligence organizations.

c. Develop Psychological Operations Programs and Products. PSYOP development includes the planning of a PSYOP program, the development of prototype information products, and the recommendation of PSYOP actions to be executed by other forces to communicate and ultimately influence the beliefs of foreign populations, thereby changing behavior. Programs primarily are developed at the PSYOP development center of the JPOTF, and at the tactical PSYOP development detachment of a tactical PSYOP company when deployed in support of a ground maneuver force. This function consists of detailed planning of informational activities, studying targeted foreign populations, constructing informational prototypes, and testing and evaluating of these informational prototypes before and after dissemination to measure and improve effectiveness.

d. Produce Psychological Operations Media. PSYOP production is the transformation of products into media that are compatible with the way foreign populations are accustomed to receiving information. Production is not just the technological transfer of script to media, but the study, refinement, and application of media technique, language, journalistic style, theater, art, music, visual cues, and media format. Most PSYOP production occurs at the media production center at Fort Bragg, North Carolina, the theater media production center deployed forward into the operational area, or forward with PSYOP units. Some production requirements may be

Leaflet rolls being packed at Fort Bragg, NC for loading on to PDU-5/B leaflet bombs that eventually will be dropped in support of Operation ENDURING FREEDOM.



contracted to private industry, while still other production requirements may be done by units attached to the PSYOP force. The production function includes the use of video, audio, and still photographic personnel to obtain visual and auditory material required for the prototypical products.

e. Distribute Psychological Operations Information. PSYOP distribution is the physical and electronic linkage of developers, producers, and disseminators, in order to facilitate the development, production, and dissemination of PSYOP informational products and programs. Telecommunications networks may be established using organic PSYOP equipment and forces, commercial assets, and other Service component resources to transfer large data files globally.

f. Disseminate Psychological Operations Messages. PSYOP dissemination involves transmitting PSYOP informational products directly to the foreign TA, via desired media. PSYOP messages may be disseminated via the organic resources of PSYOP forces, by other governmental agencies, by contracted sources of media, by multinational partners, or through airborne and seaborne platforms supporting PSYOP. PSYOP dissemination forces will attempt to leverage as many different media as possible to ensure access to the foreign TA.

g. Employ Tactical Psychological Operations. Tactical PSYOP forces with augmentation of product development and/or dissemination assets are capable of providing all functions of PSYOP, on a limited scale, to Service and functional component commands . This force provides face-to-face communications with foreign populations. Tactical forces serve as an ideal tool for the commander to resolve issues of armed resistance and local interference to military operations, while encouraging dialogue and cooperation with noncombatants. They also are trained to collect pertinent PSYOP-related intelligence information for use by the supported commander and PSYOP developers.

h. Conduct EPW, CI, and DC Operations. In virtually all situations of crisis proportion where military forces are used, the management of EPWs, CIs, and DCs will become an integral part of military operations. Military forces conducting these operations understand they usually are handling, and to a large extent controlling, the lives of people who are demoralized, desperate, apprehensive, and distrustful. These emotions can create a volatile atmosphere that is dangerous to the military force and those civilian noncombatants and EPWs being managed, handled, or interned. This function of PSYOP is used to dispel rumors, create dialogue, and pacify or indoctrinate EPWs, CIs, or DCs to minimize violence, facilitate efficient camp operations, and ensure safe and humanitarian conditions persist. PSYOP forces also may use this function to facilitate other PSYOP tasks. These tasks include testing informational PSYOP materials, assessing the culture of potential audiences, collecting intelligence, and recruiting key communicators, informants, and collaborators.

5. Planning Guidance

Specific joint PSYOP guidance and planning considerations are shown in Figure IV-3.




6. Psychological Operations Support to Joint Force Campaign Phasing

a. JP 3-0, Doctrine for Joint Operations, states that phasing operations are a tool commonly used by commanders to organize operations. Phasing assists commanders and staffs to visualize and think through the entire operation or campaign and to define requirements

Figure IV-3. Specific Psychological Operations Guidance and Planning Considerations

Convey to the target audience an awareness of US resolve to attain national security objectives

Consider and plan for the early conduct of military psychological operations (PSYOP) and, if required, use of host-nation resources and non-PSYOP military assets for media production and dissemination; e.g., use of Navy ship printing facilities for production of PSYOP products

Plan the movement of PSYOP specific equipment

Integrate PSYOP measures into counter command and control plans

Assist multinational military and/or civilian governmental organizations in developing coordinated PSYOP programs

Use host-nation and US Country Teams to gain local support

Deter and discourage would-be aggressors from threatening vital US interests

Include the use of the Psychological Operations Automated System

Maintain the capability to accomplish US-only objectives when PSYOP forces and capabilities are provided to multinational commands

Consider the effects of terrain, weather, and a nuclear, biological, and chemical environment on forces, equipment, and the planned method for dissemination of PSYOP products

Ensure comprehensive coordination of plans with emphasis on those staff elements or agencies that generate information, such as the public affairs officer, so all information activities are concordant

Integrate tactical exploitation of national capabilities and assets before and during mission execution

Establish a PSYOP reporting system to provide relevant information about:

1. Adversary PSYOP activity
2. The apparent impact of friendly PSYOP activities
3. Any anticipated changes to ongoing activities

Consider preparation of PSYOP to counter the effects of an adversary's psychological warfare effort before, during, and after US military combat operations

SPECIFIC PSYCHOLOGICAL OPERATIONS GUIDANCE
AND PLANNING CONSIDERATIONS




in terms of forces, resources, time, space, and purpose. The primary benefit of phasing is that it assists commanders in achieving major objectives that cannot be attained all at once, by planning manageable subordinate operations. Although the commander will determine the actual phases used during a campaign, use of the following phases provides a flexible model to arrange the full spectrum of operations. The notional example at Figure IV-4 reflects phases a combatant commander can use while planning and conducting a campaign in support of strategic and operational goals and objectives. As stated in Chapter I, "Psychological Operations: An Overview," there are five missions in which PSYOP units contribute to all aspects of joint operations.

b. It is important that PSYOP planning is aggressively integrated early into commanders' plans. This ensures force integration and synchronization of activities.

(1) To remain effective, commanders must continually adjust PSYOP as the battle damage assessment of programs is accomplished. Successful integration of planned PSYOP activities (e.g., TV/radio broadcasts, leaflet drops, and loudspeaker broadcasts) and diplomatic, informational, military, or economic activities enables commanders to shape the psychological environment of an operational area.

(2) PSYOP planners must be able to develop three distinct types of documents. First, they must be able to develop plans and orders that synchronize the activities of military units. Second, they must develop activities that persuade selected foreign TAs to behave in ways that support the commander's objectives. Third, they must develop an external information plan or proposal to clarify information,

PHASES - JOINT CAMPAIGN
Actions to Assure
Full Spectrum Dominance
Deter/
Engage
Transition Seize
Initiative
Decisive
Operations
Crisis
Defined
Seize Initiative
Assure Friendly
Freedom of Action
Access Theater
Infrastructure
Establish Dominant
Force Capabilities
Achieve Full
Spectrum
Dominance
Establish
Control and
Rule of Law
Redeploy

Figure IV-4. Phases — Joint Campaign



synchronize military PSYOP with national information programs, and employ national resources to facilitate the actions of commanders.

c. Deter and Engage Phase. This phase may be for deterring aggression or taking action against threats to national or multinational interests, possibly requiring mobilization and other predeployment activities . During this phase, the combatant commander expands partnerships, enhances relationships, and conducts actions to prepare for potential crises. Flexible deterrent options may be initiated in this phase supported by PSYOP as part of pre-hostility activities.

(1) PSYOP forces are key contributors to shaping the international security environment and reacting to events. PSYOP can be executed aggressively and offensively in support of all the instruments of national power.

(2) PSYOP are crafted to meet a unique set of circumstances with appropriate themes and messages.

(a) PSYOP planning and execution actions are applied to influence the behavior of foreign TAs.

(b) PSYOP planning, foreign TA analysis, product development and dissemination, and test and evaluation are conducted during this phase in the same manner for both MOOTW and war.

d. Seize Initiative Phase. JFCs seek to seize the initiative in all situations through the application of appropriate joint force capabilities. In combat operations this involves executing offensive operations at the earliest possible time, defeating the adversary and setting the conditions for decisive operations. In noncombat operations, the JFC establishes conditions for stability by providing immediate assistance to relieve the conditions that precipitated the crisis.

(1) During the seize initiative phase, the objectives of PSYOP forces are:

(a) Deploy a PSYOP force tailored to mission requirements with the capability to dominate the information environment early.

(b) Advise the commander on supporting psychological actions throughout the operation.

(c) Create and exploit opportunities.

(d) Clearly communicate multinational and US intent.

(e) Develop the situation by forcing the adversary to react by seizing the initiative on the "information front."

(f) Advise and contribute in the influence over factions in the operational area.





(g) Establish conditions conducive to political solutions by defusing/reducing factional tensions, recognizing and preempting inherent dangers, and disrupting illegal activities.

(2) Retaining the initiative requires planning beyond the initial operation and anticipating possible events. Follow-on forces are tailored to meet specific concerns of the long-term mission. Initiative requires delegating decision-making authority to the lowest practical level.

e. Decisive Operations Phase. The decisive operations phase continues with full spectrum employment of joint force capabilities and the appropriate sequencing of forces into the operational area as quickly as possible. This phase focuses on defeating the adversary and achieving the objectives. The JFC seeks to dominate the situation with decisive operations designed to establish conditions for an early, favorable conclusion, setting the conditions for the transition phase.

(1) During the decisive operations phase, the objectives of PSYOP forces are as follows:

(a) Work to gather popular support for US and multinational operations.

(b) Establish the legitimacy and credibility of US and multinational systems and programs.

(c) Weaken the legitimacy and credibility of an adversary's systems and programs.

(d) Lessen external support for an adversary — political, military, fiscal, human, and informational.

(e) Weaken the loyalty of adversaries.

(f) Deter interference with US and multinational operations.

(g) Promote cessation of hostilities to reduce casualties, minimize collateral damage, and hasten a transition to post-conflict operations.

(2) PSYOP forces must evaluate their actions as they occur and continuously assess their results.

PSYCHOLOGICAL OPERATIONS IN THE PERSIAN GULF

Planning for psychological operations [PSYOP] began immediately after the [Iraqi] invasion of Kuwait [Operation DESERT SHIELD]. A PSYOP planning group consisting of military and civilian personnel from CENTCOM [US Central Command], SOCOM [US Special Operations Command], and the 4th Psychological Operations Group (Airborne) was formed at CENTCOM Headquarters at MacDill Air Force Base, FL, in early August of 1990. This group became the nucleus of the PSYOP command and control element that deployed to Saudi Arabia.





Leaflet, radio, and loudspeaker operations were combined and this combination was key to the success of PSYOP. Leaflets were the most commonly used method of conveying PSYOP messages. Twenty-nine million leaflets consisting of 33 different messages were disseminated in the Kuwait theater of operations. Delivery means consisted of MC-130, HC -130, A-6, F-16, B-52, and artillery.

A building block approach for leaflet operations was used, with the first leaflet themes being ones of peace and brotherhood. Increasing the intensity of the PSYOP message as events evolved, leaflet themes transitioned to emphasizing the United Nations imposed 15 January deadline. After the

UN deadline passed and Operation DESERT STORM began, themes emphasizing abandonment of equipment and desertion were used. Exploiting the effects of specific munitions leaflets were also used to inform Iraqi units that they were going to be bombed. Feedback from interviews with enemy prisoners of war validated the success of leaflet operations.

"Voice of the Gulf" was the Coalition's radio network that broadcast from ground based and airborne transmitters, 18 hours per day for 40 days. The radio script was prepared daily and provided news, countered Iraqi propaganda and disinformation, and encouraged Iraqi defection and surrender.

Loudspeaker teams were used effectively throughout the theater. Each tactical maneuver brigade had loudspeaker PSYOP teams attached. Many of the 66 teams came from the Army Reserve Components. Loudspeaker teams accompanied units into Iraq and Kuwait, broadcasting tapes of prepared surrender messages. Messages were transmitted in Arabic and were developed by cross-cultural teams. These messages were similar to those on the leaflets being dropped. Iraqi soldiers were encouraged to surrender, were warned of impending bombing attacks, and told they would be treated humanely and fairly. Many Enemy Prisoners of War mentioned hearing the loudspeaker broadcasts in their area and surrendered to the Coalition forces because they feared more bombing.

SOURCE: Final Report to Congress
Conduct of the Persian Gulf War, April 1992

f. Transition Phase. The transition phase enables the JFC to focus on synchronizing joint force activities to bring operations to a successful conclusion, ideally characterized by self-sustaining peace and the establishment of the rule of law. During this phase, joint forces may conduct operations in support of other governmental, nongovernmental, and international organizations/agencies.

(1) During the transition phase, the objectives of PSYOP forces are:

(a) Modify the behavior of selected foreign TAs toward US and multinational capabilities.



(b) Support the peacetime elements of US policy.

(c) Support the geographic combatant commander's TSC.

(d) Support the US country team.

(2) As with the other joint campaign phases, PSYOP forces must be prepared to work with interagency organizations during transition.

7. Psychological Operations Plan Development

a. The following guidance is provided for the development of Tab D, (Psychological Operations) to Appendix 3, (Information Operations) to Annex C, (Operations) of plans and orders. Additional information on Tab D is provided in Appendix B, "Format for Tab D, (Psychological Operations) to Appendix 3, (Information Operations) to Annex C, (Operations)."

(1) Research and Analysis. Research must be conducted and requisite data must be collected to plan PSYOP. The data must be analyzed to determine competing and complementary US and other-party goals, and possible strategies and PSYOP supportability of COAs to achieve these goals. The planner also should make a determination of key questions about friendly intentions, capabilities, and activities vitally needed by adversaries for them to plan and act effectively so as to guarantee failure or unacceptable consequences for friendly mission accomplishment. Such key questions are termed critical information. Critical information is used to develop taskings for intelligence collection and analysis.

(2) Development. The perceptions, knowledge, and factors that influence particular targets must be evaluated. Both the sources upon which particular targets rely and the US ability to influence those sources must be determined. Target information-gathering interests and activities need to be identified. Information and indicators that should be conveyed and denied to targets to reinforce desired appreciations and preserve essential secrecy must be ascertained. Execution means and methods to convey or deny information and indicators have to be selected. A plan for a general phasing of those means has to be developed. Tasks to prepare and execute implementing actions and to supervise overall execution need to be identified. Themes and actions to be stressed or avoided must be developed to support the attainment of specific psychological objectives. Success or failure of PSYOP can hinge on analysis of culturally sensitive themes or actions that may be viewed as offensive to the foreign TA. Planners should identify the assets necessary to execute the plan and list them in OPLAN TPFDDs; otherwise, it may become difficult to obtain these assets in time to execute the plan. A

dissemination or PSYOP activity timeline also must be developed and be listed in OPLANs submitted for approval.

b. Production Requirements. The forces, assets, and capabilities needed to produce PSYOP products must be analyzed to determine the correct task organization to support mission requirements. These factors must be compared to the forces assigned or available for planning. Tasks for available





PSYOP resources, including specific requirements, also must be provided. Requirements for PSYOP resources in excess of those available to the combatant command will be forwarded to the Joint Staff.

c. Dissemination Plan. The dissemination plan must take into account the type of PSYOP product (e.g., leaflets, radio broadcasts, TV broadcasts, and internet-based products) and the means to deliver them. Coordination among the commands planning and executing PSYOP is necessary for effective use of capabilities. A joint communications plan should be prepared to ensure that communications systems are compatible and adequate. Regardless of the means used to disseminate PSYOP products, the messages and actions must be carefully evaluated for intent and impact. The effects of PSYOP actions on targets, deceptions in use or planned, OPSEC posture and vulnerabilities, and policy consistency demand close scrutiny and coordination among all planners. Planners must also ensure plans are consistent with existing environmental requirements.

8. Psychological Operations Studies Program

a. The Research and Analysis Division of the 4th POG(A), is the only source of finished PSYOP analytical intelligence products that are tailored to the needs of the entire PSYOP community, the geographic combatant commanders, and the intelligence community. The PSYOP studies program includes the special PSYOP study (SPS), the special PSYOP assessment (SPA), and the Psychological Operations Appendix to the Military Capabilities Study (MCS). The Chairman of the Joint Chiefs of Staff provides general policy guidance and establishes production priorities for the program. Commander, USSOCOM, as the supporting combatant commander, manages the PSYOP Studies Production Program, issues taskings, and monitors production.

Soldiers in CONUS use deployable video editing equipment to process raw video footage harvested by organic electronic news gathering kits in Afghanistan.





Products of the PSYOP studies program primarily are designed to support the operational requirements of the combatant commands and of US PSYOP forces worldwide, although they also are used by a variety of other organizations (e.g., Department of State). Studies provide combatant commanders with PSYOP perspectives on issues of direct significance to peacetime strategy, joint operation planning, and operational preparations. Studies on all topics of interest can be requested through a combatant command's PSYOP staff officer or supporting intelligence officer, who will enter them in the community on-line intelligence system for end-users and managers [COLISEUM] system for managing intelligence production requirements.

b. Special PSYOP Study. The SPS is a relatively narrow, focused study that may address any of a wide variety of different subjects; it has a flexible format to permit the most effective analytical approach to be taken. The SPS might identify looming problems in a country of current or potential significance to the United States or it might discuss a social institution, a region within a country, a particular target group, the PSYOP environment, or an important issue that affects the population in a given area — always with an eye toward how they might affect US interests or involvement. The SPS provides greater depth of analysis on a relatively narrower topic than any other type of PSYOP study.

c. Special PSYOP Assessment. The SPA is a time-sensitive intelligence memorandum that analyzes the PSYOP significance of such things as crisis situations, important events, or pressing issues and how they may affect US national interests or politico-military operations. SPAs normally are produced on short notice and are disseminated as electronic messages to an established distribution list in addition to being posted on INTELINK and INTELINK-S (collateral vision).

d. Psychological Operations Appendix to the Military Capabilities Study. The MCS distills the encyclopedic mass of PSYOP-relevant information (or intelligence) available on a given country into a brief, issue-oriented summary. Because of the conciseness of the format, detailed factual description and proof are avoided in favor of succinct summaries of PSYOP issues, target group or key audiences, and vulnerabilities. The challenge is to "boil down" complex realities into short statements without compromising accuracy.

e. Various products can be produced in response to requests for more narrowly focused

PSYOP analyses. Included among them are Assessments of the PSYOP Environment, which summarize and assess the basic psychological conditions in a country or region of current interest; PSYOP Audience Analyses, which identify and analyze key groups that could be targeted in a PSYOP operation, suggesting the most effective methods of communications and the lines of approach that likely are to be most influential; and PSYOP Issue Analyses, which analyze attitudes toward a specific issue or set of issues that is of concern in a particular country or region. PSYOP spot reports are short, time-sensitive notices that analyze discrete events and issues of potentially immediate interest to PSYOP.

f. Most PSYOP studies are posted on the 4th Psychological Operations Group (POG) (Airborne) home page on INTELINK-S and on INTELINK. The INTELINK home page is resident on the



USSOCOM joint staff intelligence home page under "PSYOP Studies." It should be noted that no special password is required to access these Web sites other than basic system access.

9. Coordination with other Government Agencies

a. Coordination of PSYOP with other USG agencies ensures that policies and plans supporting PSYOP objectives are articulated and in consonance with Secretary of Defenseapproved themes and policies.

b. Department of State. The Office of International Information Programs (IIP) is the principal international strategic communications service for the foreign affairs community. IIP designs, develops, and implements a variety of information initiatives and strategic communications programs, including Internet and print publications, traveling and electronically transmitted speaker programs, and information resource services. These reach — and are created strictly for — key international audiences, such as the media, government officials, opinion leaders, and the general public in more than 140 countries. The office's products and services are uniquely designed to support the State Department's initiatives, as well as those of other US foreign policy organizations. It also manages Information Resource Centers overseas and offers reference specialists based in Washington, DC, to answer specialized information queries from abroad.

(1) The IIP was created from elements of the US Information Agency when it merged with the Department of State on October 1, 1999.

(2) The IIP, operating as a reinvention laboratory through its team-based management structure, comprises three offices:

(a) The Office of Geographic Liaison is the first point of contact within IIP for missions overseas and the audiences they serve. Its writer-editors, information resource officers, program officers, and translators provide regionally oriented products and services.

(b) The Office of Thematic Programs has multifunctional teams organized in one of two ways: along subject-matter lines, such as economic security, or along product lines, such as electronic media. The thematic teams work closely with the geographic teams in preparing products and services that support Secretary of State initiatives and mission requests.

(c) The Office of Technology Services is responsible for developing, interpreting, and applying government-wide technology policies and procedures in support of the Under Secretary for Public Diplomacy and Public Affairs, the Bureau of Educational and Cultural Exchanges, and IIP.

c. In addition to the Department of State, PSYOP should be coordinated with other USG agencies, including, but not limited to, the Central Intelligence Agency; Broadcasting Board of Governors; Departments of Commerce, Homeland Security, Transportation, Energy, and Justice; Drug Enforcement Administration; and the US Coast Guard.

# CHAPTER V
# PSYCHOLOGICAL OPERATIONS APPROVAL PROCESS



"The approval chain for PSYOP [psychological operations] should be as short and streamlined as possible to facilitate timely review, approval, production and dissemination. Although coordination of PSYOP with other staff elements and organizations is absolutely critical in maximizing PSYOP effectiveness, the coordination process should not be so cumbersome as to adversely impact dissemination necessary to achieve the intended effect."

CJCSI 3110.05B, Joint Psychological Operations Supplement to the Joint Strategic Capabilities Plan FY 1998

1. Operation Plan Approval

a. Combatant commanders submit their OPLANs, including Tab D, Psychological

Operations, to the Joint Staff for review. The Joint Staff reviews the plans for adequacy, feasibility, acceptability, and compliance with joint doctrine. The OPLANs are then forwarded to the Office of the Secretary of Defense for appropriate review and interagency coordination.

b. During deliberate and crisis action planning, the geographic combatant commanders submit their overall campaign plans, which include a PSYOP annex or appendix, to the Joint Staff for Secretary of Defense approval. Once the campaign plan is approved, the JFC is delegated PSYOP approval authority.

c. ASD(SO/LIC) normally will conduct the required Office of the Secretary of Defense review and interagency staffing for the PSYOP portions of the plans. Upon completion of Office of Secretary of Defense-level coordination, the Secretary of Defense approves the OPLAN.

2. Psychological Operations Product Approval

a. The Secretary of Defense normally delegates PSYOP product approval to the supported combatant commander. This does not mean that the supported combatant commander also has been delegated approval for PSYOP product dissemination. In some cases, PSYOP products may be politically sensitive and may require separate approval for dissemination. The CJCS execute order (authorized by the Secretary of Defense) should designate who has authority for PSYOP product approval and who has authority for PSYOP product dissemination. The supported combatant commander may, in turn, delegate PSYOP product approval to a JTF commander but not lower without approval of the Secretary of Defense (see Figure V-1).

b. In all PSYOP activities, commanders must be aware of two levels of product approval.

(1) PSYOP Objectives and Themes. Objectives and themes frame the products that reach foreign TAs and reflect national and theater policy and strategy. Approval of themes and messages is reserved by USG policy at Office of the Secretary of Defense-levels where the interagency process can address PSYOP products with a broad range of considerations.




(2) Products. Commanders subordinate to JTF commanders can modify approved products, within the guidelines issued by higher headquarters, to better target local foreign TAs.

c. The JPOTF will develop PSYOP products and recommended actions, based on the Secretary of Defense-approved objectives and themes included in the execute order, for approval by the combatant commander or JTF commander.

d. The JPOTF will review all requests for PSYOP support to include those submitted by components, the US country team, other USG agencies, international organizations, and nongovernmental organizations (NGOs), and obtain combatant commander or JTF commander approval as appropriate. Upon approval, the JPOTF will produce and disseminate the product or notify the requesting component or organization that the product is approved for production and dissemination.

e. Without timely approval, the relevance of PSYOP messages to current operations may be reduced. The JFC with product approval authority can assist the JPOTF commander by the early

Figure V-1. Psychological Operations Plan and Program Approval Authorities

Product Approval can be
delegated
Objectives/Themes Approval
Advises Secretary of
Defense on PSYOP
Approval Policy
No Directive Authority
Peacetime PSYOP
Product Approval
Authority
Senior Military Supervises
Day-to-Day Activities
Product Approval Authority
when delegated
Exercises Operational Control
(OPCON) of Joint Psychological
Operations Task Force (JPOTF)
Product Approval Authority
when delegated by the
Combatant Commander
Exercises OPCON of JPOTF

No Product Approval Authority
May Exercise OPCON or Tactical
Control of Attached Psychological
Operations (PSYOP) Units
PSYCHOLOGICAL OPERATIONS PLAN AND PROGRAM
APPROVAL AUTHORITIES
Secretary
of Defense
Combatant
Commander
Commander,
Joint Task
Force
Service or
Functional
Component
Commander
Chairman
of the
Joint Chiefs
of Staff
Country Team


establishment of a streamlined internal approval process. The JFC should provide clear guidance to the participants in his/her staff review of the product, and specify coordinating and comment versus disapproval authority.

3. Approval Process in Multinational Operations

a. A multinational JPOTF may deploy to support multinational military operations as well as operations involving international and regional organizations such as the United Nations and the North Atlantic Treaty Organization. When US PSYOP forces remain under the OPCON of a US commander, the Secretary of Defense normally will delegate PSYOP product approval to the supported combatant commander in the execute order. The combatant commander may subdelegate PSYOP product approval authority to a US military officer who is serving as the commander of the multinational operation.

b. When US PSYOP forces are attached to a multinational command under the command of a non-US commander for the purposes of developing multinational products only (i.e., no US information products), PSYOP approval authority could remain with the combatant commander, be subdelegated to the senior US military officer or diplomatic official involved in the operation, or be subdelegated to the non-US commander with the Secretary of Defense approval.

4. Peacetime Psychological Operations Approval

a. The US ambassador/chief of mission, or his/her designee, normally exercises product approval for PSYOP forces deployed in support of the US country team under the auspices of peacetime PSYOP activities (see Figure V-2).

b. Annual peacetime PSYOP programs will be submitted to the Joint Staff for coordination and transmittal to USD(P) or designee, ASD(SO/LIC), for staffing and interagency coordination. Annual programs approved by the USD(P) or the ASD(SO/LIC) will be returned through the Joint Staff to the geographic combatant commanders for execution as part of their theater security cooperation program (see Figure V-3). Approval of an overall annual program is required before the conduct of specific operations. Previously approved annual programs may continue while the following year's proposed program is in the staffing and approval process.

For further details concerning peacetime PSYOP activities, refer to Chapter VI, "Psychological Operations Across the Range of Military Operations."



5. Summary

"Successful Psychological Operations [PSYOP] require: 1) the early development of an overall PSYOP strategy, 2) the early integration of PSYOP planners, 3) visibility at the CJTF [commander, joint task force] level for integrating PSYOP into current and future operations, 4) expedient approval of PSYOP products, and 5) the assets necessary for executing PSYOP."

Operation UPHOLD DEMOCRACY
Joint After Action Report (JAAR)
United States Atlantic Command
Regardless of the particular situation and the delegation of approval authority, all PSYOP
actions and messages must comply with, complement, and stay within the bounds of the approved
PSYOP objectives and themes as stated in the execute order. Requests for changes to the original
Figure V-2. Psychological Operations Program Approval Process
PSYCHOLOGICAL OPERATIONS
PROGRAM APPROVAL PROCESS
Peacetime & Contingencies Short of Declared War*
Approval With Changes
Request Recommend Recommend
Approval Approval Approval
Approval With Changes
UCC
Theater Peacetime
PSYOP Activities
J-3 DDIO
PSYOP Div
ASD (
CIA
DDIO
Div
DJS
DOS
J-2
J-3
J-5
J-7
SO/LIC) Assistant Secretary of Defense (
Central Intelligence Agency
Deputy Director of Intelligence Operations
Division
Director, Joint Staff
Department of State
Intelligence Directorate of a Joint Staff
Operations Directorate of a Joint Staff
Plans Directorate of a Joint Staff
Operational Plans and Joint Force
Development Directorate, Joint Staff
Special
Operations/Low Intensity Conflict)
LC
OASD (
Orgs
OSD
PA
PSYOP
Reps
UCC
US
USD(P)
SO/LIC)
Legal Counsel
Office of the Assistant Secretary of Defense
(
Organizations
Office of the Secretary of Defense
Public Affairs
Psychological Operations
Representatives
Unified Central Command

United States
Under Secretary of Defense for Policy
Special Operations/Low Intensity Conflict)
DJS USD(P)
ASD (SO/LIC)
Approved
For Action
Coordination Coordination Coordination
Ambassadors
US Defense Reps
Security Assist Orgs
Other US Agencies
OASD (SO/LIC)
OSD/Interagency
Coordination
(DOS, CIA, others as Required)
Joint Staff
Coordination
(J-2, 3, 5, 7, PA, LC)
* Per DODD S-3321.1
V-5
Psychological Operations Approval Process
Figure V-3. Psychological Operations Program and Product Approval
approved objectives and themes must be forwarded through the combatant commander to the Secretary of Defense for approval. PSYOP objectives and themes must support US policies concerning the operation as promulgated by the Secretary of Defense.
PSYCHOLOGICAL OPERATIONS
PROGRAM AND PRODUCT APPROVAL
Peacetime & Contingencies Short of Declared War*
ASD (
CJCSI
COMJTF
SO/LIC) OSD
PSYOP
USD(P)
Assistant Secretary of Defense (
Chairman of the Joint Chiefs of Staff instruction
Commander, Joint Task Force
Special Operations/
Low Intensity Conflict)
Office of the Secretary of Defense
Psychological Operations
Under Secretary of Defense for Policy
* Per DODD S-3321.1
USD (P)
ASD SO/LIC
Joint Staff
PROGRAM APPROVAL DELEGATION OF
PRODUCT APPROVAL "The PSYOP Plan"
Coordinated with OSD,
Interagency, and Joint
Staff
Objectives
Themes
Themes to Avoid
Target Audiences
Media
Dissemination Means
Leaflets
Pamphlets
Radio Programs
TV Programs

Advertisements
Novelty Items
. . . and, per CJCSI, may
be sub-delegated to
COMJTF
Combatant
Commander
COMJTF



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# CHAPTER VI
# PSYCHOLOGICAL OPERATIONS ACROSS THE RANGE OF MILITARY OPERATIONS



"It is your attitude, and the suspicion that you are maturing the boldest designs against him, that imposes on your enemy."

Frederick the Great
Instructions to His Generals, 1747

## 1. General

a. PSYOP support joint and multinational operations and designated government agencies. The role of PSYOP varies depending on the level of operational activity or environment. Although the following discussion of PSYOP applicability to the range of military operations describes each in discrete terms, in actual circumstance there may not be a precise boundary where a particular state ends and another begins. See the range of military operations model as outlined in JP 3-0, Doctrine for Joint Operations, for further clarification.

b. Military Operations Other Than War (MOOTW)

"MOOTW [military operations other than war] encompass a wide range of activities where the military instrument of national power is used for purposes other than large-scale combat operations usually associated with war. . . . MOOTW usually involve a combination or air, land, sea, space, and SO [special operations] forces as well as the efforts of governmental agencies and NGOs [nongovernmental organizations], in a complementary fashion."

JP 3-0, Doctrine for Joint Operations

(1) MOOTW Not Involving the Use or Threat of Force. To be effective, peacetime military PSYOP are conducted in accordance with DODD S-3321.1, Overt Peacetime Psychological Operations Conducted by the Military Services in Peacetime and in Contingencies Short of Declared War (U), and require interagency coordination and authorization at the national level. MOOTW not involving the use or threat of force that can be supported by joint PSYOP include foreign humanitarian assistance (FHA), nation assistance, foreign internal defense (FID), consequence management, and DOD support to counterdrug operations. These military activities provide training and in-theater access to allow for the facilitation and use of PSYOP during the transition to war. The broad objectives of PSYOP in these circumstances are shown in Figure VI-1.

(2) MOOTW Involving the Use or Threat of Force. When other instruments of national power (e.g., diplomatic, informational, and economic) are unable to influence a deteriorating or potential hostile situation, military force or threat of its use may be required to demonstrate US resolve and capability, support the other instruments of national power, or terminate the situation on favorable terms. Nonlethal activities such as PSYOP can be decisive in MOOTW involving the use or threat of force.





Joint PSYOP are capable of supporting operations conducted during MOOTW, to include strikes and raids, counterterrorism (CT), FID, enforcement of sanctions and maritime intercept operations, peace operations (e.g., peace enforcement operations), noncombatant evacuation

Figure VI-1. Joint Military Psychological Operations Objectives Across the Range of Military Operations

JOINT MILITARY PSYCHOLOGICAL OPERATIONS OBJECTIVES ACROSS THE RANGE OF MILITARY OPERATIONS
Military Operations Other Than War (MOOTW) War

MOOTW Not Involving the Use or Threat of Force
MOOTW

Involving the Use or Threat of Force Modify the behavior of selected target audiences toward US and multinational capabilities
Support the peacetime elements of US national policy objectives, national security strategy, and national military strategy

Support the geographic combatant commander's regional security strategy objectives

Support the objectives of the country team

Promote the ability of the host nation to defend itself against internal and external insurgencies and terrorism by fostering reliable military forces and encouraging empathy between host nation armed forces and the civilian populace Mobilize popular support for US and multinational military operations

Gain and sustain popular belief in and support for US and multinational political systems (including ideology and infrastructure) and political, social, and economic programs

Attack the legitimacy and credibility of the adversary political systems Publicize beneficial reforms and programs to be implemented after defeat of the adversary

Shift the loyalty of adversary forces and their supporters to the friendly powers

Deter adversary powers or groups from initiating actions detrimental to the interests of the US, its allies, or the conduct of friendly military operations Promote cessation of hostilities to reduce casualties on both sides, reduce collateral damage, and enhance transition to post-hostilities

Explain US policies, aims, and objectives Arouse foreign public opinion or political pressures for, or against, a military operation Influence the development of adversary strategy and tactics Amplify economic and other nonviolent forms of sanctions against an adversary Undermine confidence in the adversary leadership

Lower the morale and combat efficiency of adversary soldiers Increase the psychological impact of US and multinational combat power Support military deception and operations security Counter hostile foreign psychological operations efforts

VI-3

Psychological Operations Across the Range of Military Operations
operations or other flexible deterrent options as directed. Failure to consider the use of nonlethal activities during planning may prolong the operation at the cost of lives. In MOOTW involving the use or threat of force, PSYOP offer the Secretary of Defense options for engagement that potentially avoid the employment of additional combat forces, reduce the period of confrontation, and enhance the diplomatic, informational, military, and economic instruments of national power. PSYOP are directed toward selected foreign TAs in support of MOOTW involving the use or threat of force to achieve the objectives shown in Figure VI-1.

c. War. Actions combatant commanders are able to take before the initiation of hostilities can assist in determining the shape and character of future operations. Most inclusive is preparing the operational area, which involves intelligence and counterintelligence operations to understand clearly the capabilities, intentions, and possible actions of potential opponents, as well as the geography, weather, demographics, and culture(s) of the operational area. During prehostilities, PSYOP can provide powerful operational leverage in support of flexible deterrent options. Among their potential contributions, PSYOP can be employed to gather critical information, undermine a potential opponent's will or capacity to wage war, or enhance the capabilities of multinational forces. During war, PSYOP at the strategic, operational, and tactical level may enhance the success of operations at all echelons. PSYOP objectives during war are shown in Figure VI-1.
A SOMS-B media broadcast site operating at Kandahar, Afghanistan.
VI-4

2. Theater Security Cooperation and
Peacetime Psychological Operations
a. TSC plans are deliberate plans for all military activities involving other nations intended to shape the security environment in peacetime. Based on guidance from the Secretary of Defense and Chairman of the Joint Chiefs of Staff, the combatant commanders develop plans and employ forces and personnel in peacetime to protect and promote US interests and regional objectives. TSC is comprised of the combatant commander's strategic concept. The geographic combatant commanders and executive agents develop TSC plans; the functional combatant commanders, Services, and other Defense agencies develop supporting and/or coordinating plans.

For further details concerning TSC, refer to
CJCSM 3113.01A, Theater Engagement
Planning, and JP 3-0, Doctrine for Joint

Operations.

b. Peacetime Psychological Operations
(1) PSYOP shall be employed
routinely by combatant commanders to shape the operational environment during peacetime. PSYOP activities shall be based on Annex A to the Contingency Planning Guidance as well as thoroughly integrated and consistent with the combatant commanders TSC and any other direction provided by the Secretary of Defense. The peacetime PSYOP program, executed as part of the combatant commander's TSC, is coordinated and integrated with the country team in each country involved. Products developed in support of peacetime PSYOP program are reviewed and approved by the country team.
(2) Peacetime PSYOP plans shall be submitted to the Joint Staff for each fiscal year concurrent with the TSC and contain, as a minimum, theater objectives, priority countries, information themes encouraged to employ PSYOP in peacetime engagement activities including, but not limited to, conducting military-to-military PSYOP programs and support to CBT and counterproliferation activities.
(3) Peacetime PSYOP activities must be approved by the ASD(SO/LIC) before execution. As appropriate, PSYOP activities will be coordinated with interagency organizations to ensure coherency with other USG efforts.
The broad objectives of psychological operations
are best served by modern, sophisticated systems
such as deployable editing equipment being used
in conjunction with the SOMS-B.

PEACETIME PSYCHOLOGICAL OPERATIONS IN SUPPORT OF THE
UNITED STATES SOUTHERN COMMAND
The primary focus of the Peacetime Psychological Operations Program is the Regional Information Support Team (RIST) or the Military Information Support Team (MIST). The term "RIST" or "MIST" is used because it is more palatable than psychological operations (PSYOP) to the governments and public of Latin America. The number one mission of RIST Colombia is support to the Andean Ridge Initiative. The RIST is the United States Southern Command's (USSOUTHCOM) number one priority in the drug war. In Bolivia, the 4th PSYOP Group (Airborne) maintains permanent MISTs that coordinate their PSYOP programs with the RIST in Colombia. In addition, temporary MISTs deploy for shorter duration to Venezuela, Ecuador, Guatemala, EL Salvador, the Bahamas, and the Dominican Republic. The majority of peacetime PSYOP missions in USSOUTHCOM are funded with counterdrug (CD) money, but PSYOP also support a humanitarian demining mission each quarter.
The Fiscal Year 2001 Deployment Order authorizes up to 14 soldiers for RIST manning at the United States Embassy in Bogotá, Colombia. Currently, the United States Military Group (USMILGP) limits RIST personnel to four soldiers, plus augmentation of a civilian intelligence analyst as necessary. With prior coordination, the USMILGP authorizes the RIST to surge additional personnel as required to meet mission requirements.

Under peacetime PSYOP, the RIST integrates the national objectives of the Office of National Drug Control Policy, Commander, USSOUTHCOM's plan, and the United States Ambassador's plan. RIST operations, to include PSYOP product development, are coordinated and synchronized with the Participating Nation's (PN) military or government agencies, the country team, and the embassy's public affairs officer. The Deputy Chief of Mission (DCM) gives the final approval to all RIST-developed PSYOP products (print, audio or audiovisual). The RIST has limited production and dissemination capabilities; as a result, the production and dissemination of products are contracted to PN vendors.

The RIST uses the full gamut of PN media available in addition to other delivery systems necessary to reach intended target audiences.

Throughout 2001, RIST Colombia produced as many products as the joint PSYOP task force (JPOTF) in Sarajevo, which has 43 personnel.

RIST Colombia's support is to JTF-South [Joint Task Force-South], the main effort of USSOUTHCOM, the Country Team, and the Government of Colombia, with the focus on Human Rights. The supporting effort is eradication, interdiction, and institution building. The economy of force is demand reduction and alternative development.



[See examples of a poster, booklet, and handbill associated with this vignette on the following page.]

SOURCE: Major Leo G. Pullar
4th Psychological Operations Group (Airborne)

3. Psychological Operations Support to the Targeting Process

a. PSYOP planning and targeting is performed concurrently with the development of the higher headquarters plans and orders. The PSYOP planner plans in concert with the higher headquarters operational staff.

b. As a JPOTF within a JTF or as a member of a battlestaff, the PSYOP planner contributes to each phase (or step) of the overall plan/order and gains needed information to make decisions while formulating and refining the PSYOP plan. If targeting is successfully integrated into the higher headquarters plan or order, the PSYOP targeting plan will likely answer the following questions:

(1) Phase 1 — Commander's Objectives, Guidance, and Intent. What is the strategy translated to discrete tasks, each logically and directly related to the overall desired outcome? What are the developed MOEs to assess whether objectives have been attained?

(2) Phase 2 — Target Development, Validation, Nomination, and Prioritization. What specific foreign TAs, nodes, or links must be attacked and what objectives must be achieved with specific PSYOP forces to support the commander's intent and the concept of the operation?

(3) Phase 3 — Capabilities Analysis. What resources are necessary to determine the vulnerabilities, susceptibilities, and accessibility to reach the desired targets and audiences? How are the attitudes and impressions assessed, and how are products designed to overcome censorship, illiteracy, or interrupted communications?

(4) Phase 4 — Commander's Decision and Force Assignment. How (what assets) and when will be the attack of these adversary targets?

(5) Phase 5 — Mission Planning and Force Execution. What is the detailed information on the targets, which supported by the analytical reasoning, linked the target with the desired effect (Phase 2). As the adversary responds and deviates from friendly force assumptions, what changes are needed in order to allow commanders to maintain the initiative through flexibility?

(6) Phase 6 — Combat Assessment. What defines success for the PSYOP objectives and how will the impact be assessed? Is there an effective method to establish a direct link between a message and a specific attitude?



Human Rights - Over 30,000 Human Rights Posters were produced and disseminated to the Colombian general population and military (JTF-South soldiers). Messages on the posters included the commitment of the

Colombian military to the defense and protection of human rights in Colombia and emphasis on JTF-South respect for human rights and international law.

Eradication - Eradication handbills were produced and disseminated to the Colombian general population. The PSYOP supported objectives of these series were to discourage the planting of illicit crops and to provide notice that Colombian Security Forces would continue to eradicate new illicit crops.

Eradication - Thousands of Eradication information booklets were produced and disseminated to the Colombian general population. The booklets provided information on Glyphosate, the herbicide that is used for aerial eradication in Colombia. The booklet's objective was to persuade Colombians that Glyphosate is not harmful to the environment.

VI-8
Chapter VI
JP 3-53

4. Psychological Operations Support to Special Operations and Interagency Operations

"PSYOP [psychological operations] are the most powerful weapon in the SOF [special operations forces] inventory."

General Carl Stiner, US Army
Commander in Chief, US Special Operations Command, 1990 to 1993
Address at the Association of the US Army Symposium, April 1993

a. Special Operations. SO are integral parts of a theater campaign . While SO can be conducted unilaterally in support of specific theater or national objectives, the majority of SO are designed and conducted to enhance the likelihood of success of the overall theater campaign. SO can be conducted in support of or separate from conventional military operations. SO must complement — not compete with — conventional forces. PSYOP may support the following SO core tasks (see Figure VI-2):

For further guidance concerning SO, refer to JP 3-05, Doctrine for Joint Special Operations.

(1) Unconventional Warfare (UW). A major component of UW is psychological preparation of the battlespace. Conventional PSYOP techniques may be applicable during UW operations, but because of the changing operational environment, different target groups exist. The four major UW targets of PSYOP are listed below.

(a) The Uncommitted. Members of the general populace who are neutral, but may doubt the potential success of a resistance organization or friendly government supported by the United States and its allies or coalition partners. PSYOP efforts focus on obtaining the support of these neutral citizens for a US-backed resistance movement or government.

(b) Hostile Sympathizers. Hostile sympathizers can be categorized as willing collaborators, persons under duress, or passive hostile sympathizers. PSYOP are used to halt or

SPECIAL OPERATIONS SUPPORTED BY
PSYCHOLOGICAL OPERATIONS
Unconventional Warfare
Foreign Internal Defense
Direct Action
Special Reconnaissance
Counterterrorism
Counterproliferation of
Weapons of Mass Destruction
Civil Affairs Operations

Figure VI-2. Special Operations Supported by Psychological Operations

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Psychological Operations Across the Range of Military Operations

prevent the sympathizer's support by sowing doubt as the validity of the hostile power's actions and instilling fear for collaborating.

(c) Hostile Military Forces. Hostile military forces may be government forces, an occupying power, or other forces helping the hostile government. The hostile military forces' nationality may or may not be the same as the populace. PSYOP directed at this foreign TA seek to provoke feelings of isolation to the point of distrust of one another, and insecurity about the outcome of the struggle and the legitimacy of their cause.

(d) Resistance Sympathizers. Resistance sympathizers are in favor of the resistance movement's goals but are not active members of a resistance organization. PSYOP promote the foreign TA active support or passive cooperation.

(2) Foreign Internal Defense. In FID, PSYOP forces target particular groups with

specific objectives.
(a) PSYOP support the achievement of national goals by targeting specific
audiences. In FID, specific PSYOP goals exist for the following foreign TAs.
1. Insurgents. Create dissension, disorganization, low morale, subversion,
and defection within insurgent forces, as well as help discredit them.
Inside the video production and editing tent of the SOMS-B complex at Kandahar, Afghanistan
during a broadcast in support of Operation ENDURING FREEDOM.
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2. Civilian populace. Gain, preserve, and strengthen civilian support for the HN
government and its counterinsurgency programs.
3. Military forces. Strengthen military support, with emphasis on building
and maintaining the morale of the HN forces.
4. Neutral elements. Gain the support of uncommitted groups inside and
outside the HN.
5. External hostile powers. Convince hostile foreign TAs the insurgency
will fail.
(b) PSYOP forces can assist a FID core task by:
1. Improving popular support for the HN government.
2. Discrediting the insurgent forces with neutral groups and the insurgents
themselves.
3. Projecting a favorable image of the HN government and the United States.
4. Supporting defector programs.
5. Providing close and continuous support to CMO.
6. Supporting HN programs that protect the population from insurgent
activities.
7. Strengthening HN support of programs that provide positive populace
control and protection from insurgent activities.
8. Informing the international community of HN and US intent and goodwill.
9. Passing instructions to the HN populace.
10. Developing HN PSYOP capabilities.
For further guidance on FID, refer to JP 3-07.1, Joint Tactics, Techniques, and Procedures for
Foreign Internal Defense (FID).
(3) Direct Action (DA). PSYOP in support the DA core task depend on the situation,
mission, and type of forces involved. When PSYOP forces participate in DA, their presence needs to
be closely coordinated and linked to US public diplomacy and command information programs. The
following are common PSYOP objectives in DA operations:
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Psychological Operations Across the Range of Military Operations
(a) Explain the purpose of the operation to counter the adversary's reaction and ensure
that friendly, neutral, and hostile audiences know what has occurred and why.
(b) Influence noncombatants, neutrals, and other groups in the operational area.
(c) Reduce interference in the DA operation by hostile forces and nations.
(d) Exploit foreign TAs that might not otherwise be accessible. Exploitation
includes demoralizing potential adversaries with the results of the operation.
(e) Assess the psychological impact of the operation.
(f) Reduce the adverse effects of mission failure.
(g) Capitalize on DA mission success in strategic PSYOP.
(h) Support DA missions in contingency operations.
(4) Special Reconnaissance (SR). PSYOP support SR by assessing the psychological
impact of the operation to include the impact on compromised operations, limiting or negating
the effects of compromise, conducting deception operations, and providing personnel to help in
area assessments.
(5) Counterterrorism. PSYOP must integrate with other security operations to target the
elements employing terrorism. The aim is to place the terrorists on the psychological defensive. To do
so, PSYOP forces analyze the terrorists' goals and use psychological programs to frustrate those goals.
PSYOP support CT by the following means:
(a) Countering the adverse psychological effects of a terrorist act.
(b) Lessening popular support for the terrorist cause.
(c) Publicizing incentives to the local people to inform on the terrorist groups.
(d) Deterring terrorist acts by persuading potential terrorists of the futility of their

actions or guarantee of defeat/death in the attempt.
(e) Promoting legitimacy of US and HN governments.
(6) Counterproliferation of Weapons of Mass Destruction. PSYOP support operations to counter the proliferation of weapons of mass destruction in numerous ways. Specifically, PSYOP perform the following:
(a) Discredit the adversary or nonstate actor with neutral groups and the adversarial group itself.
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(b) Project a favorable image of the USG.
(c) Strengthen HN support of programs that provide positive populace control and protection from weapons of mass destruction.
(d) Explain the purpose of the operation to counter the adversary action and ensure that friendly, neutral, and hostile audiences know what has occurred and why.
(e) Inform the international community of US and HN intent and goodwill.
(f) Assess the psychological impact of the operation.
(g) Provide personnel to help in area assessments.
(7) Civil-Affairs Operations (CAO). PSYOP can provide key support and information for CAO. PSYOP can provide support in the following areas:
(a) In addition to military intelligence PSYOP can develop information for CAO concerning the location, state of mind, and health of civilians and the physical characteristics of the operational area.
(b) Disseminate information concerning the safety and welfare of the indigenous civilian population.
(c) Influence a civilian population's attitude toward US policy and prepare it for CAO involvement across the range of military operations.
(d) Maximize CAO efforts in the area of FHA by exploiting the goodwill created by US efforts in the area of medical and veterinary aid, construction, and public facilities activities.
(e) During disaster-relief operations, foster international support for host governments and coordinate publicity for US and HN efforts.
(f) Conduct assessments before and after the operation to determine the most effective application of effort and document the results.
(g) Provide direct support to CAO conducting emergency relocation operations of DCs and for operation of the DCs camps.
(h) As a corollary, when conducted within the framework of a viable civil-military concept, CAO activities can contribute significantly to the overall success of PSYOP activities.
For further details, refer to JP 3-57, Joint Doctrine for Civil-Military Operations, and JP 3-57.1, Joint Doctrine for Civil Affairs.
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Psychological Operations Across the Range of Military Operations
b. Interagency Operations
"The common thread throughout all major operations, whether in war or military operations other than war, is the broad range of agencies — many with indispensable practical competencies and major legal responsibilities — that interact with the Armed Forces of the United States."
JP 3-08, Interagency Coordination During Joint Operations Vol I
(1) Military operations must be synchronized with operations of other agencies of the USG as well as with foreign forces, NGOs, and regional and international organizations for the purpose of accomplishing an objective. Success will depend to a large extent on the ability to blend and engage all instruments of national power. These actions must be mutually supporting and proceed in a logical sequence. Interagency coordination forges the vital link between the military instrument of that power and the economic, diplomatic, and informational entities of the USG as well as NGOs and international organizations. Successful interagency coordination enables these agencies, departments, and organizations to mount a coherent and efficient collective operation.
(2) The impact of interagency operations on PSYOP planning is significant. PSYOP planners must understand not only the interagency environment but also the criticality of interagency coordination. As the use of information activities in support of US objectives increases, so does the role of military PSYOP in the interagency arena. Presidential Decision Directive-68 directs the integration and synchronization of interagency PA, public diplomacy, and international military information, a euphemism for military PSYOP.

This integration is accomplished through high-level interagency coordination committees and working groups.
(3) The projection of information to targeted foreign audiences by the USG is an important element of US national power.
For further details concerning interagency operations, refer to JP 3-08, Interagency Coordination During Joint Operations.
5. Multinational Operations
"NATO [North Atlantic treaty Organization] planners established the need for a campaign targeted at the local population of B-H [Bosnia-Herzegovina] and designed to shape attitudes and behavior in favor of IFOR [Implementation Force] (later SFOR [Stabilization Force]) troops and operations. To carry out this task, IFOR's primary tool was its psychological operations [PSYOP] campaign, called the IFOR Information Campaign (IIC). Although an official NATO term, the term 'psychological operations' was not used. Some NAC [North Atlantic Council] members did not want to be associated with a 'psychological operations campaign. 'IFOR Information Campaign' seemed to ease these fears. However, there is

little doubt that the 'information campaign' was a psychological operations campaign. It was conducted by PSYOP forces and according to NATO's draft peace support psychological activities doctrine.
The PSYOP Campaign was primarily conceived as a force protection tool. First, by making NATO's mandate and intentions clear to the local population and FWF [Former Warring Factions], the IIC sought to prevent misunderstanding leading to unnecessary violence. Second, the IIC objective was to ensure broad compliance with the Dayton Peace Agreement and discourage the factions from interfering with IFOR/SFOR operations. The NAC themes and objectives, approved in December 1995, reflected the overwhelming importance attached to the force protection aspect of the mission. Indeed, a majority of themes emphasized that IFOR/SFOR had robust rules of engagement and the capability to enforce the peace agreement, and would respond in an even-handed manner to all violations of the peace agreement. Further themes sought to discourage the factions and local populations from hindering IFOR/SFOR operations and to encourage cooperation with NATO."
Target Bosnia: Integrating Information Activities in Peace Operations
NATO-Led Operations in Bosnia-Herzegovina December 1995-1997
Pascale Combelles Siegel
a. PSYOP units should be integrated into all multinational operations. The multinational force commander must ensure that all PSYOP activities, regardless of national origin, are coordinated. PSYOP must begin early, preferably before deployment, to prepare a population for the arrival of multinational forces and develop communication channels that can be used from day one of an operation. PSYOP provide the commander with a controlled mechanism to communicate with all elements of a population: civilians, military, or belligerent factions. PSYOP communicate policy, provide information, and can persuade groups to cooperate with multinational forces. A detailed analysis of a country's culture, religion, political climate, and military organization can help the multinational force commander to effectively apply PSYOP to communicate policy, provide information, and persuade groups to cooperate with friendly forces.
b. When the Armed Forces of the United States are integrated into a multinational command structure, peacetime PSYOP policies and wartime conduct should be coordinated and integrated to the maximum extent possible for the attainment of US and multinational security objectives. However, US PSYOP normally will be approved in US channels regardless of the composition of the multinational force chain of command.
For further details concerning multinational operations, refer to JP 3-16, Joint Doctrine for Multinational Operations.
CHAPTER VII
PSYCHOLOGICAL OPERATIONS ENABLERS

"The enemy bombards our front not only with a drumfire of artillery, but also with a drumfire of printed paper. Besides bombs which kill the body, his airmen also throw down leaflets which are intended to kill the soul."

Field Marshal Paul von Hindenburg
1847 - 1934

1. Intelligence

a. The use of PSYOP forces and assets is predicated on political, military, economic, cultural, religious, and psychological or social conditions. PSYOP planners must possess a thorough and current knowledge of these conditions to develop PSYOP targeted at selected foreign groups to influence their objective and emotional reasoning. This knowledge is obtained through the intelligence process producing actionable, timely, and relevant intelligence, and made available to PSYOP. The intelligence process, shown in Figure VII-1, has six integrated phases that include planning and direction, collection, processing and exploitation, analysis and production, dissemination and integration, and evaluation and feedback.

b. Intelligence and counterintelligence requirements include current intelligence, background studies of foreign countries, and intelligence and counterintelligence estimates. Each command must evaluate its assigned missions and operational areas and identify specific PSYOP intelligence and counterintelligence needs. The thoroughness of this evaluation and identification will determine how well intelligence-gathering organizations and counterintelligence support organizations can gather essential information and produce relevant intelligence and counterintelligence products. Development of PSYOP-related intelligence and counterintelligence should be predicated on a detailed collection plan with specific collection requirements to exploit all available sources and techniques. It should include basic intelligence and country studies on foreign cultures and particular target groups as well as current intelligence on foreign group attitudes, behavior, and capabilities.

c. Intelligence should be provided continually about specified target groups to keep PSYOP estimates current and to provide feedback about group reactions to PSYOP messages. In addition, interrogations of EPWs and line crossers, CIs, current defector information, and other similar current data are needed to evaluate, plan, and execute real-time PSYOP and to ascertain the effectiveness of ongoing operations.

d. PSYOP planners should ensure that specific needs for finished intelligence products are communicated to the intelligence community so that the requests can be tasked, processed, exploited, and disseminated in a timely manner. When appropriate, planners also should ensure that information gaps are identified as intelligence requirements to drive collection or as a HUMINT collection requirement, time-sensitive collection requirement, or ad hoc HUMINT requirement for tasking to the Defense HUMINT Service.




e. Any factor that presents a recurring and identifiable obstacle to achieving success of a military PSYOP program is deemed a threat. The early identification and exploitation of threats increase the potential for successful fulfillment of PSYOP program goals and objectives. The collections manager, in coordination with the PSYOP planner, needs to develop a collection plan with specific information requirements pertinent to PSYOP. Intelligence and counterintelligence assets can then be tasked to collect the information for analysis. Generally, three environments are viewed as posing a threat to the effectiveness of military PSYOP.

(1) Conflict environment threats are those that can stem from governments, organizations, groups, and individuals using military and economic power to gain control of a region and influence or counter the strategic intent of the United States and its allies or coalition partners. Whatever the method used, the US PSYOP analyst should identify specific information requirements for which the intelligence collection manager can levy collection requirements,

Figure VII-1. The Intelligence Process

THE INTELLIGENCE PROCESS
PLANNING
AND
DIRECTION
DISSEMINATION
AND
INTEGRATION
COLLECTION
PROCESSING
AND
EXPLOITATION
ANALYSIS
AND

PRODUCTION
MISSION
EVALUATION
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assisting the PSYOP planner in recognizing the PSYOP effort to influence the behavior of individuals toward a desired goal.

(2) Technological environment threats are products of an expanding ability of governments, organizations, groups, and individuals worldwide to use easily accessed communications resources. Many of these entities possess electronic attack and electronic protection assets that can degrade US military PSYOP efforts. The PSYOP planner needs to submit specific information requirements so the intelligence collection manager can task collection assets to assist in determining the adversary's capabilities to jam PSYOP signals, counter US and multinational PSYOP messages, and conduct other technical operations.

(3) Social and political environment threats are created through upheavals in a country's economic, religious, cultural, and political structures. These changes may be sudden or anticipated, temporary or permanent, and may alter the perceptions held by the country's populace. This can pose a threat to the success of US military PSYOP if planners do not recognize the potential for these changes in perception. The PSYOP planner needs to submit specific information requirements so the collection manager can task collection assets to assist in determining changes to political, religious, economic, and cultural structures.

(4) PSYOP studies are unique in format; however, other military intelligence products can contain this type of intelligence. In general, they profile the salient features of a country or its people; provide an analysis of the influences that lead different social, occupational, and ethnic groups of that country to act as they do; discuss issues that elicit strong responses from the indigenous population; assess attitudes; identify vulnerabilities; and suggest ways and means to influence people.

For further detail concerning intelligence support to operations, refer to the JP 2-0 series.

2. Command, Control, Communications, and Computer Systems

a. Communications between commands that are planning and executing PSYOP actions are necessary for effective use of capabilities. A joint PSYOP communications plan should be prepared to ensure that communications systems are compatible and adequate. Theater communications architecture must include plans for integration of PSYOP support requirements into secure voice and data nets, satellite communications systems, and a capability to communicate with US national level agencies, multinational, and HN communications systems.

b. Control should favor centralized planning and direction and decentralized execution. Control is exercised from the lowest level that accomplishes the required coordination. PSYOP considerations may dictate that control be at high national levels. The flexibility needed necessitates that PSYOP forces have access to long- and short-haul communications.

c. The POAS, which originated as a joint computer system, has been absorbed into the United States Army Special Operations Command's REDNET system. POAS plays an important part in supporting PSYOP worldwide — for the combatant commands, the Joint Staff, and the interagency

community. Unique POAS capabilities facilitate the research and analysis that underlie foreign TA analysis, PSYOP product development, finished PSYOP intelligence production, special projects, and operational deployments by conventional as well as special operations forces. POAS users can draw on a number of different database collections:

(1) DOD Message Traffic Collections. These collections contain daily Automatic Digital Network (AUTODIN) and Defense Messaging System (DMS) messages from different government agencies and military sources, including the Department of State, Central Intelligence Agency, and Foreign Broadcast Information Service. The system has the capability to do a full search and retrieval against AUTODIN/DMS message traffic with a continuous real-time message feed and indexing. The message archives are readily accessed and extensive, running from October 1989 to the present. This unique feature makes historical searches easy and allows immediate retrieval of material for discernment of long-range trends.

(2) PSYOP Study Collection. This collection holds all extant PSYOP studies and

assessments produced by the Strategic Studies Detachments. The PSYOP collection is the most complete archive available for past PSYOP studies.

(3) Radio/TV Collection. This collection has statistics on radio and TV facilities in various countries. It includes such information as location, equipment range, and frequencies, and users can search the collection based on facility characteristics.

(4) The POAS electronically archives studies and also offers analysts access to various classified and unclassified databases. Commanders can obtain most of these studies through the 4th POG(Airborne)'s home page on the secret-level classified intelligence system, INTELINK-S. PSYOP intelligence products of all types are posted on this site as soon as they are completed, making dissemination far faster and easier than in the pre-electronic past. All of the PSYOP studies are posted on INTELINK (Joint Worldwide Intelligence Communications System) along with studies that are excluded from INTELINK-S because of dissemination restrictions or classification constraints. On INTELINK, they can be found on the home page of the USSOCOM, under intelligence products. Copies of PSYOP studies can be downloaded or printed from the computer system. In the unlikely event that an end user does not have access to INTELINK or INTELINK-S, the POAS staff can, by exception, forward a copy.

d. The Joint Center for Lessons Learned has reports and reviews regarding PSYOP at their SECRET Internet Protocol Router Network website.

3. Logistics

a. PSYOP forces normally will deploy with a 30-day basic load of PSYOP supplies. This is a baseline-planning figure and may not be sufficient to meet specific contingency mission requirements. Commanders and their staffs must ensure that PSYOP support requirements are taken into account when planning logistic support.

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Psychological Operations Enablers

b. Although PSYOP rely heavily on state-of-the-art systems, planning must take into consideration the potential for having to integrate into less sophisticated equipment often found in remote areas of the world. Host-nation support (HNS) may provide much of PSYOP-required supplies. HN personnel and organizations can perform many of the support-related functions, thus reducing the strain on US logistic systems. CA can identify potential sources of HNS for PSYOP requirements. Early identification of PSYOP HNS requirements is critical to facilitate location and establishment of agreements or contracts to provide necessary PSYOP-related supplies, equipment, and facilities.

c. When US PSYOP forces support multinational operations, they normally will be supported by US logistic systems unless otherwise determined by agreements, directives, or approved OPLANs. HN forces involved in US-sponsored or US-supported PSYOP activities may provide the major portion of their logistic support requirements. When approved by the combatant commander, US PSYOP or logistic systems may furnish military supplies, services, PSYOPspecific equipment, and US medical support in accordance with directives and approved OPLANs.

d. JPOTFs must submit statements of requirements for additional material and equipment to support ongoing operations.

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Chapter VII

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APPENDIX A

DEPARTMENT OF DEFENSE PSYCHOLOGICAL
OPERATIONS CAPABILITIES

A-1

"To capture the enemy's entire army is better than to destroy it; to take intact a regiment, a company, or a squad is better than to destroy them. For to win one hundred victories in one hundred battles is not the acme of skill. To subdue the enemy without fighting is the supreme excellence. Thus, what is of supreme importance in war is to attack the enemy's strategy. Next best is to disrupt his alliances by diplomacy. The next best is to attack his army. And the worst policy is to attack cities."

Sun Tsu

The Art of War

1. General

Each Military Service has the inherent capability to support US national strategic objectives with organic assets for production and/or dissemination of PSYOP products. Aircraft, ships, and other military equipment can have psychological effects on a TA through presence, weapons employment, or delivery of goods/equipment. Planning guidance is contained in the JSCP, JOPES, and Service doctrine. Plans should address the use of strategic, operational, and tactical PSYOP as aspects of the overall strategy for conducting operations.

2. US Army Psychological Operations Assets

"The role of psychological operations (PSYOP) in the information age is to assist military commanders in articulating their mission objectives, to help identify the decision makers who can promote or interfere with these objectives, and to recommend appropriate courses of action to properly influence them. In this regard, PSYOP are applicable across the operational continuum because command objectives may vary at any point in time and because key decision makers exist at every level of military endeavor. . . . By converting command objectives into the people who have the ability to act on them, and by recommending the use of available military and nonmilitary resources, PSYOP soldiers attempt to educate and motivate targeted decision makers to act, or refrain from acting, in ways that support the commander's objectives."

Colonel Robert M. Schoenhaus
7th PSYOP Group Commander, June 1999
FM 3-05.03, Psychological Operations

a. Army PSYOP capability consists of one AC PSYOP group and two RC PSYOP groups. The AC PSYOP group is capable of conducting limited strategic PSYOP. However, it primarily conducts operational and tactical PSYOP. The two RC PSYOP groups are tactical units. They have some regional capabilities due mainly to their assigned parts of the world, and some language competencies.



b. Psychological Operations Group. A POG plans, coordinates, and executes PSYOP activities at the operational and tactical levels. It also can provide limited support to strategic planning and operations. A POG is structured to support conventional and special operations forces deployed worldwide. It can support several JPOTFs at the combatant command and the JTF level. A POG may contain the following organizations:

(1) Research and Analysis Division. Department of the Army civilian analysts give the 4th POG (Airborne) a unique research and analysis capability and add a deeper dimension of socio-cultural expertise and institutional continuity to the array of operational skills possessed by the POG. No other operational unit in the US Army has a comparable pool of experts organic to it. The analysts have advanced degrees and many have had years of military experience. As a condition of employment, they must be able to read and understand the language of their primary country of specialization. Some speak with native fluency, while others are competent in several languages. Virtually all of the analysts have lived in their geographical area of focus, some for many years. Their knowledge of foreign cultures and their analytical capabilities undergird all of the efforts of the 4th POG (Airborne) — in planning and operational deployments as well as in research and analysis.

(2) Regional PSYOP Battalion (POB). Regional POBs provide cultural and linguistic expertise and is capable of providing simultaneous PSYOP support to two or more organizations within the combatant command.

(3) Dissemination PSYOP Battalion. Dissemination POBs provide audio, visual, and audiovisual materials production, signal support, and media broadcast capabilities to the POG, JPOTF, and tactical PSYOP units. The dissemination POBs are structured to support two separate operational areas at the combatant command level.

(4) Tactical PSYOP Battalion (TPB). TPBs provide tactical PSYOP support to corpslevel units and below and select special operations and conventional task forces at Army-level equivalent-sized units. The TPB develops, produces, and disseminates tactical products within the guidance (themes, objectives, and foreign TAs) assigned by the JPOTF and authorized by the product approval authority (combatant commander or subordinate JFC). The TPB's capabilities include dissemination of PSYOP products by loudspeaker message, leaflet, handbill, and face-to-face communications.

(5) EPW/CI/DC PSYOP Battalion. This POB collects and evaluates PSYOP-relevant intelligence directly from EPW, CIs, and DCs through interrogations, face-to-face communications, and pre- and post-testing of PSYOP products and themes. Camp functions performed by the battalion dispel rumors, create dialogue, and pacify or indoctrinate EPWs/CIs/DCs to minimize violence, facilitate efficient camp operations, and ensure safe and humane conditions persist.

3. US Navy Psychological Operations Assets
a. Capabilities to produce audiovisual products are available from Fleet Audiovisual Command, Pacific; Fleet Imagery Command, Atlantic; Fleet Combat Camera Groups; various film libraries; Naval Imaging Command; and limited assistance from ships and aircraft of the fleet. Naval Reserve USJFCOM PSYOP Audiovisual Unit 0286 provides audiovisual and training support to USJFCOM.
b. The Navy is developing the capability to produce documents, posters, articles, leaflets, handbills, and other material for PSYOP. Administrative capabilities ashore and afloat exist to prepare and produce various quantities of printed materials. The Navy is developing in large deck ships a high-speed leaflet and handbill production capability that can be used in conjunction with naval air assets to rapidly disseminate PSYOP products early in a crisis. Language capabilities exist in naval intelligence and among naval personnel for most Asian and European languages.
c. The Fleet Information Warfare Center (FIWC), located at the Little Creek Naval Amphibious Base, Norfolk, Virginia, has a limited ability to provide specialized training in planning and executing PSYOP, FHA, military support to civil authorities, and is available to assist fleet units. FIWC maintains a close relationship with the 4th POG (Airborne), Fort Bragg, North Carolina, for training, equipment employment, product dissemination, and tactics, techniques, and procedures development in the area of Navy support to PSYOP.
The soldiers of a tactical PSYOP team stand beside their loudspeaker-equipped HMMWV in Afghanistan before a mission in support of Operation ANACONDA.


(1) TARBS is a prototype high-power radio station installed on selected ships with the primary mission of supporting PSYOP. TARBS provides the ability to conduct PSYOP broadcasts intended for the civilian and military population as part of naval IO in littoral areas. Secondary non-PSYOP using TARBS include providing radio broadcast capability in support of FHA and military support to civil authorities in the event of US domestic disasters.
(2) TARBS ideally will be installed onboard one ship in each amphibious ready group. When needed, TARBS will broadcast voice information as directed and authorized by the JFC. PSYOP broadcast information products will be produced for the JFC by the 4th POG (Airborne) or the JPOTF supporting the JFC, and forwarded to the TARBS operators for final dissemination. The products will be forwarded either electronically to the TARBS laptop computer or by other means as necessary (e.g., cassette and compact disc-read only memory). Once authorized by the JFC, the TARBS operators will conduct both AM and FM broadcasts of this product on designated frequencies.
(3) TARBS is designated as a portable system divided into three subsystems, mostly contained in a transportable shelter 173 inches long, 86 inches wide, and 84 inches high, with an approximate loaded weight of 9,600 pounds. TARBS is comprised of an audio transmitter and antenna subsystems capable of operations ashore or afloat.
(4) Most US Navy vessels have the ability to support PSYOP through an organic high frequency transmission capability.
d. Several US naval aircraft have the capability to support PSYOP. Naval F/A-18 aircraft can disperse leaflets by dropping SUU-76 (PDU-5) ROCKEYE leaflet bombs. Shipborne helicopters can provide leaflet drop, loudspeaker broadcast, and foreign humanitarian aid dissemination.
4. United States Air Force Contribution to Psychological Operations
“Air Force PSYOP [psychological operations] support national and military objectives by conveying specially tailored information to target audiences.”
AFDD 2-5.3, Psychological Operations
a. Air Force contributions to PSYOP leverage air and space power, and applicable technologies to achieve USG and theater commander objectives. Air Force PSYOP is focused on the employment of air and space as the Air Force’s primary means of preparing, shaping, and exploiting the psychological dimension of the battlespace.
b. Air Force PSYOP forces support JFC objectives through a variety of operations and activities that include development of psychologically informed targeting strategies. The US Air Force (USAF) information warfare flights have individuals located in either Air Force air and space operations center (AFAOC) or joint air operations center that assist commanders in many disciplines of IO, to include PSYOP. They coordinate/liaise between the AFAOC and the

JPOTF, and utilize all-source analysis of an adversary's sociological, cultural, and demographic information to recommend effective PSYOP.

c. A wide variety of USAF assets have the inherent capability to execute missions in support of JFC/JPOTF PSYOP objectives. Certain aircraft have PSYOP as their primary mission. The EC-130 COMMANDO SOLO aircraft are equipped for airborne broadcasts of PSYOP messages via radio and television signals. In addition to disseminating PSYOP messages electronically, a number of airdrop aircraft are capable of performing leaflet airdrop missions. Also, USAF fighter and bomber aircraft can dispense leaflets by dropping leaflet bombs.

5. US Marine Corps Psychological Operations Assets

Although the Marine Corps has no organizational PSYOP structure, it does have the capability to execute both audible and visible actions designed to convey specific impressions to an adversary. These actions can include broadcasts from either shore-based or airborne loudspeaker systems and leaflet dissemination by various aircraft. PSYOP expertise within the Marine Corps resides in the individual Marines who have received training from joint and Service schools. The civil affairs groups, when activated, normally will have formally trained personnel capable of advising the Marine air-ground task force commander on PSYOP.

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Appendix A

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APPENDIX B

FORMAT FOR TAB D, (PSYCHOLOGICAL OPERATIONS) TO APPENDIX 3, (INFORMATION OPERATIONS) TO ANNEX C, (OPERATIONS)

B-1

1. Overview

The guidance in this appendix relates to the development of Tab D (Psychological Operations) to Appendix 3 (Information Operations) to Annex C (Operations) for plans and orders.

a. Situation and Overview

(1) What is the general psychological situation in the operational area?

(2) What, if any, are the ongoing PSYOP programs?

(3) What are the significant factors influencing PSYOP activities?

(4) What are the competing PSYOP goals in the operational area?

(5) What is the PSYOP task to be accomplished?

b. US (or US and Allied/Coalition) Perspective

(1) How will the assigned PSYOP task be accomplished?

(2) What resources will be used?

(3) What will be the general phasing of current actions with future actions?

c. Neutral Perspective (if applicable)

(1) What are the projected actions of the neutral populations under various circumstances?

(2) What activities and resources are available to these neutral intentions?

(3) What actions and behavior by the neutral population(s) would favor mission accomplishment?

(4) Which apparent current COAs might affect mission accomplishment?

(5) What resources are available to execute alternative COAs?

(6) What objective and subjective factors could affect decisions and resource effectiveness?

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Appendix B

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(7) What are the staff factions and who are the particularly influential individuals?

(8) What are the characteristics of decision makers and their key advisors, major staff planners, staff factions (to include particularly influential individuals), and intelligence system analysts?

(9) What are the groups of related planner and decision maker critical information?

(10) What is the estimated background knowledge and desired and harmful appreciations for each group?

d. Adversary Perspectives

(1) Decision Makers and Staffs

(a) What COAs might affect friendly task accomplishment?

(b) What resources are available to execute each COA?

(c) Who are the decision makers who can direct development or allocation of

resources of COAs pertinent to the task assigned?
(d) What are the characteristics of adversary decision makers, their key advisors, and staff (particularly intelligence analysts)?
(2) Intelligence Systems
(a) What are the intelligence systems that support decision makers and their staffs?
(b) What are the intelligence systems' capabilities pertinent to the situation?
(c) What are the objective and subjective factors and the characteristics of collection planners and decision makers that affect their development and selection for use of information gathering resources?
(d) What are the groups of related planner and decision maker critical information?
(e) What is the estimated background knowledge and desired and harmful appreciations for each group?
(3) Target Audiences
(a) What groups can influence plans, decisions, and operational effectiveness in task accomplishment?


(b) How susceptible are these groups to PSYOP?
(c) What group behavior is favorable or harmful to task accomplishment?
(d) What are the apparent goals, motivations, and characteristics of each group?
(e) Who are the leaders who can cause these groups to behave in various ways?
(f) What are the groups of related foreign TA critical information?
(g) What is the estimated background knowledge and desired and harmful appreciations for each group?
(4) Command Systems
(a) What communications systems and command centers will be used to plan COAs and control, coordinate, and supervise execution of the planned COA?
(b) What is the purpose and what are the characteristics of each C2 communications net?
(c) What are the PSYOP targets for jamming or attacking?
(d) When should PSYOP to demoralize and disorganize opposing command be executed?
(e) When should PSYOP to reduce opposing operational effectiveness be executed?
(f) When should PSYOP to enhance the effectiveness of planned deceptions be executed?
(g) When should PSYOP to support OPSEC to the maximum advantage be executed?
e. Mission. How will PSYOP support the maneuver commander's mission?
f. Execution
(1) Concept of Operations
(a) Overview
1. What is the commander's intent?


2. What is the overall concept for using PSYOP in support of task accomplishment?
3. Who will plan and conduct strategic PSYOP in peacetime and in support of preconflict deterrence options? Who are the supporting commanders?
4. Who will plan and conduct strategic and theater PSYOP in support of sustained hostilities? Who are the supporting commanders?
5. Who will plan and conduct joint tactical PSYOP in support of operational COAs? Who are the supporting commanders?
(b) General Guidance to Units and Forces
1. What are the valid PSYOP themes to be promoted to induce strategic and theater PSYOP objectives?
2. What are the valid or invalid PSYOP themes to be discouraged? Include indications of specific foreign TA sensitivities and harm that might occur if foreign TAs accept the themes.
(c) PSYOP Actions Suitable for Use
1. What is the guidance for the conduct of military operations, actions, and

personnel behavior to promote valid PSYOP themes?
2. What is the guidance for avoiding military operations and actions and
personnel behavior that would result in harmful foreign TA attitudes and behavior?
3. What are the cultural and psychological characteristics of foreign TAs,
which will aid operational planners and personnel in selecting COAs and interacting with foreign TA members?
(d) Adversary PSYOP
1. What adversary PSYOP will be directed at US personnel and at foreign
groups in the operational area?
2. What is the guidance for countering such adversary operations?
(e) Outline of Each Planned PSYOP
1. What is the foreign TA and set of PSYOP objectives, overall themes,
subgroups to be targeted (to include their characteristics), and specific themes to be promoted for each subgroup?

2. What are the provisions for testing, producing, stocking, and disseminating
PSYOP materials and for measuring PSYOP effectiveness?
3. What are the command and staff arrangements? Who are the supporting
commanders?
4. What resources are required to plan and conduct PSYOP actions? Include
civil capabilities; indigenous assets; exploitation of EPWs, internees, and detainees for PSYOP; and military PSYOP resources.
5. What are the logistic requirements? Include preparation, distribution, and
stocking of PSYOP materials; transport of PSYOP material and personnel to operational areas and their basing and support while conducting PSYOP; provisions for the supply and maintenance of US and indigenous PSYOP material; and fiscal and personnel matters.
6. What are the requirements for implementing schedules and PSYOP control
sheets?
7. What is the code word for OPSEC-sensitive PSYOP?
(f) What is the OPSEC planning guidance? Include planning for, preparing for,
and conducting PSYOP and PSYOP actions to maintain essential secrecy for the commander's intent and to gain and maintain essential secrecy for OPSEC-sensitive PSYOP COAs.
(2) Situation Monitoring
(a) How will intelligence, multidiscipline counterintelligence, security monitoring,
and operational feedback be provided?
(b) What is the requirement for running situation estimates; periodic estimates of
target appreciations responsive to critical information, actions, and attitudes and behavior; and current reporting of intelligence and multidiscipline counterintelligence information, security monitoring results, and implementing actions?
(c) What resources are required? What is their availability?
(3) Control
(a) How will control be affected and implementation centrally coordinated?
(b) What are the coordinating instructions?
(c) How will implementation planning and supervision of the planned action be
accomplished?

(d) What is the need for specific PSYOP?
(e) What coordination is required with adjacent commands and civilian agencies,
to include US diplomatic missions and US Agency for International Development (USAID)?
(f) What coordination is required with military deception and OPSEC planners,
electronic warfare planners, and planners in the fields of civic action; FHA; CMO; EPWs; detainees, command, control, and communications; legal; captured US personnel; and operations?
(4) Tasks
(a) What responsibilities must be assigned to implement the concept?
(b) Is designation of an executive agent to coordinate implementation among
multiple organizations required?
(c) How will feedback to ensure effectiveness of tasks be provided?
g. Administration and Logistics

(1) Logistics
(a) What is the guidance on stocking of PSYOP and information materials and provisions to disseminating organizations?
(b) What are the provisions for the supply and maintenance of PSYOP-unique supplies and equipment?
(c) What are the provisions for control and maintenance of indigenous equipment and materials?
(d) What are the fiscal matters relating to special funds?
(e) What are the personnel matters relating to indigenous personnel?
(2) Administration
(a) What are the requirements for special reports?
(b) What are the requirements for planning and operations in support of education programs regarding EPWs and CIs?
(c) What will be the participation in interrogation of EPWs, CIs, and detainees to obtain information essential or peculiar to PSYOP?


h. Command and Control
(1) Refer to appropriate sections of Annex K (Command, Control, Communication, and Computer Systems) and provide pertinent extracts of information included in the basic plan or Annex K, to include the following.
(2) What are the recognition and identification instructions?
(3) What is the electronic policy?
(4) What are the headquarters locations and movements?
(5) What are the code words?
(6) What is the frequency allocation?
2. Tab D Format
CLASSIFICATION
HEADQUARTERS, US EUROPEAN COMMAND
APO AE 09128
8 February 1999
TAB D TO APPENDIX 3 TO ANNEX C TO USEURCOM OPLAN 4999-99 ( )
PSYCHOLOGICAL OPERATIONS ( )
( ) References:
a. JP 3-53, Doctrine for Joint Psychological Operations.
b. Presidential Decision Directive-68, International Public Information.
c. CJCSI 3110.05B, Joint Psychological Operations Supplement to the Joint Strategic Capabilities Plan FY 1998.
d. Memorandum in the Name of the Chairman-163-98, Cooperation Agreement for Policy Coordination between the United States Information Agency and the Department of Defense (1997).
e. List plans, estimates, basic PSYOP studies, special PSYOP studies, special PSYOP assessments, and other documents that have a significant bearing on the conduct of PSYOP.


1. ( ) Situation. Summary of the psychological situation in the operational area, any ongoing PSYOP programs and any significant factors influencing PSYOP activities. (If parts of the situation description are long or complex, include as attachments.)
a. ( ) Overview. Describe the general situation, competing goals, and the task(s) to be accomplished.
b. ( ) US (or US and Allied) Perspective. Briefly outline intentions (how the assigned task(s) will be accomplished), capabilities (resources to be used), and activities (current actions and general phasing of future actions).
c. ( ) Neutral Perspective (if applicable). Briefly outline estimated neutral intentions under various circumstances, the resources available to them, and their activities. State neutral actions and behavior that would favor mission accomplishment. Indicate apparent current COAs that might affect mission accomplishment and summarize resources available to execute alternative COAs. (Include the abilities to execute information operations strategies.) State objective and subjective factors that could affect decisions and resource effectiveness. Identify staff factions and particularly influential individuals. Describe the characteristics of decision makers, their

key advisers, major staff planners, staff factions (particularly influential individuals), and intelligence system analysts. List groups of related planner and decision maker critical information, and for each group, list estimates of background knowledge and desired and harmful appreciations.

d. ( ) Adversary Perspectives

(1) ( ) Decision Maker and Staff. Identify the decision makers who can direct development or allocation of resources of COA execution pertinent to the task assigned. Outline feasible, alternative actions that would favor or harm friendly operational effectiveness. Indicate COAs that might affect friendly task accomplishment and summarize resources available to execute each COA. Describe the characteristics of adversary decision makers, their key advisers, and staff (particularly intelligence analysts).

(2) ( ) Intelligence Systems. Identify intelligence systems that support decision makers and their staffs. Summarize intelligence systems' capabilities pertinent to the situation. Cite references for detail. Describe objective and subjective factors and the characteristics of collection planners and decision makers that affect their development and selection for use of informationgathering resources. List groups of related collection planner and decision maker critical information and for each group, list estimates of background knowledge and desired and harmful appreciation.

(3) ( ) Target Audiences. Identify groups that can influence plans, decisions, and operational effectiveness in task accomplishment; identify their susceptibility to PSYOP. State group behavior favorable and harmful to task accomplishment. Briefly describe the apparent goals, motivations, and characteristics of each group and the leaders who can cause groups to





behave in various ways. List groups of related target audience critical information and, for each group, list estimates of background knowledge as well as desired and harmful appreciations.

(4) ( ) Command Systems. Describe communication and computer systems and command centers used to plan COAs and control, coordinate, and supervise execution of the planned COA. Briefly identify the purpose of each C4S and its characteristics. State targets for jamming or attacking. Indicate when to execute operations to demoralize and disorganize opposing command, reduce opposing operational effectiveness, enhance the effectiveness of planned deceptions and PSYOP, and support OPSEC to the maximum advantage.

2. ( ) Mission. Refer to the Basic Plan

3. ( ) Execution

a. ( ) Concept of Operations

(1) ( ) Overview. State the commander's intent. Outline the overall concept for using PSYOP in support of task accomplishment. Sequentially address strategic PSYOP in peacetime and in support of preconflict deterrence options; strategic and theater PSYOP in support of sustained hostilities (conduct of war globally or in a region, and support for campaigns and operations); and joint tactical PSYOP in support of operational COAs. State who will plan and conduct each PSYOP and the supporting commanders.

(2) ( ) Provide the following as general guidance to units and forces involved:

(a) ( ) Valid PSYOP themes to be promoted to induce strategic and theater PSYOP objectives.

(b) ( ) Valid or invalid PSYOP themes to be discouraged and indications of specific target audience sensitivities and harm that might occur if the themes are accepted by target audiences.

(c) ( ) PSYOP actions suitable for use:

1. ( ) Guidance for the conduct of military operations and actions, and personnel behavior, to promote valid PSYOP themes.

2. ( ) Guidance for avoiding military operations and actions, and personnel behavior, that would result in harmful target audience attitudes and behavior.

3. ( ) Description of the cultural and psychological characteristics of target audiences to aid operational planners and personnel in selecting COAs and interacting with target audience members.



(d) ( ) Description of adversary PSYOP (including disinformation and propaganda) directed at US personnel and at foreign groups in the operational area and guidance for countering such adversary operations.

(3) ( ) Provide an outline of each planned PSYOP operation. Indicate for each target audience and set of PSYOP objectives, overall themes, subgroups to be targeted, their characteristics, and specific themes to be promoted for each subgroup. As appropriate, refer to intelligence studies, basic PSYOP study, SPS, and SPA for detailed intelligence. State provisions for testing, producing, stocking, and disseminating PSYOP materials and for measuring PSYOP effectiveness. Describe command and staff arrangements for each campaign or operation and indicate supporting commanders. List resources required to plan and conduct PSYOP actions, including civil capabilities, indigenous assets, exploitation of EPWs, CIs, and detainees for PSYOP, and military PSYOP resources. State logistic requirements, including preparation, distribution, and stocking of PSYOP materials; transport of PSYOP material and personnel to operational areas and their basing and support while conducting PSYOP; provisions for the supply and maintenance of US and indigenous PSYOP material; and fiscal and personnel matters. Indicate requirements for implementing schedules and PSYOP operation control sheets. (Note: Treat plans for PSYOP conducted in support of UW operations by SO forces in support of military deceptions as OPSEC-sensitive. Assign each plan a code word and distribute it separately from the Basic Plan and Tab D.)

(4) ( ) In the basic concept description and in each tab describing separate operations, provide OPSEC planning guidance. The guidance should address planning for, preparing for, and conducting PSYOP and PSYOP actions to maintain essential secrecy for the commander's intentions and to gain and maintain essential secrecy for OPSEC-sensitive PSYOP COAs.

b. ( ) Situation Monitoring. Describe how intelligence, multidiscipline counterintelligence, security monitoring, and operational feedback will be provided. State requirement for running situation estimates; periodic estimates of target appreciations responsive to critical information, actions, and attitudes and behavior; and current reporting of intelligence and multidiscipline counterintelligence information, security monitoring results, and implementing actions. Identify resources required and their availability.

c. ( ) Control. Outline how control will be affected and implementation centrally coordinated. State coordinating instructions. Describe accomplishment of implementation planning and supervision of the planned action. Identify the need for specific PSYOP. Address coordination with adjacent commands and civilian agencies, including US diplomatic missions and USAID. Address also coordination with military deception and OPSEC planners, EW planners, and planners in the fields of civic action, FHA, PA, CMO, EPW, civilian internees, detainees, command, control, communications, and computers, legal, captured US personnel, and operations.

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Format for Tab D, (Psychological Operations) to Appendix 3,
(Information Operations) to Annex C, (Operations)

d. ( ) Tasks. Assign responsibilities to implement the concept. When multiple organizations are involved, designate an executive agent to coordinate implementation. Ensure that tasks clearly fix responsibilities and provide for feedback about effectiveness.

4. ( ) Administration and Logistics. Provide a statement of the administrative and logistic arrangements applicable to PSYOP but not covered in the Basic Plan or another annex thereof. Include data on:

a. ( ) Logistics

(1) ( ) Stocking of propaganda and information materials and provisions to disseminating organizations.

(2) ( ) Provisions for the supply and maintenance of PSYOP-unique supplies and equipment.

(3) ( ) Provisions for control and maintenance of indigenous equipment and materials.

(4) ( ) Fiscal matters relating to special funds.

(5) ( ) Personnel matters relating to indigenous personnel.

b. ( ) Administration

(1) ( ) Requirements for special reports.

(2) ( ) Requirements for planning and operations in support of education programs regarding EPWs and CIs.

(3) ( ) Participation in interrogation of EPWs, CIs, and detainees to obtain information essential for or peculiar to PSYOP.

5. ( ) Command and Control. Refer to appropriate sections of Annex K and provide pertinent extracts of information included in the Basic Plan or Annex K, including:

a. ( ) Recognition and identification instructions.

b. ( ) Electronic policy.

c. ( ) Headquarters locations and movements.

d. ( ) Code words.
e. ( ) Frequency allocation.


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APPENDIX C
REFERENCES

The development of JP 3-53 is based upon the following primary references.
1. US Public Laws
a. National Security Act of 1947 (50 USC 413).
b. DOD Reorganization Acts of 1958 and 1986.
c. Cohen-Nunn Amendment to the National Defense Authorization Act for Fiscal Year 1987 (Public Laws 99-591 and 99-661).
d. 10 USC 167, Unified Combatant Command for Special Operations Forces.
2. Executive Branch Documents
a. Executive Order 12333, United States Intelligence Activities.
b. National Security Directive 51, US Government International Broadcasting.
c. National Security Decision Directive 130, US International Information Policy.
d. Presidential Decision Directive/NSC-68, International Public Information (IPI).
e. National Security Strategy of the United States (current year).
f. National Drug Control Strategy (current year).
g. "US Capabilities to Engage in Low-Intensity Conflict and Conduct Special Operations," The President's Report to Congress.
h. National Security Decision Directive 77.
3. Department of State Publication
Department of State Publication 9434, Treaties in Force.
4. DOD Publications
a. DODD S-3321.1, Overt Peacetime Psychological Operations Conducted by the Military Services in Contingencies Short of Declared War.
b. DODD S-3600.1, Information Operations (IO) (U).


c. DODD 5100.1, Functions of the Department of Defense and its Major Components.
d. DODD 5132.3 w/ch1, DOD Policy and Responsibilities Relating to Security Assistance.
e. DODD 5138.3, Assistant Secretary of Defense (Special Operations and Low-Intensity Conflict).
f. DODD 5525.1 w/ch2, Status-of-Forces Policies and Information.
g. DODD 5530.3 w/ch1, International Agreements.
h. DODI 5240.10 w/ch1, DOD Counterintelligence Support to Unified and Specified Commands.
i. DOD Handbook 0-2000.12-H w/ch1, ch2, Protection of DOD Personnel and Activities Against Acts of Terrorism and Political Turbulence.
5. Chairman of the Joint Chiefs of Staff Instructions and Manuals
a. CJCSI 3110.05B, Joint Psychological Operations Supplement to the Joint Strategic Capabilities Plan FY 1998.
b. CJCSI 3210.01A, Joint Information Operations Policy (u).
c. CJCSM 3113.01A, Theater Engagement Planning.
d. CJCSM 3122.01, Joint Operation Planning and Execution System (JOPES) Vol I: (Planning Policies and Procedures).
e. CJCSM 3122.03A, Joint Operation Planning and Execution System Vol II: (Planning Formats and Guidance).
6. Joint Publications
a. JP 0-2, Unified Action Armed Forces (UNAAF).
b. JP 1-05, Religion and Religious Support in Joint Operations.
c. JP 2-0, Doctrine for Intelligence Support to Joint Operations.
d. JP 2-01, Joint Intelligence Support to Military Operations.
e. JP 2-01.2, Joint Tactics, Techniques, and Procedures for Counterintelligence in Joint Operations.

References
f. JP 3-0, Doctrine for Joint Operations.
g. JP 3-05, Doctrine for Joint Special Operations.
h. JP 3-05.1, Joint Tactics, Techniques, and Procedures for Joint Special Operations Task Force Operations.
i. JP 3-05.2, Joint Tactics, Techniques, and Procedures for Special Operations Targeting and Mission Planning.
j. JP 3-07, Joint Doctrine for Military Operations Other Than War.
k. JP 3.07.1, Joint Tactics, Techniques, and Procedures for Foreign Internal Defense (FID).
l. JP 3.07.2, Joint Tactics, Techniques, and Procedures for Antiterrorism.
m. JP 3.07.3, Joint Tactics, Techniques, and Procedures for Peace Operations.
n. JP 3-07.4, Joint Counterdrug Operations.
o. JP 3-08, Interagency Coordination During Joint Operations.
p. JP 3-13, Joint Doctrine for Information Operations.
q. JP 3-13.1, Joint Doctrine for Command and Control Warfare (C2W).
r. JP 3-16, Joint Doctrine for Multinational Operations.
s. JP 3-51, Joint Doctrine for Electronic Warfare.
t. JP 3-54, Joint Doctrine for Operations Security.
u. JP 3-57, Joint Doctrine for Civil-Military Operations.
v. JP 3-57.1, Joint Doctrine for Civil Affairs.
w. JP 3-58, Joint Doctrine for Military Deception.
x. JP 3-60, Joint Doctrine for Targeting.
y. JP 3-61, Doctrine for Public Affairs in Joint Operations.
z. JP 4-0, Doctrine for Logistic Support of Joint Operations.
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Appendix C
JP 3-53
aa. JP 5-0, Doctrine for Planning Joint Operations.
bb. JP 5-00.2, Joint Task Force Planning Guidance and Procedures.
7. Department of the Army Publications
a. FM 3-0, Operations.
b. FM 3-05, Doctrine for Army Special Operations.
c. FM 3-05.30, Psychological Operations.
d. FM 3-05.40, Civil Affairs Operations.
e. FM 27-10, Law of Land Warfare.
f. FM 31-20(C), Special Forces Operations.
g. FM 33-1-1, Psychological Operations Techniques and Procedures.
h. FM 100-6, Information Operations.
8. Department of the Navy Publications
a. OPNAVINST 3430.25, Information Warfare and Command and Control Warfare.
b. OPNAVINST 3430.26, Implementing Instruction for Information Warfare Command.
c. OPNAVINST 3434.1, Psychological Operations.
d. SECNAVINST 3300.1A, Law of Armed Conflict (Law of War) Program to Insure Compliance by the Naval Establishment.
e. Navy Warfare Publication 1-14M, The Commander's Handbook on the Law of Naval Operations.
9. Department of the Air Force Publications
a. AFDD 1, Air Force Basic Doctrine.
b. AFDD 2-5, Information Operations.
c. AFDD 2-5.3, Psychological Operations.
d. AFDD 2-7, Special Operations.
C-5
References
e. AFDD 2-7.1, Foreign Internal Defense.
f. AFPD 51-4, Compliance with the Law of Armed Conflict.
g. AFPD 51-7, International Law.
h. AFI 51-401, Training and Reporting to Ensure Compliance with the Law of Armed Conflict.
i. AFI 51-701, Negotiating, Concluding, Reporting, and Maintaining International Agreements.
10. United States Marine Corps Publications
a. MCWP 3-33.1, MAGTF Civil-Military Operations.

b. MCWP 3-33.5, Counterinsurgency.
c. MCWP 3-40.6, Psychological Operations.

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APPENDIX D
ADMINISTRATIVE INSTRUCTIONS

1. User Comments
Users in the field are highly encouraged to submit comments on this publication to:
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usefulness, consistency, and organization), writing, and appearance.
2. Authorship
The lead agent for this publication is the US Special Operations Command. The Joint Staff
doctrine sponsor for this publication is the Director for Operations (J-3).
3. Supersession
This publication supersedes JP 3-53, 10 July 1996, Doctrine for Joint Psychological
Operations.
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USJFCOM NORFOLK VA//JW100//
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Appendix D
JP 3-53
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GLOSSARY
PART I — ABBREVIATIONS AND ACRONYMS
GL-1
AC Active Component
AFAOC Air Force air and space operations center
AM amplitude modulation
AOR area of responsibility
ASD(SO/LIC) Assistant Secretary of Defense (Special Operations/Low Intensity Conflict)
AUTODIN Automatic Digital Network
C2 command and control
C4S command, control, communications, and computer systems
CAO civil affairs operations
CI civilian internee
CJCS Chairman of the Joint Chiefs of Staff
CJCSI Chairman of the Joint Chiefs of Staff instruction
CJCSM Chairman of the Joint Chiefs of Staff manual
CMO civil-military operations
CNO computer network operations
COA course of action
COCOM combatant command (command authority)
COLISEUM community on-line intelligence system for end-users and managers
CONUS continental United States
CT counterterrorism
DA direct action
DC dislocated civilian
DMS defense message system
DOD Department of Defense
DODD Department of Defense directive
EPW enemy prisoner of war
EW electronic warfare
FHA foreign humanitarian assistance
FID foreign internal defense
FIWC fleet information warfare center
FM frequency modulation

HN host nation
HNS host-nation support
HUMINT human intelligence
GL-2
Glossary
JP 3-53
IIP international information program
IO information operations
J-3 operations directorate of a joint staff
JFC joint force commander
JOPES Joint Operation Planning and Execution System
JP joint publication
JPOTF joint psychological operations task force
JSCP Joint Strategic Capabilities Plan
JSOTF joint special operations task force
JTCB joint targeting coordination board
JTF joint task force
MCS Military Capabilities Study
MOE measure of effectiveness
MOOTW military operations other than war
NGO nongovernmental organization
OPCON operational control
OPLAN operation plan
OPSEC operations security
PA public affairs
POAS PSYOP automated system
POAT psychological operations assessment team
POB psychological operations battalion
POG psychological operations group
PSE psychological operations support element
PSYOP psychological operations
RC Reserve Components
SO special operations
SPA special psychological operations (PSYOP) assessment
SPS special psychological operations (PSYOP) study
SR special reconnaissance
TA target audience
TARBS transportable amplitude modulation and frequency modulation
radio broadcast system
TPB tactical psychological operations battalion
TPFDD time-phased force and deployment data
TSC theater security cooperation
TV television
GL-3
Glossary
USAF United States Air Force
USAID United States Agency for International Development
USD(P) Under Secretary of Defense for Policy
USG United States Government
USJFCOM United States Joint Forces Command
USSOCOM United States Special Operations Command
UW unconventional warfare
basic psychological operations study. None. (Approved for removal from the next edition of JP 1-02.)
battle damage assessment. The timely and accurate estimate of damage resulting from the application of military force, either lethal or non-lethal, against a predetermined objective. Battle damage assessment can be applied to the employment of all types of weapon systems (air, ground, naval, and special forces weapon systems) throughout the range of military operations. Battle damage assessment is primarily an intelligence responsibility with required inputs and coordination from the operators. Battle damage assessment is composed of physical damage assessment, functional damage assessment, and target system assessment. Also called BDA. See also combat assessment; measures of effectiveness. (JP 1-02)

battlefield psychological activities. None. (Approved for removal from the next edition of JP 1-02.)
civil affairs. Designated Active and Reserve Component forces and units organized, trained, and equipped specifically to conduct civil affairs activities and to support civil-military operations. Also called CA. (JP 1-02)
civil affairs activities. Activities performed or supported by civil affairs that (1) enhance the relationship between military forces and civil authorities in areas where military forces are present; and (2) involve application of civil affairs functional specialty skills, in areas normally the responsibility of civil government, to enhance conduct of civil-military operations. (JP 1-02)
civil-military operations. The activities of a commander that establish, maintain, influence, or exploit relations between military forces, governmental and nongovernmental civilian organizations and authorities, and the civilian populace in a friendly, neutral, or hostile operational area in order to facilitate military operations, to consolidate and achieve operational US objectives. Civil-military operations may include performance by military forces of activities and functions normally the responsibility of the local, regional, or national government. These activities may occur prior to, during, or subsequent to other military actions. They may also occur, if directed, in the absence of other military operations. Civilmilitary operations may be performed by designated civil affairs, by other military forces, or by a combination of civil affairs and other forces. Also called CMO. (JP 1-02)
combatant command (command authority). Nontransferable command authority established by title 10 ("Armed Forces"), United States Code, section 164, exercised only by commanders of unified or specified combatant commands unless otherwise directed by the President or the Secretary of Defense. Combatant command (command authority) cannot be delegated and is the authority of a combatant commander to perform those functions of command over assigned forces involving organizing and employing commands and forces, assigning tasks, designating objectives, and giving authoritative direction over all aspects of military



operations, joint training, and logistics necessary to accomplish the missions assigned to the command. Combatant command (command authority) should be exercised through the commanders of subordinate organizations. Normally this authority is exercised through subordinate joint force commanders and Service and/or functional component commanders. Combatant command (command authority) provides full authority to organize and employ commands and forces as the combatant commander considers necessary to accomplish assigned missions. Operational control is inherent in combatant command (command authority). Also called COCOM. (JP 1-02)
combat assessment. The determination of the overall effectiveness of force employment during military operations. Combat assessment is composed of three major components: (a) battle damage assessment; (b) munitions effectiveness assessment; and (c) reattack recommendation. Also called CA. See also battle damage assessment; measures of effectiveness. (JP 1-02)

combatting terrorism. Actions, including antiterrorism (defensive measures taken to reduce vulnerability to terrorist acts) and counterterrorism (offensive measures taken to prevent, deter, and respond to terrorism), taken to oppose terrorism throughout the entire threat spectrum. Also called CBT. (JP 1-02)
consolidation psychological operations. None. (Approved for removal from the next edition of JP 1-02.)

coordinating authority. A commander or individual assigned responsibility for coordinating specific functions or activities involving forces of two or more Military Departments, two or more joint force components, or two or more forces of the same Service. The commander or individual has the authority to require consultation between the agencies involved, but does not have the authority to compel agreement. In the event that essential agreement cannot be obtained, the matter shall be referred to the appointing authority. Coordinating authority is a consultation relationship, not an authority through which command may be exercised. Coordinating authority is more applicable to planning and similar activities than to operations. (JP 1-02) counterintelligence. Information gathered and activities conducted to protect against espionage, other intelligence activities, sabotage, or assassinations conducted by or on behalf of foreign governments or elements thereof, foreign organizations, or foreign persons, or international terrorist activities. Also called CI. (JP 1-02)

counterpropaganda operations. Those psychological operations activities that identify adversary propaganda, contribute to situational awareness, and serve to expose adversary attempts to influence friendly populations and military forces. (Approved for inclusion in the next edition of JP 1-02.)

critical information. Specific facts about friendly intentions, capabilities, and activities vitally needed by adversaries for them to plan and act effectively so as to guarantee failure or unacceptable consequences for friendly mission accomplishment. (JP 1-02)

direct action. Short-duration strikes and other small-scale offensive actions by special operations forces or special operations-capable units to seize, destroy, capture, recover, or inflict damage on designated personnel or materiel. In the conduct of these operations, special operations forces or special operations-capable units may employ raid, ambush, or direct assault tactics; emplace mines and other munitions; conduct standoff attacks by fire from air, ground, or maritime platforms; provide terminal guidance for precision-guided munitions; conduct independent sabotage; and conduct anti-ship operations. Also called DA. (JP 1-02)

dislocated civilian. A broad term that includes a displaced person, an evacuee, an expellee, an internally displaced person, a migrant, a refugee, or a stateless person. Also called DC. (JP 1-02)

foreign internal defense. Participation by civilian and military agencies of a government in any of the action programs taken by another government to free and protect its society from subversion, lawlessness, and insurgency. Also called FID. (JP 1-02)

information operations. Actions taken to affect adversary information and information systems while defending one's own information and information systems. Also called IO. (JP 1-02)

interagency coordination. Within the context of Department of Defense involvement, the coordination that occurs between elements of Department of Defense, and engaged US Government agencies, nongovernmental organizations, and regional and international organizations for the purpose of accomplishing an objective. (JP 1-02)

joint psychological operations task force. A joint special operations task force composed of headquarters and operational assets. It assists the joint force commander in developing strategic, operational, and tactical psychological operation plans for a theater campaign or other operations. Mission requirements will determine its composition and assigned or attached units to support the joint task force commander. Also called JPOTF. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of JP 1-02.)

measures of effectiveness. Tools used to measure results achieved in the overall mission and execution of assigned tasks. Measures of effectiveness are a prerequisite to the performance of combat assessment. Also called MOEs. (JP 1-02)

military deception. Actions executed to deliberately mislead adversary military decision makers as to friendly military capabilities, intentions, and operations, thereby causing the adversary to take specific actions (or inactions) that will contribute to the accomplishment of the friendly mission. The five categories of military deception are as follows. a. strategic





military deception — Military deception planned and executed by and in support of senior military commanders to result in adversary military policies and actions that support the originator's strategic military objectives, policies, and operations. b. operational military deception — Military deception planned and executed by and in support of operational-level commanders to result in adversary actions that are favorable to the originator's objectives and operations. Operational military deception is planned and conducted in a theater to support campaigns and major operations. c. tactical military deception — Military deception planned and executed by and in support of tactical commanders to result in adversary actions that are favorable to the originator's objectives and operations. Tactical military deception is planned and conducted to support battles and engagements. d. Service military deception — Military deception planned and executed by the Services that pertain to Service support to joint operations. Service military deception is designed to protect and enhance the combat capabilities of Service forces and systems. e. military deception in support of operations security (OPSEC) — Military deception planned and executed by and in support of all levels of command to support the prevention of the inadvertent compromise of sensitive or classified activities, capabilities, or intentions. Deceptive OPSEC measures are designed to distract foreign intelligence away from, or provide cover for, military operations and activities. (JP 1-02)

operations security. A process of identifying critical information and subsequently analyzing friendly actions attendant to military operations and other activities to: a. identify those actions that can be observed by adversary intelligence systems; b. determine indicators that hostile intelligence systems might obtain that could be interpreted or pieced together to derive critical information in time to be useful to adversaries; and c. select and execute measures that eliminate or reduce to an acceptable level the vulnerabilities of friendly actions to adversary exploitation. Also called OPSEC. (JP 1-02)

perception management. Actions to convey and/or deny selected information and indicators to foreign audiences to influence their emotions, motives, and objective reasoning as well as to intelligence systems and leaders at all levels to influence official estimates, ultimately resulting in foreign behaviors and official actions favorable to the originator's objectives. In various ways, perception management combines truth projection, operations security, cover and deception, and psychological operations. (JP 1-02)

propaganda. Any form of communication in support of national objectives designed to influence the opinions, emotions, attitudes, or behavior of any group in order to benefit the sponsor, either directly or indirectly. (JP 1-02)

psychological operations. Planned operations to convey selected information and indicators to foreign audiences to influence their emotions, motives, objective reasoning, and ultimately the behavior of foreign governments, organizations, groups, and individuals. The purpose of psychological operations is to induce or reinforce foreign attitudes and behavior favorable to the originator's objectives. Also called PSYOP. (JP 1-02)

psychological operations assessment team. A small, tailored team (approximately 4-12 personnel) that consists of psychological operations planners and product distribution/dissemination and logistic specialists. The team is deployed to theater at the request of the combatant commander to assess the situation, develop psychological operations objectives and recommend the appropriate level of support to accomplish the mission. Also called POAT. (Approved for inclusion in the next edition of JP 1-02.)

psychological operations impact indicators. An observable event or a discernible subjectively determined behavioral change that represents an effect of a psychological operations activity on the intended foreign target audience at a particular point in time. It is measured evidence, ascertained during the analytical phase of the psychological operations development process, to evaluate the degree to which the psychological operations objective is achieved. (Approved for inclusion in the next edition of JP 1-02.)

psychological operations support element. A tailored element that can provide limited

psychological operations support. Psychological operations support elements do not contain organic command and control capability; therefore, command relationships must be clearly defined. The size, composition and capability of the psychological operations support element are determined by the requirements of the supported commander. A psychological operations support element is not designed to provide full-spectrum psychological operations capability; reachback is critical for its mission success. Also called PSE. (Approved for inclusion in the next edition of JP 1-02.)

psychological warfare. None. (Approved for removal from the next edition of JP 1-02.)
public affairs. Those public information, command information, and community relations activities directed toward both the external and internal publics with interest in the Department of Defense. Also called PA. (JP 1-02)
public diplomacy. Those overt international public information activities of the United States Government designed to promote United States foreign policy objectives by seeking to understand, inform, and influence foreign audiences and opinion makers, and by broadening the dialogue between American citizens and institutions and their counterparts abroad. (Approved for inclusion in the next edition of JP 1-02.)
public information. Information of a military nature, the dissemination of which through public news media is not inconsistent with security, and the release of which is considered desirable or nonobjectionable to the responsible releasing agency. (JP 1-02)
receptivity. None. (Approved for removal from the next edition of JP 1-02.)
special reconnaissance. Reconnaissance and surveillance actions conducted by special operations forces to obtain or verify, by visual observation or other collection methods, information concerning the capabilities, intentions, and activities of an actual or potential enemy or to secure data concerning the meteorological, hydrographic, or geographic characteristics of a particular area. It includes target acquisition, area assessment, and post-strike reconnaissance. Also called SR. (JP 1-02)

strategic psychological activities. Planned psychological activities in peace, crisis, and war, which pursue objectives to gain the support and cooperation of friendly and neutral countries and to reduce the will and the capacity of hostile or potentially hostile countries to wage war. (JP 1-02)

susceptibility. None. (Approved for removal from the next edition of JP 1-02.)
target audience. An individual or group selected for influence or attack by means of psychological operations. (JP 1-02)

unconventional warfare. A broad spectrum of military and paramilitary operations, normally of long duration, predominantly conducted by indigenous or surrogate forces who are organized, trained, equipped, supported, and directed in varying degrees by an external source. It includes guerrilla warfare and other direct offensive, low visibility, covert, or clandestine operations, as well as the indirect activities of subversion, sabotage, intelligence activities, and evasion and escape. Also called UW. (JP 1-02)

## What is hypnotic trance?
## Does it provide unusual physical or mental capacities?
### by Todd I. Stark

Most of the classical notions of hypnosis have long held that hypnosis was special in some way from other types of interpersonal communication **and** that an *induction* (preparatory process considered by some to be neccessary in the production of hypnotic phenomena) would lead to a state in which the subject's awareness and behavioral responding was some how altered from the usual.

The name historically most commonly associated with this altered state of functioning is 'trance,' a term shared by the description of the activities of certain spiritualist mediums and other phenomena that some psychologists might refer to as 'dissociative,' because something about the individual's personality appears split off from the usual response patterns to the environment.

Trance, for reasons we shall examine here, can be a very misleading term for what is going on in hypnosis, since it is not neccessarily a sleep or stupor as some of traditional connotations of the term trance imply.

But 'trance' is so ubiquitous in literature that it might serve us to be familiar with its uses and the issues underlying it, and to use it as a starting point.

There were a great many experimental and clinical studies done to try to determine what might be unique about hypnosis, as opposed to other kinds of situations (e.g. people simply being motivated to comply with the hypnotist; i.e. hypnotic simulators). Outward behavioral signs and virtually every physiological measurement reported in hypnosis differ seemingly not at all from the usual waking state of consciousness, as the non-state theorists contend.

Years of careful analysis by a number of researchers were mostly fruitless in turning up any reliable physiological correlates of hypnosis that were not (1) related to the relaxation associated with the induction (most inductions, but not all, involve physical relaxation); or (2) an obvious result of a suggestion Comparison of various relaxation methods with regard to both objective measurements and subjective reports indicate deep relaxation accompanying some hypnosis but not all hypnosis. Hypnotic suggestibility is apparently not limited to relaxed states.

In Morse, Martin, Furst, & Dubin, "A physiological and subjective evaluation of meditation, hypnosis, and relaxation," from Journal Psychosomatic Medicine. 39(5):304-24, 1977 Sep-Oct, a representative study of relaxation was done.

Subjects were monitored for respiratory rate, pulse rate, blood pressure, skin resistance, EEG activity, and muscle activity. They were monitored during the alert state, meditation (TM or simple word type), hypnosis (relaxation and task types), and relaxation. Ss gave a verbal comparative evaluation of each state. The results showed significantly better relaxation responses for the relaxation states (relaxation, relaxation- hypnosis, meditation) than for the alert state. There were no significant differences between the relaxation states except for the measure "muscle activity" in which meditation was significantly better than the other relaxation states. Overall, there were significant differences between task-hypnosis and relaxation-hypnosis. No significant differences were found between TM and simple word meditation. For the subjective measures, relaxation-hypnosis and meditation were significantly better than relaxation, but no significant differences were found between meditation and relaxation-hypnosis.

There are a few more recent attempts to find physiological correlates of hypnotic suggestibility. One of these was EEG research by David Spiegel of Stanford, published in the *Journal of Abnormal Psychology*, 94:249-255, by Spiegel, Cutcomb, Ren, and Pribram, (1985) "Hypnotic Hallucination Alters Evoked Potentials." Spiegel seemed to find an evoked response pattern that appeared during hypnotically suggested hallucination yet not during simulation of hypnotic hallucination. Nicholas Spanos and others have argued that this EEG data has been misinterpreted given the nature of the control subjects used. (Author's response to commentary by Spiegel, of Spanos, N. (1986) "Hypnotic Behavior: A Social-Psychological Interpretation of Amnesia, Analgesia, and 'Trance Logic'." *Behavioral and Brain Sciences* 9:449-502).

In another similar attempt, from 1976, but measuring certain frequencies of EEG activity rather than evoked potentials, a Russian journal reports some tentative success at finding a physiological correlate to hypnotic induction. See Aladzhalova, Rozhnov, & Kamenetskii, "Human hypnosis and superslow electrical activity of the brain." [RUSSIAN] Zhurnal Nevropatologii I Psikhiatrii Imeni S - S - Korsakova. 76(5):704- 9, 1976.

In the above article, the authors studied the transformation of infraslow oscillations of brain potentials in 15 patients with neuroses during 50 sessions of hypnosis. The results of such studies permitted to distinguish some important traits in the changes of infraslow oscillations of brain potentials in

### 2.2. Are there potential clues in 'trance logic?'

One particular researcher, psychiatrist M.T. Orne of the University of Pennsylvania, finally concluded that objective correlates were not to be found in the available physiological measurements of the time, and that they were apparently of no value in determining whether a hypnotized subject was 'truly hypnotized' or 'simulating hypnosis.'

Orne, who did recognize from both highly consistent verbal reports of hypnotized subjects and from various clinical and empirical studies that there was indeed *something* unique about hypnosis in at least *some* subjects, concluded that that he would have to use verbal reports of subjective experience rather than rely on measurements. He carried out a series of clever experiments which seemed to establish a reliable way of distinguishing simulators from hypnotized subjects by their verbal reports. The resulting alteration of mental function was found to be present in nearly all deeply hypnotized subjects, and almost never found to the same degree in people who were not hypnotized but were motivated to simulate hypnotic phenomena.

The most obvious aspects of this alteration of function were dubbed 'trance logic,' and appeared to correlate well with the anecdotal reports of the clinicians like Milton Erickson who had long considered verbal reports of hypnotized subjects to be valuable in distinguishing what was going on in hypnosis.

### 2.3. What is Trance Logic?

Trance logic refers to a set of characteristics of mental functioning that are specifically found in 'deep trance' phenomena of hypnosis, as opposed to 'light trance,' which has not even reliable subjective correlates and cannot really be distinguished from simulation experimentally. These characteristics involve particularly an alteration in language processing. Words, in trance logic, are interpreted much more literally, communication being conveyed by focusing on words themselves rather than ideas. There is also an associated decrease in critical judgement of language being processed, and an increased tolerance for incongruity.

It is in some ways as if the subject were like a small child with very limited experience to use in interpreting ideas conveyed by the hypnotist. There also is a shift toward what psychoanalysts call 'primary process' thinking, or thinking in terms of images and symbols more than words; an increased availability of affect; and other characteristics that simulators do not consistently reproduce.

This consistent set of characteristics of deep trance has been one of the forgotten childhood memories can apparently sometimes be vividly reexperienced (see the later section on the reliability of recall in hypnosis) the theory that trance generally represents some kind of psychological regression to an earlier developmental stage has long been popular in some circles.

2. Partly because the individual appears to become disconnected somehow with the usual context they use to evaluate ideas, a cognitive dissociation theory arose. (Also partly because of anomalies involving apparent multiple simultaneous 'intentions.')

3. Partly because the cues prompting the subject's behavior become more internal and progressively more obscure to an outside observer, trance has been viewed as 'contact with the unconscious mind.'

4. Largely because some of the characteristics of trance logic correlate well with some of those discovered to be specialized in many people in the non-dominant cerebral hemisphere, there is also a popular theory that deep trance involves a somehow selective use of one hemisphere of the brain, or in the most simplified version of this theory, a 'putting to sleep' somehow of the dominant (language specialized) hemisphere. Some brain scientists strongly disagree with this view, emphasizing the complex interdependence of the brain hemispheres even in typical

hypnotic-type situations.

### 2.4. Critique of Trance Logic

The notion of trance logic, rooted as it is in subjective reports, has been questioned by some of the non-state theorists, such as Nicholas Spanos, who do not believe that trance logic represents any sort of defining characteristic of hypnotic responding.

Examples of critiques of this concept can be found in Nicholas Spanos, "Hypnotic behavior: A social-psychological interpretation of amnesia, analgesia, and 'trance logic,'" *Behavioral and Brain Sciences* 9(1986):449-502, and a paper cited by Spanos in the above; Nicholas P. Spanos, H.P. de Groot, D.K. Tiller, J.R. Weekes, and L.D. Bertrand, "'Trance logic' duality and hidden observer responding in hypnotic, imagination control, and simulating subjects," *Journal of Abnormal Psychology* 94(1985):611-623.

### 2.5. Trance as distinct from sleep or stupor

I think we can fairly conclude from the research on hypnosis done so far that 'trance' may in fact have useful meaning for describing the subjective experience of subjects in hypnotic situations, but is not explained, or even described, by any one simple theory yet proposed, either neurological or psychological. All of the current theories seem to leave aspects unexplained. Clearly, selective cerebral inhibition and activation of *some kind* is involved the normal sleep state. It is a much more highly specific effect, if indeed it truly is distinct in some way, as subjective data appear to suggest.

The most common neurological theories of hypnosis over the years as a form of partial sleep have mostly been based on (1) the superficial resemblance of a classically induced subject to a near-sleeping person, (2) on the ease with which a deeply hypnotized subject will fall off to sleep on suggestion or if hypnosis is not explicitly ended, and (3) because various drugs that induce sleep-like or stuporous states can produce some of the same characteristics as hypnotic trance.

It has been very consistently determined that trance itself has nothing at all to do with sleep, and is much more easily distinguished from a sleeping state physiologically than from a waking state. Measurements attempted included a number of famous early experimental studies in the 1930's, on such variables as EEG measurements, cerebral circulation, heart rate, respiration, basal metabolism, and various behavioral parameters. Representative of these experiments comparing hypnosis and sleep was: M.J. Bass, "Differentiation of the hypnotic trance from normal sleep," *Journal of Experimental Psychology*, 1931, 14:382-399.

Though the mentation in hypnosis often resembles dreaming, it appears much closer to *daydreaming* in character than to normal night time dreaming. Clark Hull, in his 1936 classic *Hypnosis and Sugestibility* describes a number of experimental setups for distinguishing the *mental* characteristics of sleep from those of hypnotic trance.

One thing suggested by this is that if sleep can be viewed as largely a generallized cortical inhibition, and trance is not in any determinable way identified with sleep, that trance is **not** a form of sleep or a stupor. This is also easily determined by observing the range of activities possible in hypnotized subjects (compared to waking subjects and those under the influence of depressant drugs).

## 2.6. 'Trance Reflex' and the appearance of stupor

So the question remains, if trance is not sleep or stupor, then why do hypnotized subjects commonly appear so passive?

The consensus on this subject, from studies of 'waking hypnosis,' ('trance' in which the subject acts normally and does not show any evidence of the classical relaxed deep trance state), and from many years of clinical observations, is that the apparent lethargy and catalepsy are more a result of suggestions used to deepen hypnosis than a neccessary correlate of suggestibility or trance itself in general. In a way, a side-effect of trance rather than a quality or cause of trance. There is also seemingly a temporary but Monotonous visual stimuli, surprise, fear, physical restraint, and a number of other factors have long been observed to produce 'trance' with fixation (followed by defocusing) of gaze, narrowing or attenuation of externally focused attention, general immobility, and various physiological changes which resemble the correlates of relaxation and *internally directed* (visual) attention in humans.

Perhaps the most routine observance of this is with people gazing into television sets or in the familiar case of 'highway hypnosis.' It appears that this type of 'trance' induction often precedes the production of hypnotic suggestion phenomena, and can occur prior to any verbal suggestions, from proprioceptive or visual stimuli alone. It is probably closest to the traditional view of the hypnotist swinging a watch to put their subjects 'to sleep.'

One means of searching for the basis for this seemingly reflexive trance response is from phylogenetic data, using animals. A similar response occurs in monkeys and other animals under both laboratory and natural conditions, as an apparent passive defensive response (resembling death) under certain extreme conditions.

Various Russian researchers investigating animal hypnosis seem to have discovered electroencephalographic correlates of this animal 'death trance' which resembles the initial trance/inhibition effect that sometimes precedes human hypnotic suggestibility. They report an interhemispheric asymmetry of the brain, which a recent Russian email journal article, (Petrova E.V., Shlyk G.G., Kuznetsova G.D., Shirvinska M.A., Pirozhenko A.V., HYPNOSIS IN MACACA RHESUS IS CHARACTERIZED BY DIFFERENT PHASES AND INTERHEMISPHERIC EEG ASYMMETRY), summarizes as being "created as the result of the activation of the right hemisphere."

They cite:

● Simonov P.V. The Motivation Brain, Gordon a. Breach Pub., N.Y.-L., 1992.

● Kuznetsova G.D., Nezlina N. I., Petrova E.V. Dokl. Akad. Nauk, 1988, 302:623.

● Petrova E.V., Luchkova T.I.,Kuznetsova G.D. Zh. Vyssh. Nerv. Deyat. 1992, 42: 129.

As evidence of a correlation between right hemisphere cortical activity and human hypnosis, they cite:

● Gruzeiler J., Brow T., Perry A. et al. Int. J. Psychophysiol., 1984, 2:131.

● Meszaros J., Growford H.J., Nady-Kovacs A, Szabo Cs., Neuroscience, 1987, Suppl. 22:472.

One investigation into the relationship of primate behavior and electrical
In this experiment, six of the monkeys immediately stopped motor activity. At first their eyes were fixed on the ball, then muscle tonus weakened, eyes became unfocused, and respiration slowed. These same symptoms appeared in the remaining animals, although they developed slower. During the first 2-3 minutes of the stimulation, the slower responding monkeys showed a negative reaction to the ball (a monkey abruptly turned away or tried to push it away). Then the negativism ceased and the first signs of inhibition appeared: yawning, scratching, and obtrusive hand motions.

Finally, what the experimenters call the 'hypnotic state' ensued; eyes fixed on the ball, the animal became calm, and closed its eyes. This state continued from several seconds to several minutes and could be observed several times during an experimental session. In 12 monkeys that displayed orienting or aggressive response to the ball, visual signs of inhibition were not observed under these conditions. Further physical restraint (fixation of hands and trunk) resulted in the 'hypnotized' behavior. This is in contrast to the more usual behavior of monkeys, what the authors of the article call the 'freedom reflex' which results when they are taken from their home cages and placed in the primatologic chair.

As they describe the EEG observations:

"The electrical activity of monkey brain cortex before hypnosis was characterized by a robust polyrhythmia and presence of theta- and beta-rhythms. In one monkey the alpha-rhythm was dominate. During hypnosis, slow activity (delta and theta) with increased amplitude appeared, periodically alternating with lowamplitude activity. Power spectrum maps showed that in the low-amplitude phase the decrease in the power of all rhythms was paralleled in three monkeys with robust beta-1 rhythm with a predominance in the left hemisphere. In the high-amplitude phase, delta and theta-rhythms dominated in the right hemisphere."

"The analysis of the coherence and correlation functions showed the decreased relationship between hemispheres (especially in the frontal cortical areas) under hypnosis and its increase during relaxation (as compared to the background)."

"The analysis of the EEG showed that in the brain of hypnotized monkeys interhemispheric asymmetry appears: the domination of the theta- and delta-rhythms in the right hemisphere or beta-rhythm in the left hemisphere - depending upon the phase of hypnosis."

Factors shown to facilitate this "animal hypnosis" include vestibular (pose in the chair) and somatosensory (fixation) stimuli and emotional stress (fear), novelty to the experimental conditions, and additional proprioceptive (restriction of the motor freedom) and visual influences. Various sources precede hypnotic induction, the factor of 'trance logic' which surfaces under deep trance also adds to the catatonic appearance, as the primitive language capacity in trance logic could easily contribute to the appearance of stupor. But the individual is actually, in general, wide awake and thinking, and in control of themself, but extraordinarily focused on their internal experience, and on the voice of the hypnotist.

"... the general tendency of the hypnotic subject to be passive and receptive is simply expressive of the suggestibility of the hypnotic subject and hence a direct result of the suggestions employed to induce hypnosis and not a function of the hypnotic state."

Milton Erickson, circa 1944.

The most obvious reason to make this distinction is to dispell the popular myth that a hypnotized person is unconscious or unable to respond to emergencies, or to oppose the will of the hypnotist if they should wish to do so. In fact, Erickson did a famous detailed study of attempts by the hypnotist to force their will on hypnotized subjects, and observed that not only did the subjects discriminate what suggestions they would and would not respond to, and refused to respond to some, but then often came up with ways to hurt or humiliate the hypnotist in retaliation for the attempt. And that they were even more selective about what suggestions they would not respond to under hypnosis than they were normally!

Another reason this distinction is made is because of extraordinary skills of some hypnotists to 'induce trance' (gain a unique kind of compliance or communication) with people who had not been prepared or relaxed by a classical induction, and who in fact steadfastly and effectively resisted all attempts at classical induction of trance.

A third reason is that we observe in some hypnotic phenomena that an individual can be hypnotized, with the help of a traditional progressive relaxation procedure for example, and then "remain hypnotized" (equally responsive to suggestion) long after leaving the state of physiological relaxation and classic apparent catatonia. So, the 'trance,' though it may in fact start with a process similar to that which commonly leads to sleep, or may start with the 'trance reflex,' it is not dependent upon stupor, nor even neccessarily relaxation.

### 2.7. Evidence of enhanced functioning following suggestion?

Some of the 'unusual capacities' often claimed of hypnosis are actually legitimate, but found to be quite normal capacities seen in various nonhypnotic situations as well, though the hypnotic 'deep trance' context does

apparently give a unique kind of *access* to those normal capacities. Seemingly in everyday life."
Milton Erickson
T.X. Barber, a highly respected researcher into human functioning under hypnosis has long promoted the view that people can bring out their own inner capabilities by direct requests to think, feel, and experience in a suggested way, without any need for hypnotic induction. He says that the secret of hypnosis involves the ability to fantasize in a hallucinatory way and provide the drama and excitement. Also important, according to Barber, is the way in which suggestions are given, language which gives firm but metaphorical suggestions.
Keith Harary, in his March/April 1992 *Psychology Today* article, "The trouble with HYPNOSIS. Whose power is it, anyway?" reviews a number of critical studies of hypnosis and concludes a a similar view:
"Packaging them [the true claims made about hypnosis] under the label 'hypnosis' conceals what is really going on. It doesn't even begin to suggest that they are our very own powers and there might be ways to get at them directly and entirely on our own."

### 2.7.1. 'Mind and Body' in medicine

We see that there is little of any consistency that can be said about light trance objectively, and possibly only 'trance logic' (if that) as a common characteristic of deep trance. Yet the subjective experience of the individual is sometimes very profoundly altered.
And some phenomena can be reliably reproduced in good subjects which are medically considered very unusual and hard to explain (though not neccessarily limited to hypnosis situations). The working medical framework that had traditionally cleanly separated psychogenic from physiological effects has been revised in parts to allow for some of the mechanisms related to effects found in good hypnotic subjects; such as influences between neural and immunological systems, dermatological (skin) responses that were previously believed not to be able to be influenced by the brain and nervous system, and the difficult but demonstrable 'biofeedback' ability to indirectly control very small neural units previously considered completely autonomic.
In terms of the prevailing medical paradigm, numerous functional interconnections within the brain and between the nervous system and other body systems have been found that may gradually help to explain such remarkable effects as we see in hypnosis and under various other seemingly special psychological conditions. Among other key discoveries, the study of neuropeptides and their distribution throughout the body as well as the brain provides some potential answers for some of the more perplexing questions arising from effects due to suggestion.
that are fairly typical are in the June 1989 issue of the mainstream medical specialty journal *Gastroenterology*, "Hypnosis and the relaxation response" and "Modulation of gastric acid secretion by hypnosis."
An excellent review of the research into the exact physiological effects found

to result from hypnotic suggestions in particular may be found in these two of T.X. Barber's articles ...

- "Physiological effects of 'hypnosis,' *Psychological Bulletin*, 58: 390-419, 1961.
- "Physiological effects of 'hypnotic suggestions': a critical review of recent research (1960-1964)," *Psychological Bulletin*, 63: 201-222, 1965.

In addition to these general references, the following sections may help to followup on any interest into various specific apparent unusual effects of suggestion.

### 2.7.2. Hypermnesia, perceptual distortions, hallucinations

Hypermnesia is perceived enhanced recall of memories. See also the later section on the reliability of hypnotic recall.

An excellent overview of experimental and clinical studies of hypermnesia, perceptual distortions, and hallucinations under hypnosis may be found in the hypnosis section of the *Annual Review of Psychology*, especially these issues spanning 20 years of research into hypnotic phenomena:

- Vol 16, 1965, E. Hilgard, p. 157-180
- Vol 26, 1975, E. Hilgard, p. 19-44
- Vol 36, 1985, J.R. Kihlstrom, p. 385-418

Another related area is the remarkable phenomena of eidetic imagery, or 'photographic memory.' In recent years, this formerly controversial phenomenon has been demonstrated by means of computer generated random pixel patterns which stereoscopically encode a visual image. There would be two images which, one seen by each eye at the same time, produce a three dimensional visual image. It is considered virtually impossible to detect the encoded image by looking at the separate encoded patterns at different times. People with eidetic imagery can memorize one pattern, and then mentally project it with one eye while looking at the other pattern with the other eye. The result is that they can see the three dimensional image, while apparently no amount of motivation will permit someone without eidetic imagery to see the final image.

It is now known that many five year old children can experience eidetic imagery, and that it is very rare in adults. A study published in the Journal of This could be interpreted as evidence of true temporal regression in hypnosis in some sense, although that interpretation seems unlikely in the face of evidence in other areas. It is more likely to provide unique evidence of statespecific abilities accessible through hypnotic suggestion.

The following are the studies quoted above:

- Walker, Garrett, & Wallace, 1976, "Restoration of Eidetic Imagery via Hypnotic Age Regression: A Preliminary Report," *Journal of Abnormal Psychology*, 85, 335-337.
- Wallace, 1978, "Restoration of Eidetic Imagery via Hypnotic Age Regression: More Evidence," *Journal of Abnormal Psychology*, 87, 673-675.

In addition, Michael Nash in his chapter "Hypnosis as Psychological Regression," in Lynn and Rhue's 1991 *Theories of Hypnosis* discusses the evidence around different kinds of psychological regrression and also refers to an unpublished manuscript by Crawford, Wallace, Katsuhiko, and Slater, from 1985, which is said to also discuss positive evidence for the faciitation of eidetic imagery phenomenon with hypnotic techniques: "Eidetic Images in Hypnosis, Rare but There."

### 2.7.3. Posthypnotic suggestion and amnesia

Amnesia (basically selective forgetting in this case) sometimes occurs spontaneously in hypnosis, and sometimes happens as the result of a direct or indirect suggestion to forget something. The amnesia effect may last a variable time, possibly months or longer, depending on the psychological significance of the amnesia and the forgotten material and on the intensity of attempts to recall and availability of recall cues in the environment.

A posthypnotic suggestion in general is a response to hypnotic suggestion that extends beyond the boundary of the actual trance period. Posthypnotic suggestions are often performed without any knowledge that they were previously suggested (thus the neccessary link to hypnotic amnesia of this phenomena). The individual responding to a posthypnotic suggestion and with amnesia for the source of the suggestion will generally incorporate the response into their ongoing activities without disruption, in a similar manner to rituallized actions that we pay little attention to such as brushing our teeth in the morning or making the right sequence of turns in our well established route to work each morning. If the response involves some bizarre action, the individual will either be confused or typically will come up with a creative rationalization for the behavior. Very rarely will there be any awareness of the action resulting from a previous suggestion.

It is the contention of many experts in hypnotic work that individuals can and do resist posthypnotic suggestions that they do not wish to perform, except that implicit trust of the hypnotist may promote a behavior out of the ordinary. This is sometimes (especially per Orne) considered more a factor of

See the following sources of information on post-hypnotic research, in addition to the Hilgard article in Vol. 16 of *Annual Reviews* (1965), cited above:

- W. Wells, 1940, "The extent and duration of post-hypnotic amnesia," *Journal of Psychology*, 9:137-151.
- Edwards, 1963, "Duration of post-hypnotic effect," *British Journal of Psychiatry*, 109: 259-266.
- Dixon, 1981, "Preconscious Processing" (book)

Various studies have also been done to try to determine what kinds of psychological pressure will cause hypnotic amnesia to be breached, and under what conditions.

Schuyler & Coe, "A physiological investigation of volitional and nonvolitional experience during posthypnotic amnesia," *Journal of Personality & Social Psychology*, 40(6):1160-9, 1981 Jun was a good example.

Highly responsive hypnotic subjects, who were classified as having control over remembering (voluntaries) or not having control over remembering (involuntaries) during posthypnotic amnesia, were compared with each other on four physiological measures (heart rate, electrodermal response, respiration rate, muscle tension) during posthypnotic recall. Two contextual conditions were employed: One was meant to create pressure to breach posthypnotic amnesia (lie detector instructions); the other, a relax condition, served as a control. The recall data confirmed earlier findings of Howard and Coe and showed that voluntary subjects under the lie detector condition recalled more than the other three samples that did not differ from each other. However, using another measure of voluntariness showed that both voluntary and involuntary subjects breached under lie detector conditions. Electrodermal response supported the subjects' reports of control in this case. Physiological measures were otherwise insignificant. The results are discussed as they relate to (a) studies attempting to breach posthypnotic amnesia, (b) the voluntary/involuntary classification of subjects, and (c) theories of hypnosis.

### 2.7.4. Pain control (analgesia and anesthesia)

Hypnosis was at one time frequently and sucessfully used for surgical anesthesia. It is still sometimes used effectively for dental work, childbirth, and chronic pain of various types. Pain control is one of the most reliable and most studied of the hypnotic phenomena.

In addition to Hilgard's article in Vol 26 of *Annual Reviews* (1975) see:

● Hilgard, Hilgard, Macdonald, Morgan, and Johnson, 1978, "The reality of hypnotic analgesia: a comparison of highly hypnotizables with simulators." The authors find that motivated simulation of *Pain*, 1977, J. Barber and D. Mayer reported that effective analgesia was produced by a refinement of hypnotic technique, and was not reduced by naloxone. J. Barber, neuropsychiatry at UCLA, seems to have somewhat specialized in this area.

● Another 1977 study, Stern, Brown, Ulett, and Sletten, 'A comparison of hypnosis, acupuncture, morphine, Valium, aspirin, and placebo in the management of experimentally induced pain,' *Annals of the New York Academy of Sciences*, 296, 175-193, found that acupuncture, morphine, and hypnotic analgesia all produced significantly reduced pain ratings for cold pressor and ischemic pain.

● Van Gorp, Meyer, and Dunbar, 'The efficacy of direct versus indirect hypnotic induction techniques on reduction of experimental pain,' *International Journal of Clinical and Experimental Hypnosis*, 33, 319-328, 1985 (with cold pressor pain).

● Tripp and Marks, 1986, compared hypnosis and relaxation with regard to analgesia for cold pressor pain in 'Hypnosis, relaxation, and analgesia suggestions for the reduction of reported pain in high- and low-suggestible subjects,' *Austrailian Journal of Clinical and Experimental Hypnosis*, 33, 319-328.

● H.B. Crasilneck et al., 1955, "Use of hypnosis in the management of patients with burns," *Journal of the American Medical Association*, 158: 103-106.

● D. Turk, D.H. Meichenbaum, and M. Genest, (1983), *Pain and behavioral medicine: a cognitive-behavioral perspective*, New York: Guilford Press has a review of cognitive-behavioral strategies for pain control in general, not limited to hypnosis.

● In Larbig W. Elbert T. Lutzenberger W. Rockstroh B. Schnerr G. Birbaumer N. EEG and slow brain potentials during anticipation and control of painful stimulation. Electroencephalography & Clinical Neurophysiology. 53(3):298 -309, 1982 Mar., EEG corrrelates of pain control were studied.

Cerebral responses in anticipation of painful stimulation and while coping with it were investigated in a "fakir" and 12 male volunteers. Experiment 1 consisted of 3 periods of 40 trials each. During period 1, subjects heart one of two acoustic warning stimuli of 6 sec duration signalling that either an aversive noise or a neutral tone would be presented at S1 offset. During period 2, subjects were asked to use any technique for coping with pain that they had ever found to be successful. During period 3, the neutral S2 was presented simultaneously with a weak electric shock and the aversive noise was presented simultaneously with a strong, painful shock. EEG activity within the theta band increased in anticipation of aversive events. Theta peak was most prominent in the fakir's EEG. A negative slow potential shift during the S1-82 interval was generally more pronounced in anticipation of the aversive events that the neutral ones, even though no overt motor response was required. Negativity tended to increase across the three periods, opposite to the usually observed diminution. In Experiment 2, all subjects self-administered 21 strong shock-noise presentations. The fakir again showed more theta power and more pronounced EEG negativity after stimulus delivery compared with control subjects. Contrary to the controls, selfhttp://

Some of the most interesting hypnotic phenomena involve the apparent precision production of subtle skin responses by suggestion. Allergic reactions, pseudo-sunburns, blisters, and weals have been produced by suggestion. In addition, it has long been known that certain highly troublesome skin conditions have been influenced or healed in some people by suggestion (with or without hypnotic induction).

See the following for further information on studies of this:

● Ullman & Dudek, 1960, "On the psyche and warts: II. Hypnotic suggestion and warts," *Psychosomatic Medicine*, 22:68-76

● Rulison, 1942, "Warts, A statistical study of nine hundred and twenty one cases," *Archives of Dermatology and Syphilology*, 46:66-81.

● Asher, 1956, "Respectable Hypnosis," *British Medical Journal*, 1: 309-312.

● R.F.Q. Johnson and T.X. Barber, 1976, "Hypnotic suggestions for blister formation: Subjective and physiological effects," *American Journal of Clinical Hypnosis*, 18: 172-181.

● Mason, 1955, "Icthyosis and hypnosis," *British Medical Journal*, 2: 57-

58.
● M. Ullman, 1947, "Herpes Simplex and second degree burn induced under hypnosis, *American Journal of Psychiatry*, 103: 828-830.

### 2.7.6. Control of bleeding

Experiments with hypnosis during surgery have found that suggestion during and after surgery can reduce bleeding significantly, as well as help with the management of pain.

See Clawson and Swade, 1975, "The hypnotic control of blood flow and pain: The cure of warts and the potential for the use of hypnosis in the treatment of cancer," *American Journal of Clinical Hypnosis*, 17: 160-169.

### 2.7.7. Cognition and learning

This is a broad area covering a number of factors that are difficult to separate. In addition to the critical review by Barber in 1965 cited above in (1), see G.S. Blum, 1968. "Effects of hypnotically controlled strength of registration vs. rehearsal," *Psychonomic Science*, 10: 351-352, which discusses hypnosis as a possible way of reducing rehearsal needed to learn something new.

In some of his publications, researcher Charles Tart discusses the concept of state-specific abilities, including the possibility that some might apply to hypnotic phenomena. See his *States of Consciousness*, and other related works for more on this.

### 2.7.8. Enhanced strength or dexterity

concentration and increased motivation in some athletes, and can be used to modify or lessen the influence of inhibiting beliefs or attitudes. Similar effects are seen when athletes are motivated in other ways, outside of hypnosis.

See T.X. Barber's 1966 paper, "The effects of 'hypnosis' and motivational suggestion on strength and endurance: a critical review of research studies," *British Journal of Social and Clinical Psychology*, 5:42-50.

### 2.7.9. Immune Response

It has long been supposed (and in recent years demonstrated experimentally) that emotions and psychological state somehow have an effect on human immune response, but even though detailed mechanisms and the limits of this effect have not been well understood in modern medical science. A recent article in Science News, Sept. 4,1993, pp. 153, describes 'the first solid evidence that hypnosis can modify the immune system far more than relaxation alone."

The report concerns the research of Patricia Ruzyla-Smith of Washington State University in Pullman and her co-workers, who conclude that "hypnosis strengthens the disease-fighting capacity of two types of immune cells, particularly among people who enter a hypnotic trance easily."

This appears to correspond well with and bolster the previous findings related to enhanced 'placebo' (psychosomatic) effects in good hypnotic subjects, in the hypnotic induction situation. However, it does not appear to address the persistent question of whether highly hypnotizable subjects have a unique capacity for psychosomatic regulation, or whether they simply exhibit this capacity common to all of us in a uniquely accessible and convenient way by responding to hypnotic suggestion.

In this research, the psychologists recruited 33 college students who achieved a hypnotic trance easily and 32 students who had great difficulty doing so. Volunteers viewed a brief video describing the immune system and then were assigned to one of three groups: hypnosis, in which they listened to a hypnotic induction asking them to imagine their white blood cells attacking "germ cells" in their body and then performed this exercise through self-hypnosis twice daily for one week; relaxation, in which they floated effortlessly in a large tank of warm water containing Epsom salts and repeated the session one week later; or neither method.

Students who underwent hypnosis displayed larger jumps in two important classes of white blood cells than participants in the other groups. The greatest immune enhancement occurred among highly hypnotizable students in the hypnosis group.

### 2.8. Highly extraordinary experiences

out of the range of what most people think of as usual human experiences. For the present discussion, we might divide these extraordinary experience into three overlapping types:

1. Experiences which seem extraordinary because what is remembered (while under hypnosis) as having previously happened seems to defy commonly accepted canons of plausibility, such as the controversial UFO abduction phenomenon,
2. Experiences which, perceived as happening during hypnosis, seem to defy commonly accepted canons of plausibility, or would require a drastic theoretical revision to accept, such as psychic phenomena,
3. Experiences which seem extraordinary because they have an unusually powerful or lasting effect on the individual, such as certain deeply religious or mystical experiences,

#### 2.8.1. Bizarre remembrances under hypnosis

The veracity of events recalled under hypnosis is considered by most experts today to be problematic to determine. Hypnosis facilitates the recall of details in good subjects, and also facilitates the manufacture of details during recall that were not neccessarily present previously. This in fact is characteristic of recall in general, which has been demonstrated to be far from a permanent and unchanging record, but more a dynamic and adaptive process; a shapeshifting moire pattern of sorts, conforming to inner needs and ongoing mental activity, more than a videotape recording of the precise details of perceptual events.

There is also some evidence that hypnosis may additionally aid in providing 'state-specific' context to aid in the recall of information and experience of which the individual is otherwise normally unaware.

Which of these complex and incompletely understood processes is dominant in the recall of someone's extraordinary memories of seemingly implausible events is extremely difficult if not impossible to determine from the hypnotic session alone.

Neither claims of unimpeachable veracity under hypnosis (the 'hypnosis as truth serum' idea) nor those of hypnosis being completely unreliable in

facilitating recall ('false memory') stand up to close scrutiny as a general principle applicable to all cases of controversial hypnotic recall. The best evidence available seems to indicate that hypnotic methods can sometimes be valuable in a number of ways, both to the individual's psychological health and in helping to gather factual information, but that they should not be relied upon by themselves or given special preference over other kinds of testimony for such things as legal evidence, nor considered to be accessing anything like a perfectly faithful permanent record of past perceptual events.
This section closes with an illustrative philosophical excerpt from a recent Tarcher/Putnam Publishing 1993, ISBN 0-87477-738-0:
"While pointing out the overlap between emotion and memory, I want to emphasize that memory is not simply a fixed look-up table. It too is a creative process during which the state of the brain's electrical fields change. The sensory cortices generate a distinct pattern for each act of recognition and recall, with no two ever exactly the same. They are close enough to cause the illusion that we understand and have seen the event before, although this is never quite true. Each time we recall something it comes tainted with the circumstances of the recall. When it is recalled again, it carries with it a new kind of baggage, and so on. So each act of recognition and recall is a fresh creative process and not merely a retrieval of some fixed item from storage."
"Furthermore, persons, objects, and events are not perceived in their entirety but only by those aspects which are, have been, or can be experienced and acted upon by an observer..."
"... All that we can know about anything outside ourselves is what the brain creates from raw sensory fragments, which were actively sought by the limbic brain in the first place as salient chunks of information..."
"... Put in a more familiar context, artists and creative writers look at the world in a certain way. It is the same world that everyone else sees, but seen differently. Contemporary people often call artists weird because they do not seem to be seeing the same things that the majority sees. It is critical to realize that the sensory gateways that feed into the brain establish their own conditions for the creation of images and knowledge. Artistic giants knew full well that their visions were not shared by most people. Even when persecuted or abandoned because of their vision artists persist. That is all the can do because their visions are their reality, and for many of us they subsequently become our reality when we experience their art."
(copyright (c) Richard E. Cytowic, MD)

### 2.8.2. Psychic phenomena under hypnosis

There are a number of links between the sorts of situations commonly associated with hypnosis, and the experience of what are often called 'psychic phenomena,' (herein primarily meaning apparent extrasensory perceptions, and psychokinesis, but also such related experiences as apparitions mediumistic phenomena, and such strange occurrances as the apparent suspension of death).

has very strong associations with both the origins of various schools of psychology, and modern parapsychology, and the study of 'psychic phenomena' in general. The reason for quoting that term here is to emphasize that the term originally meant such subtleties of mental life as what we today often think of as the'subconscious' or 'unconscious' mind, rather than specifically and exclusively such things as ESP, hauntings, or poltergeists. At the time, it seems there had been less of a feeling that there was a distinct difference in plausibility between 'unconscious processes' and those today generally considered paranormal. Because of this, the term may tend to be ambiguous when used in a discussion where a wide variety of experiences are being included.

Early (circa late 19th century, early 20th century) psychology was largely a philosophical endeavor, which included a wide range of areas of investigations that were grouped in ways that might seem a little strange today. For example, the American Society of Psychical Research (ASPR), today probably thought of mostly as having been a pioneering organization in the study of the paranormal, devoted a great deal of its early efforts (and an explicit section of its charter) to studying what we today usually consider mundane aspects of hypnosis.

Hypnosis has thus long had a popular traditional association with such controversial psychic phenomena as ESP, PK, poltergeist activity, and clairvoyance, as well as various forms of occultism and some kinds of religious healing rituals.

Of particular pertinence here, there is also a tenuous but persistent experimental link between hypnotic processes and laboratory psi. The link is particularly prominent in anecdotal evidence, but this is often of questionable reliability, for reasons that will be described here. It is in the more controlled laboratory psi data that the more truly demonstrable anomalous results appear that give us cause for further investigation.

First, the difficulty with this sort of experiment, and the kinds of protocols and controls required should be recognized. While the open-minded researcher of anomalies might not wish to reject the useful subjective verbal reports of hypnotic subjects, they also have to contend with the remarkable subtlety of non-paranormal (conventional sensory) human perception and communication.

Milton Erickson, for example, described an experiment with hearing impaired 'lip readers.' He discovered that they actually read a much richer panorama of cues than simply the moving lips. The lip reading subjects would sit with their backs to a blackboard on which there were various geometric designs. The designs were then covered with sheets of paper. In front of the lip readers sat a group of non-hearing-impaired participants, who were instructed to look at the blackboard and say and do nothing. Someone else removed the paper

covering the geometric symbols, one at a time. The lip readers were instructed to write down anything that they read from the participants in front of them who were observing the geometric figures.
people's thoughts about them, was reported as having perfect accuracy. Erickson applied this insight to his hypnotic technique, by recognizing the significance of messages he himself didn't realize he was giving. A similar analysis has frequently been applied to anecdotal reports of cases of apparent telepathy, but where 'cold reading', or the skill of gathering information surreptitiously through subtle but conventional sensory clues, appears to be a likely factor.

Someone might actually suggest that the paranoid psychotic patient in this particular experiment, and some or all of the other hearing-impaired patients, were actually employing some telepathic faculty to some degree. But most interpretations would probably focus on the use of subtle clues that the participants observing the blackboard were unaware of providing. The nature of hypnotic communication ('rapport') is such that the participants are particularly well attuned to the nuances of each other's movement, speech and expression. This, combined with the lip readers' existing capacity for attending to subtle body language, contributes to the appearance of an even more extraordinary, even paranormal, information transfer, and makes it more difficult to sort out the precise mechanisms of information transfer involved.

Modern psychological reviews might also focus on the hypothesis that the paranoid psychotic subject was likely dissociating their perception of what they were reading from their awareness of its source (rather than the obvious appearance of receiving it from an extrasensory source). This resembles the dissociation theory of how trance mediumistic (trance channelling) behaviors and some religious experiences (such as hearing the voice of God) may occur, at least in some cases. The concept of cognitive dissociation is a central one to many modern psychological descriptions of hypnotic and peripheral phenomena, as we will see in more detail later. In particular, we will see that dissociation provides an extremely useful description, but not neccessarily an adequate explanation of all of the data.

Today, most psychologists, and virtually all of those investigators known as parapsychologists, are aware of the complexity of human perception under even conventional circumstances. They would generally tend *not* to consider a psi hypothesis to be demonstrated in this sort of situation, given the apparently demonstrated correlation of exceptional body language reading skills and high hit rates. This is of course entirely different from demonstrating that a psi faculty is *not operating*. Just that the experimental situation in this particular case does not provide evidence of psi.

But there are other experimental results, with protocols more specifically designed to rule out subtle conventional sensory communication. These give us reason to at least consider and test a psi hypothesis, with an eye toward ruling out subtle body reading effects, in hypnotic situations. It appears from some results that under certain kinds of conditions hypnosis may at least be slightly conducive to anomalous information transfer, even when subtle cues

are eliminated.
hypnosis as an altered state in which paranormal capacities are provided or enhanced may not be the best or only explanation, even if the psi hypothesis itself were to receive growing experimental support. There is also the crucially important matter of just exactly what it is *about* the process of hypnotic induction and its effects on the subject that changes hit rates in certain laboratory psi tests.
In another section, we briefly review T.X. Barber's work demonstrating that most if not all of the unusual phenomena reported during hypnosis are also seen under other conditions. He and his colleague Sheryl Wilson in their work on the theory of the 'Fantasy Prone Personality' also provide us with another link between psi and hypnosis, the observation that there are distinct similarities in personality variables between people who are excellent hypnotic subjects, and those who report large numbers of psychic experiences.
It should be emphasized here that this theory does not support the once popular notion that good hypnotic subjects are simply gullible or neurotic, or otherwise mentally ill; as no correlation with any of these personality variables has ever been determined. Rather, the FPP theory paints a picture of natural visionary individuals with a rich inner life and often extraordinary psychosomatic responses, but who are perfectly well able to distinguish their vivid fantasy life from reality, just as most of us can distinguish a dream from a memory of actual events, most of the time.
In other words, among the factors that the FPP does NOT correlate with well at all is any diminished capacity for reality testing. This should be born in mind particularly because of the popular connotations of the term 'fantasyprone,' and the questionable veracity of recollections occurring under
hypnotic procedures. A report from an FPP subject is not inherently either more or less reliable than one from other subjects, in or out of hypnosis. Their rich mental life does not neccessarily intrude on their external perceptions, except under various very unusual kinds of conditions, such as spontaneous hallucination triggered by hypnotic suggestion.
Additionally, there is the complex psychological question of whether the individual interprets their experience as 'real' or 'imagined.' When an LSD user comes down from their trip, they don't generally continue to believe that their face was melting or that the sky actually changed to flourescent green during their experience, they distinguish it as an 'altered state.' However, during the trip, the altered perception may be quite convincing.
In hypnotic extraordinary experiences, we find both cases where the individual believes that their perceptions were due to an altered state, even though it seemed real at the time, and those where they believe something quite bizarre actually happened, not the result of an unusual perceptual state. And the two types of cases are not at all easy to distinguish by any means other than relying on the report of the subject.
unambiguous independent historical records indicate that it did not.
The particular conditions under which spontaneous hallucination can occur,

and under which they can be confused with external perceptual experiences are not well known, nor is there any known method of distinguishing a spontaneous hallucination from an external sensory perception. Even theories of how drug action (e.g. LSD) causes hallucinations are highly speculative, and spontaneous hallucinations are much more slippery.

Two current theories of spontaneous hallucination concern changes in the chemical environment of endogenous neurotransmitters or neuromodulators which influence perception (endorphins and serotonin being the most commonly cited); and possibly some unique mode of function of temporal or temporolimbic brain pathways, perhaps influenced by electromagnetic fields. How these unusual brain conditions relate to psychic phenomena and to other observations related to hypnosis in general is not yet well established.

### What is Hypnosis?[

Hypnosis refers to just about any situation where we respond to verbal suggestions in a particular special way. This involves a mentally very flexible condition where our imagination and fantasy are more free and more vivid. A series of instructions, called an **induction**, is the most common way to do this. Just about any situation where we relax and allow ourselves to become absorbed in something can lead to the appropriate conditions for hypnosis. These conditions also sometimes occur without relaxation, such as immediately following confusion or distraction. Most hypnotic inductions involve a highly cooperative process, rather than hypnosis being something that is "done to" someone.

### Science and the Arts of Hypnosis

Hypnosis today is often considered from two different perspectives : the *sciences* used to study how it works, and the *arts* used to make use of it for specific purposes. These are such very different perspectives for two main reasons. First, there is the schism between the academic and the clinical subcultures that is found in many fields of psychology. Second, there is the particularly wide gap between hypnosis practice and academic psychology because of the periods when hypnosis was considered completely disreputable. This helped to polarize even further those who helped the arts using hypnosis to survive and those who would study hypnosis scientifically.

In science, there is the basic idea of being able to create psychological conditions where people respond to verbal suggestions in a seemingly unusual way. This is what researchers study, and what forms the foundation for the practice of hypnosis as an adjunctive treatment in medicine. In order to study hypnosis in this manner, we define it as precisely as possible, and in most cases we utilize simple tests and suggestions. It is primarily from this perspective that the current document has been written.

The second perspective is the historical creation of the arts of hypnotic influence. This means making use of response to verbal suggestion in order to influence attitudes and behaviors more dramatically or over a longer period of time. This might be a healing art, a performing art, or a form of self-help. When we use hypnosis as a healing art, it is a form of psychotherapy and adheres to the same basic principles and ethical considerations as other forms of therapy. As a performing art, hypnosis has very little in common with psychotherapy aside from the occasional elimination of superficial symptoms by suggestion.

For more information on the arts of hypnotic influence, especially hypnotherapy as practiced by non-psychologists, I recommend starting with Roy Hunter's excellent FAQ on the **alt.hypnosis** newsgroup, maintained at Roy's home page at http://www.hunter.holowww.com. In order to learn more about psychotherapy in general, I highly recommend either of two starting places : Dr. John Grohol's award winning Mental Health page, or Mental Health Net.

## 1.1 Defining Hypnosis

Since there is no single well accepted theory of hypnosis, the trick is to make the definition as theory neutral as possible, descriptive and not implicitly explanatory. Yet even the description is sometimes controversial. One thing that has become known for certain is that hypnosis is only interesting from a phenomenal perspective.

The **subjective experience** of hypnotized people is what is special about hypnosis, not any identifiable objective measurements. If there are any objective behavioral correlates of hypnotic experience, they are either so subtle as to escape detection, or so idiosyncratic that we can't draw general conclusions from them.

Prominent researcher E.R. Hilgard provided the following in his 1965 review of the scientific data on hypnosis up to that point (Hilgard, 1965) :

"*Without attempting a formal definition of hypnosis, the field appears to be well enough specified by the increased suggestibility of subjects following induction procedures stressing relaxation, free play of imagination, and the withdrawal of reality supports through closed eyes, narrowing of attention, and concentration on the hypnotist. That some of the same phenomena will occur outside of hypnosis is expected, and this fact does not invalidate hypnosis as a research topic.*"

Specifying exactly what "increased suggestibility" means has been extremely difficult. What this means in practical terms is that the hypnotized person experiences certain classical **hypnotic phenomena**, particularly in response to verbal suggestion. Years ago, one of the hypnosis researchers (Weitzenhoffer) dubbed this the "classic suggestion effect." The thing that sets these hypnotic phenomena apart from simple compliance with a suggestion is that they are experienced as being somehow effortless or involuntary. This is what sets **hypnotic suggestibility** (sometimes called **primary suggestibility**) apart from other kinds of compliance. **The sensation of responding in an involuntary way is the most notable difference between hypnosis and other conditions.** (Zamansky and Ruehle, 1995).

Both the concept of hypnosis and the practice of hypnosis have been hypnosis is actually unique to hypnosis. A hypnotic induction is not essential to demonstrate hypnotic phenomena. Modern research has largely confirmed that hypnosis is not a unique physiological state, and that imagination is indeed a central element. At the same time, though, we have come to *an increasing regard for the depth and subtlety of human imagination under all conditions !*

One of the most promising advances in the theoretical perspective on hypnosis has been the communications analysis approach. This was pioneered by the followers of Milton Erickson and other innovative hypnosis experts who saw hypnosis as a *dynamic cooperative process* involving intimate human communication as well as imagination, rather than (or in addition to) a problematic *state of consciousness.*

### 1.2 What else is "like hypnosis ?"

There are basically three varieties of things that are commonly called hypnosis or compared to hypnosis :

1. Formal hypnosis, which includes relaxation and the use of suggestion,
2. Self hypnosis ("suggestions" are provided mentally and silently, or provided on a previously made tape)
3. Alert hypnosis (there is no relaxation component)

Common examples of how these processes are used include :

- **Hypnotherapy :** Psychotherapy which emphasizes the use of hypnosis.
- **Medical hypnosis** : Used as an adjunct to medical treatment to reduce pain or other symptoms.
- **Stage hypnosis** : Emphasizing confusion, distraction, and social pressure to gain quick, dramatic compliance for entertainment purposes.
- **Self-Help** : Using taped inductions, prepared scripts, or self-talk to attempt personal changes with the help of suggestion.

Things that have little or nothing directly to do with hypnosis include :

- sleep
- barbiturate-induced stupor
- gullibility or moral weakness
- mental illness
- "brainwashing"

The important elements in things we call hypnosis are, roughly in order of decreasing importance :

- slightly enhanced **primary suggestibility** for verbal language (words vivid imagery and intense emotion
- cooperative interpersonal communication, response to social cues (there is a guide, and we trust them)
- relaxation and enjoyable stillness

One of the ways to help make a complex definition more clear is to provide examples of things that don't fit. Some of the things that are not hypnosis but appear to share some similarities include :

- **Meditation** : Meditation often shares some characteristics with our psychological state under hypnosis. Descriptions of our spontaneous experience under some kinds of meditation are similar to those under some conditions of hypnosis. Some people infer from this that the "trance" seen in hypnosis and that seen under meditation is the same. The observation is an interesting one, but there is currently no good way to confirm or disprove this notion, without actually turning meditation into hypnosis by testing for response to suggestions. Meditation does not necessarily involve specific responsiveness to verbal suggestion, or an enhanced sensitivity to social cues. It may or may not involve fantasy. These are important elements in hypnosis, particularly from a process perspective. Sensitivity to social cues is a cornerstone of the communications analysis view of hypnosis, and is absent during meditation. **A meaningful definition of hypnosis that emphasizes how we use it will not include meditation as an example, and vice versa.**

● **Guided imagery** : While it appears very similar, and often overlaps, hypnosis is not "just" guided imagery. There are additional important elements to hypnosis that are not generally found in guided imagery. We can certainly engage in guided imagery during hypnosis. But not all hypnosis involves guided imagery, and guided imagery does not necessarily result in hypnosis. More importantly, **the skill for imagery is not the same as the skill for entering and using hypnosis**. Vivid imagery is an important element in hypnosis, but it is not sufficient. There are other elements needed for hypnosis, including but not limited to hypnosis-relevant attitudes (Glisky, Tataryn, and Kihlstrom, 1995). There is evidence that guided imagery under hypnosis has subtly different effects on the body than guided imagery under relaxation alone. Also, there is so far no strong correlation between abilities at imagery and abilities at hypnosis. Vividness and motor imagery are only weakly correlated with hypnotizability, although the ability to become absorbed in imagery is slightly better correlated with hypnotizability. Ultradian cycles for imagery and hypnotic susceptibility vary at different rates (Wallace & Kokoszka, 1995). Overall, imagery is an important component in hypnosis, but guided imagery is not in any sense synonymous with hypnosis, the underlying ability to do hypnosis and the underlying ability to do imagery are two different things. To illustrate in practical terms that imagery is not the primary factor, it has been observed that verbal hypnotic suggestion takes effect even when we concentrate on imagery that is contrary to the suggestion ! (Zamansky and Ruehle, 1995)

entirely true. Like meditation, however, self-hypnosis is not dependent upon responsiveness to verbal suggestion or responding to subtle social cues, so it really is a different process in some important ways. The key experience of involuntariness or effortlessness in hypnotic responding is shared by hypnosis and self-hypnosis, so they clearly share a similar kind of psychological state in general. However, one involves dynamic responses to ideas, and the other dynamic responses to words. There is no external guide during self-hypnosis. There are differences in the ease with which we can be hypnotized by another person and with which we can hypnotize ourselves. There is some evidence that automated response to words is an important element in hypnosis. For a number of reasons, it is necessary to make a distinction in spite of the similarity of hypnosis and self-hypnosis.

● **Self-regulation, or "alert hypnosis"** : This includes autogenics, biofeedback, and other methods used to influence autonomic body processes or increase primary suggestibility that do not involve a formal hypnotic induction. These are often distinct from hypnosis because they do not involve responding to social cues, but rather to cues provided by instrumentation. In addition, there is often no essential verbal component, and no necessity for relaxation. Some would call these methods kinds of "alert hypnosis," and in cases where the remaining elements are present, this is probably as reasonable as the distinction of self-hypnosis for cases where only the interpersonal element is missing.

● **Subliminal self-help tapes** : Let's assume for the sake of discussion that there exists a "subliminal" technology that actually works. This means that a message is encoded which we can reliably perceive but not be aware that we are receiving it. The message would become what is known as "implicit," meaning that it can affect our behavior though we do not recognize it as a memory of anything in particular. Hypnosis can also create or make use of implicit memory, however that doesn't mean that anything that affects implicit memory is hypnosis. As far as is known, subliminal suggestion would have none of the important elements that distinguish hypnosis ! Why do we even for a moment think that this would work in some way similarly to hypnotic suggestion ? I discuss this in detail in another section.

● **Neurolinguistic Programming (NLP)** : Neurolinguistic Programming (NLP) is partially derived from careful observation of the patterns in what happens during hypnosis. It is therefore, at least in part, an extension of the communications analysis view of hypnosis. NLP borrows its basic concepts largely from cognitive psychology, which views behavior as guided by schemata or strategies. NLP practitioners use a variety of methods to attempt to determine what strategies people use for various activities, and then to modify those strategies or utilize them for other purposes. Some of the techniques used in NLP also resemble "alert hypnosis," because they use language patterns also used in hypnotic induction to elicit cooperation, build trust, and increase the effectiveness of suggestions. In practical terms, very little of NLP involves hypnosis.

● **The Placebo Effect** : The placebo effect is the most common name for positive result. Attitudes, beliefs, and expectations are known to play a very important role in our behavior under hypnosis, just as they play an important role at other times, and suggestion is a factor in placebo response. The role of expectations in hypnosis is particularly interesting because of the dramatic effect on our imagination. One of the most fascinating examples is in the elaborate role enactment known as "age regression," where the content is often directly related to expectations set prior to hypnosis. **Hypnotic suggestion cannot entirely be described as placebo effect, however, as there are a number of distinct differences.** Some of these differences can be demonstrated experimentally. This is why we can meaningfully compare hypnosis experimental groups with placebo control groups. Response to hypnotic suggestion is much more closely related to the semantic content of the suggestion than the more general effects of placebo, that is, it is far more specific. The correlation between placebo responders and hypnotizability is good but nearly strong enough to conclude that they are the same attribute. **The placebo effect has some overlap with hypnosis, but is not the same thing as hypnotic suggestion. (Evans, 1977; Evans 1981; McGlashan, Evans & Orne, 1969; Orne, 1974)**

Article by Todd I. Stark

From the Hypnosis FAQ by Todd I. Stark

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"Bower, G. (1990). Awareness, the unconscious and repression : An experimental psychologist's perspective . In J.L. Singer (Ed.),..."

## Hypnosis, volition, and mind control.[credits]

## by Todd I. Stark

## 5.1. Is the hypnotist in control of me?

The exact nature of what we experience as 'will' or *volition* is anage-old philosophical problem that has yet to be resolved by brain scientistsor psychologists.

Some aspects of hypnotic responding point out weaknesses in our understanding of the nature of volition, such as: its exact relationship to conscious*awareness*; the capacity and limitations of external stimulii (such as'suggestion') to influence our sensory experience and behavior; and thedetails of the patterns by which specific phenomenological and physiologicalevents influence each other.

The vast majority of hypnosis researchers seem to believe that the individualhas a capacity for volition which may be influenced but not ablated byhypnotic suggestion. That the individual under hypnosis is still acting ontheir own will in some sense, although possibly with distorted or limitedinformation presented by the hypnotist. In addition, there may be influenceson their behavior which the subject is not *consciously* aware ofresponding to, or does not report an *awareness* of responding to. This has been challenged by some theorists by questioning the nature ofself-awareness itself in various ways.
The question of volition becomes important when we consider the longstudied question of whether a hypnotist can influence an individual to performbehaviors which they would not 'ordinarily' want to perform, such as to commitcrimes or to injure themselves or others.
This issue arose in part from the commonly held premise that an individual's character traits are more important than immediate stimulii in guiding their behavior. Some of the behaviorist theorists of hypnosis have historicallydownplayed the stable traits of individuals and attributed their behavior to agreater extent to responses to external stimulii. To them, there is less question of 'ordinary' behavior, and more a matter of conditioned responses. Andrew Salter's *What is Hypnosis* published in the middle of this (20th) century is a good representation of that viewpoint.
The likelihood is that the truth lies between stable character theory andconditioned response theory. There are seemingly what some call Individuals can probably be influenced under a situation of contrived hypnoticimagery to do things that would ordinarily be considered very unusual, and todo them at unusual times and places. But there are clearly 'ecological' limits to this as well.
For example, most studies have sugggested that the individual can and does*reject* suggestions of some types, in some way, both during hypnosis,and in the form of post-hypnotic suggestions, and is not being coerced directly under hypnosis to act against their 'will' in any meaningful sense,though they may act under false premises.
A classic early study supporting this view was done by Milton Erickson, published in *Psychiatry* in 1939 (2,391-414), "An experimental investigation of the possible anti-social use of hypnosis." M.T. Orne's similar view is represented by his chapter on hypnosis in the 1961 *TheManipulation of Human Behavior*, by Biderman and Zimmer (p. 169-215).Orne argues that the coercion or 'Svengali Effect' sometimes attributed tohypnosis is an artifact of the hypnotic experimental situation.
However, it has also been shown that an individual can be tricked by the hypnotist, and possibly led by their trust in the hypnotist, to performunusual behaviors in unusual situations, even potentially dangerous orembarrasing ones. This potential is well known to fans of 'stage hypnosis,' particularly with that subset of individual's particularly susceptible to the dramatic tactics of the stage hypnotist. These tactics are for the most partdifferent from the classical induction used in medicine and psychotherapy,relying on surprise,

sudden confusion, social pressure, and other factors notunknown to medical hypnotherapists, but not normally emphasized by themeither.

A classic study which illustrated how far individuals would go in hypnotic responses to contrived hypnotic situations was Loyd W. Rowland, "Will Hypnotized Persons Try To Harm Themselves or Others?", *Journal of Abnormal and Social Psychology* 34(1939):114-117. This study is described in William Corliss' *The Unfathomed Mind: A Handbook of Unusual Mental Phenomena*, pp. 120-123. This study showed subjects sticking their handsinto boxes with what they presumably believed were live rattlesnakes, and throwing concentrated acid into what they presumably believed was theunprotected face of another person.

Other studies showing response to suggestions of anti-social behavior in anexperimental setting included:

- W.R. Wells, "Experiments in the hypnotic production of crime," *Journalof Psychology*, 1941, 11:63-102,
- M. Brenman, "Experiments in the hypnotic production of anti-social and self-injurious behavior," *Psychiatry*, 1942, 5:49-61.

Various authors have reported attempts by the U.S. CIA to research or use hypnotic techniques for mind control. All seem to report failure rates form of hypnosis, this seems to be the type most powerful ininfluencing the minds of people. And this type of situation is perhaps as well described in terms of social/group psychology as individual response tohypnotic suggestion.

Another class of mind control technology reportedly attempted was thedeliberate cultivation of secondary or multiple personalities. The true nature of multiple personality disorder is still under intensive research,with a few leads from PET scans suggesting that in some people, a true neurological distinction between personality states may occur, in spite of theapparent inability of EEG to pick up such a distinction. If true, this would tend to imply that at least for *some* individuals, Hilgard's neo-dissociation theory is closest to the truth, and that a cognitivedissociation of some sort does literally occur. As with the mind control attempts based on stage hypnosis, this never seems to have been consideredpractical as a means of controlling the minds of individuals in general.

The experimental studies showing people performing aberrant, criminal, or self-destructive acts have long been criticized, notably by M.T. Orne, asreflecting the implicit trust of the hypnotic subject that the experimenter would not put them into truly dangerous situations during the experiment, andthat the experimental conditions were too contrived to represent what the individual would do in real life. The dialog here is obviously very reminiscent of the critiques of Stanley Milgram's "obedience to authority" experiments, where subjects believed they were giving progressively more painful and dangerous electric shocks to other subjects as part of a behavioral learning experiment.

Which brings us to reports of someone actually committing a crime, or becomingthe victim of one, under the influence of hypnosis, *outside* of the experimental laboratory. Leo Katz, *Bad Acts and Guilty Minds*, 1987, University of Chicago Press, pp. 128-133, describes cases of crimes committed by patients of unethical hypnotists. The *Fortean Times*, #58, July 1991,reports in an article "The Eyes Have It," by Michael Gross, the prosecution of a man who sexually assaulted at least 113 women, preceded by hypnosis, and there vocation of the medical license of a psychiatrist in 1982 for abusing women under hypnosis.

Similar allegations and sometimes prosecutions of cases of misconduct or rapewith the aid of hypnosis by therapists have been reported in the media inrecent years as well.

The actual role of hypnosis in each of these cases is unknown. It is likely that it provided the abusing therapists assistance in the seduction of the women in question, but that again, it was a matter of using the hypnotic induction to abuse their already elevated trust in the therapist at least asmuch as any loss of their 'will to resist' at the time of the abuse.

For contrast, compare the case of a victim being drugged into
iteasier to 'trick' an individual in some sense into doing something that theywouldn't 'ordinarily' do in that particular situation with that particularperson at that time. Thus the justifiable sense of remorse and violation whenthey realize what they've been led to do. Not dissimilar from the also controversial situation with abuse or alleged abuse by parents, where the child's implicit trust in the parent's interest in their welfare often complicates the evaluation and treatment of the situation after the fact.

## 5.2. Voluntary vs. Involuntary

Who or what is in control when a hypnotist gives a suggestion, and their subject apparently responds, but reports that they had no *awareness* of responding? Is it the same mechanism in some ways as that in control during biofeedback experiments when the subject has no direct awareness of altering markers of their physiological functions? Or is it closer to the mechanism that permits the well known 'automatisms' or behaviors performed by habitoutside our awareness? Or are these all aspects of the the same mechanism insome way?

These behaviors have all long been called 'involuntary' responses, and this iswhat provides the impression that the hypnotist is directly controlling the subject. Weitzenhoffer in 1974 called this the "Classical Suggestion Effect,"the "transformation of the essential, manifest, ideational content of acommunication" into behavior that appears involuntary.

What exactly does it mean for a behavior to appear to be involuntary?In their 1991 *Theories of Hypnosis*, Lynn and Rhue identify three distinct views of involuntariness in hypnnosis:

1. The experience of diminished or absent control over a behavior
2. The inability to resist a suggestion
3. An automatic response, experienced as effortless and uncaused by thesubject, but with a capacity in reserve to resist if desired.

#1 above, apparently a blocking of awareness of feedback about a behavior, isa common experience in hypnosis. Some theorists contend that this kind of

experience is actually the defining characteristic of hypnosis.
#2 above has very few supporters today. Most modern hypnosis experts agree that their subject can and does resist undesireable suggestions. Even the neodissociation viewpoint, which holds that cognitive function can split into differing factions, never admits to a complete relinquishing of control of the 'will,' more a removal from a usual high level executive planning function.
#3 above is the most controversial of the three views. The subjective perception of non-volition in hypnosis is widely agreed upon, and the idea ofat least a latent capacity to resist suggestions in some way is also pretty much agreed upon by experts. But the notion of effortless reponse with accurately reporting a lack of volition with another part. Theolder ideomotor theory held that the response was a direct result of thesuggestion, presumably some automated language-behavior response mechanism('the unconscious') that they believed a hypnotist could tap in to.
The final details of what aspects of the social psychological view, whataspects of the neo-dissociative cognitive view, and what aspects of variousothers are actually the best description for various hypnotic phenomena arelargely up to future research to determine.

## 5.3. Conscious vs. Unconscious

Is there actually an 'unconscious mind' in some sense? And if so, does itexplain certain kinds of response to hypnotic suggestion?
First, it is very likely that information is actually processed, at least under certain conditions, outside of conscious awareness, and that it can influence behavior. A modern look at this old topic can be found inKihlstrom's 1987 *Science* article, "The Cognitive Unconscious," 237,1445-1452. This is not to say that any particular 'subliminal learning'claims have support from this notion, only that it is possible for perceptionof a sort to occur without apparent conscious awareness.
One study demonstrating a subliminal influence on subsequent behavior was Borgeat & Goulet, 1983, "Psychophysiological changes following auditory subliminal suggestions for activation and deactivation," appearing in*Perceptual & Motor Skills*. 56(3):759-66, 1983 Jun.
This study was to measure eventual psychophysiological changes resulting from auditory subliminal activation or deactivation suggestions. 18 subjects were alternately exposed to a control situation and to 25-dB activating and deactivating suggestions masked by a 40-dB white noise. Physiological measures(EMG, heart rate, skin-conductance levels and responses, and skin temperature)were recorded while subjects listened passively to the suggestions, during astressing task that followed and after that task. Multivariate analysis ofvariance showed a significant effect of the activation subliminal suggestions during and following the stressing task. This result is discussed asindicating effects of consciously unrecognized perceptions on psychophysiological responses.
A hypnotic subject clearly also takes an active and voluntary role in somesense as well when carrying out suggestions, as pointed out by Spanos and thesocial-psychological theorists.

Perhaps the data showing this contrast most strikingly is from the study of'hypnotic blindness.' One example is Bryant and McConkey's 1989 "HypnoticBlindness: A Behavioral and Experimental Analysis," *Journal of Abnormal Psychology*, 98, 71-77, and also p. 443-447, "Hypnotic

It appears that some form of neurological events involving more or lessintelligent response to information can occur, in or out of hypnosis, withoutour direct awareness of them. One theory proposes that the brain has a simultaneous parallel capacity for cognitive learning and forstimulus-response learning, independently of each other and by differentneural mechanisms. This has been proposed by some as a partial explanationfor automatisms and some hypnotic responses. One version of this view may befound in the article by Mishkin, Malamut, and Bachevalier, "Memories andHabits: Two Neural Systems," in *The Neurobiology of Learning andBehavior*, edited by McGangh, Lynch, and Weinberger, by Guilford Press.

It is important to recognize that the detailed physiological mechanismsunderlying the processing of information in general are largely speculative,and that the gaps in our understanding of hypnotic phenomena (or 'states of consciousness' in general) complicate the situation. It has been contended that even some of the simpler forms of learning and information processingconsist of a number of different processes, each with its own specialproperties.

One important distinction is between explicit and implicit learning. Explicit learning is what we commonly think of as doing as part of the consciousreasoning process when we try to learn something deliberately. It generallyinvolves reasoning and hypothesis testing. Implicit learning is acquiring newinformation which either cannot be verballized, or which occurs apparently without conscious reasoning and hypothesis testing. Kihlstrom, oneinvestigator of hypnotic and unconscious psychological processes, has shown that a particular variant of implicit learning, involving certain nonnovel information (such as word pairings), can occur under medical anesthesia. Thedegree to which this can be considered a form of learning in the more generalnon-technical sense is difficult to say, and the precise neurobiological mechanism of anesthesia is likewise somewhat elusive. But it has also been observed that implicitly learned material has certain unique characteristics, as compared to explicitly learned material, such as that implicit material ismore often preserved intact in cases of amnesia.

Some examples of research into learning and perception which occurs outside of sensory (visual) attention:

- Mandler, Nakamura & Van Zandt (1987). Nonspecific effects of exposure on stimuli that connot be recognized. J Exp Psych: Learning, Memory andCognition, 13, 646-648.
- Miller (1987). Priming is not necessary for selective-attention failures: Semantic effects of unattended, unprimed letters. Perception and Psychophysics, 41, 419-431.
- Carlson & Dulany (1985). Conscious attention and abstraction inconcept learning. J Exp Psych: Learning, Memory, and Cognition,

11, 45-58.
● Dienes, Broadbent, & Berry (1991). Implicit and explicit knowledge bases in artificial grammar learning. JEPLMC, 17, 875-887.
● Hayes & Broadbent (1988). Two modes of learning for interactive tasks.Cognition, 28, 249-276.
On the concept of attention in general:
● Allport (1989) Visual Attention. In M.I.Posner (Ed.) Foundations ofCognitive Science. (pp. 631-682).
● Kahneman & Treisman (1984). Changing views of attention andautomaticity. In Parasuraman & Davies (Eds.) Varieties of Attention.
● Navon (1985). Attention division or attention sharing? In Posner and Marin (Eds) Attention and Performance XI.
● Neumann (1987). Beyond capacity: A functional view of attention. In Heuer& Sanders (Eds.) Perspectives on Perception and Action.
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## Hypnosis: A Selected Bibliography[credits]

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10. The Reliability of Hypnotic Recall (8 entries)
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3. Journal of Personality and Social Psychology
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5. Psychological Bulletin
6. Behavioral and Brain Sciences
7. American Journal of Clinical Hypnosis
12. Journal of Behavioral Medicine
13. Archives of General Psychiatry
14. Psychiatry
2. Edited collections of diverse viewpoints.
1. * Lynn, Stephen, and Judith Rhue (eds.),1991,"Theories of Hypnosis:Current Models and Perspectives," N.Y.:Guilford Press.
2. Fromm, E. and R.E. Shor (eds.), 1979, "Hypnosis: Developments in Researchand New Perspectives," Chicago:Aldine.
3. Tinterow, M.M. (ed.), 1855 (1970), "Foundations of Hypnosis," Springfield,Il.: Charles Thomas.
4. Lecron, L.M. (ed.), 1954, "Experimental Hypnosis," Macmillan.
5. Naish, P.L.N. (ed.), 1986, "What is hypnosis? Current Theories andResearch," Philadelphia: Open University Press.
3. General overviews by single authors and important or useful articles addressing specific major issues related to hypnosis.
1. General single-author overviews, non-special-state views,

social andexperimental views.
1. * Bowers, K.S., "Hypnosis for the Seriously Curious"
2. Barber, Theodore X., Spanos, Nicholas P., and Chaves, John F. (1974)Hypnosis, Imagination, and Human Potentialities. Pergamon.
3. Spanos, N.P. and J.F. Chaves (eds.), 1989, "Hypnosis: TheCognitive-Behavioral Perspective," N.Y., Prometheus Press.
4. * Barber, T.X., 1969, "Hypnosis: A Scientific Approach," N.Y.: VanNostrand Reinhold.
5. Spanos, N.P., 1986, "Hypnotic Behavior: A Social-Psychological interpretation of amnesia, analgesia, and 'trance logic,'" *Behavioral andBrain Sciences*, 9:449-467.
6. Wagstaff, G.F., 1981, "Hypnosis, Compliance, and Belief," N.Y.:St. MartinsPress.
7. Hull, Clark L., 1933, "Hypnosis and Suggestibility: An ExperimentalApproach," Appleton-Century-Crofts.
8. Sarbin, Theodore and William Coe, 1972, "Hypnosis," N.Y.:Holt.
9. Weitzenhoffer, Andre, 1953, "Hypnotism: An Objective Study in Suggestibility," N.Y.: Wiley.
10. Bowers, K.S., and Thomas M. Davidson, 1991, "A Neodissociative Critique ofSpanos' Social Psychological Model of Hypnosis," in Lynn and Rhue, *Theories of Hypnosis*, 1991, N.Y.: Guilford Press, pp. 105-143.
2. On state-specific theories, dissociation, and multiple personality.
1. * Hilgard, Ernest R., 1977, "Divided Consciousness: Multiple Controls inHuman Thought and Action," John Wiley & Sons.
PersonalityResearch, vol. 14, pp. 1-62. Academic Press. (Critical of dissociationtheory).
3. White, R.W., 1941, "A Preface to a Theory of Hypnotism," *The Journal ofAbnormal and Social Psychology*.
4. White, R.W., and B.J. Shevach, 1942, "Hypnosis and the Concept ofDissociation," *Journal of Abnormal and Social Psychology*, 37:309-328.
5. Hilgard, E.R., 1991, "A Neodissociation Interpretation of Hypnosis," inLynn and Rhue (eds.), *Theories of Hypnosis*, N.Y.:Guilford Press, pp.83-104.
6. Fischer, Roland, "State-Bound Knowledge," Aug. 1976, *Psychology Today*, 10, pp. 68-72.
7. Prince, Morton, 1957, "The Dissociation of a Personality," N.Y.:MeridianBooks.

8. Thigpen, Corbett and Hervey Cleckley, 1957, "The Three Faces of Eve,"N.Y.: McGraw Hill.
9. Putnam, F., 1984, "The Psychophysiological Investigation of Multiple Personality Disorder," *Psychiatric Clinics or North America*, 7:31-39.
10. Goleman, D., 1988, "Probing the Enigma of Multiple Personality," *N.Y.Times*, June 28, pp. C1,C13.
11. Braun, B., 1983, "Psychophysiologic Phenomena in Multiple Personality andHypnosis," *American Journal of Clinical Hypnosis*, 26:124-135.
12. Coons, P.M. et al., 1982, "EEG Studies of two multiple personalities and acontrol," *Archives of General Psychiatry*, July, 39:823.
13. * Bliss, E., 1984, "Spontaneous Self-Hypnosis in Multiple Personality Disorder," *Psychiatric Clinics of North America*, 7:137.
14. Humphrey, N. and D.C. Dennett, 1989, "Speaking for Ourselves: An Assessment of Multiple Personality Disorder," *Raritan*, 9: pp. 68-98.
15. O'Regan, B. and T. Hurley, 1985, "Multiple Personality: Mirrors of a NewModel of Mind?," *Investigations*, Institute of Noetic Sciences.
16. Ross, C.A. (1989) Multiple Personality Disorder: Diagnosis, Clinical Features, and Treatment. John Wiley and Sons
17. Putnam, F.W.(1989) Diagnosis & Treatment of Multiple Personality Disorder. Guilford Press.
18. Kluft, R.P & Fine, C.G. (eds) (1993) Clinical Perspectives on MultiplePersonality Disorder. American Psychiatric Press.
19. Lowenstein, R.J. (guest editor) The Psychiatric Clinics of North America,Special volume on multiple personality disorder, September, 1991 (Volume 14,No.3). W.B. Saunders Company.
20. An exhaustive bibliography on multiple personality Psychiatric Disorder and Mental Health." New York:Brunner/Mazel.
22. Braude, Stephen, (1991), "First Person Plural: Multiple Personality andthe Philosophy of Mind." London: Routledge.
3. The Communications Perspective: Milton Erickson, NeurolinguisticProgramming, etc..
1. * Rossi, E. (ed.), 1980, "The Collected Papers of Milton H. Erickson on hypnosis", (4 vols), N.Y.: Irvington.
2. Zeig, Jeffrey and Peter Rennick, 1991, "Ericksonian Hypnotherapy: ACommunications Approach to

Hypnosis," in Lynn and Rhue (eds),*Theories of Hypnosis*, N.Y.:Guilford Press.
3. Havens, R.A. (ed.), 1992, "The Wisdom of Milton H. Erickson", (2 vols),N.Y., Irvington
4. Bandler, RIchard and John Grinder, (Judith Delozier), 1975/1977 (2 vols),"Patterns of the hypnotic techniques of Milton H. Erickson, M.D." Cupertino,Ca.: Meta Publications
5. Grinder, John and Richard Bandler (ed. Connirae Andreas), 1981,"Trance-Formations: Neurolinguistic Programming and the Structure ofHypnosis," Utah:Real People Press.
6. Moine, Donald and Kenneth Lloyd, 1990, "Unlimited Selling Power: How toMaster Hypnotic Selling Skills," N.J.:Prentice Hall.
4. Hypnosis, volition, mind control, abuse of hypnosis. Also legal aspectsand psychology of coercion.
1. Barber, Theodore X. (1961) "Antisocial and Criminal Acts Induced by Hypnosis: A Review of Experimental and Clinical Findings," Archives of GeneralPsychiatry 5:301-312.
2. Hoencamp, Erik (1990) "Sexual Abuse and the Abuse of Hypnosis in theTherapeutic Relationship," International Journal of Clinical and Experimental Hypnosis 38:283-297.
3. Katz, Leo (1987) Bad Acts and Guilty Minds: Conundrums of the CriminalLaw. University of Chicago Press.
4. * Levitt, Eugene E. (1977) "Research Strategies in Evaluating the CoercivePower of Hypnosis," Annals of the New York Academy of Sciences 296:86-89.
5. Levitt, Eugene E., Baker, Elgan L., Jr., and Fish, Ronald C. (1990) "Some Conditions of Compliance and Resistance Among Hypnotic Subjects," American Journal of Clinical Hypnosis 32(April):225-236.
6. Marks, John (1979) The Search for the "Manchurian Candidate": The CIA and Mind Control. Times Books.
7. Milgram, Stanley (1974) Obedience to Authority: An Experimental View.Harper & Row.
9. Orne, Martin T. and Evans, Frederick J. (1965) "Social Control in the Psychological Experiment: Antisocial Behavior and Hypnosis," Journal of Personality and Social Psychology 1:189-200.
10. Rowland, Lloyd W. (1939) "Will Hypnotized Persons Try To Harm Themselves or Others?" Journal of Abnormal and Social Psychology 34:114-117.

11. Thomas, Gordon (1989) Journey into Madness: The True Story of Secret CIAMind Control and Medical Abuse. N.Y.: Bantam.
12. Erickson, Milton H., 1939, "An Experimental Investigation into thePossible Anti-Social Use of Hypnosis," *Psychiatry*, 2, 391-414.
13. * Orne, M. T., 1961, chapter on hypnosis in Biderman and Zimmer, (eds),*The Manipulation of Human Behavior*, pp. 169-215.
14. * Wells, W.R., 1941, "Experiments in the Hypnotic Production of Crime,"*Journal of Psychology*, 11:63-102.
15. Brenman, M., 1942, "Experiments in the Hypnotic Production of Anti-Socialand Self-Injurious Behavior," *Psychiatry*, 5:49-61.
16. Gross, Michael, 1991, "The Eyes Have It," *The Fortean Times*, #58,July, 1991).
17. Rosenbaum, M. (ed.), 1983, *Compliance Behavior*, Free Press.

5. The Human Mind in Science (Consciousness, Intentionality, the "Unconscious Mind" from diverse perspectives in science and philosophy ofscience).

1. * Bowers, K.S. and D. Meichenbaum (eds), 1984, *The UnconsciousReconsidered*, N.Y.:Wiley.
2. * Bowers, K.S., 1990, "Unconscious influences and hypnosis," in J.L.Singer (ed), *Repression and Dissociation: Defense Mechanisms andPersonality Styles* (pp. 143-179), Chicageo:Univ of Chicago Press.
3. * R.L. Gregory, 1981, *Mind in Science*, Cambridge: Cambridge Univ.Press.
4. Tart, Charles T., 1975, *States of Consciousness*, N.Y.:Dutton
5. McGaugh, J.L., G. Lynch, and N.M. Weinberger (eds), 1993, *TheNeurobiology of Learning and Memory*, N.Y., Guilford Press.
6. * Ornstein, Robert E. (ed), 1968, *The Nature of Human Consciousness: A Book of Readings*, San Francisco:W.H. Freeman.
7. * Davidson, J.M. and Richard J. Davidson (eds), 1980, *The Psychobiology of Consciousness*, N.Y.:Plenum Press.
8. Erdelyi, M.H., 1985, "Psychoanalysis: Freud's Cognitive Psychology,"N.Y.:Freeman.
9. Marcel, A., and E. Bisiach (eds), 1988, *Consciousness in* Little, Brown.
12. Flanagan, O.J. Jr., 1991, (2nd ed), *The Science of the Mind*,Cambridge, Mass., Cambridge Univ. Press.

13. Bartless, F.C., 1964, *Remembering: A Study in Experimental and Social Psychology*, Cambridge: Cambridge Univ. Press.
14. Montefiore, A. and D. Noble (eds), 1989, "Goals, Own Goals, and No Goals:A Debate on Goal-Directed and Intentional Behavior," London: Unwin Hyman
15. Libet, B., 1965, "Cortical Activation in Conscious and Unconscious Experience," *Perspectives in Biology and Medicine*, 9, pp. 77-86.
16. Libet, B., 1985, "Unconscious Cerebral Initiative and the Role ofConscious Will in Voluntary Action," *Behavioral and Brain Sciences*, 8,pp. 529-566.
17. Globus, Gordon G., Grover Maxwell, and Irving Savodnik (eds), 1976,*Consciousness and the Brain: A Scientific and Philosophical Inquiry*,N.Y.: Plenum Press.
18. Davidson, Davidson, Schwartz, Shapiro, (eds), 1986, *Consciousness andSelf-Regulation*, N.Y.: Plenum Press
19. * Ellenberger, H., 1970, "The Discovery of the Unconscious: The History and Evolution of Dynamic Psychology," N.Y.: Basic Books.
20. * Kihlstrom, J.F., 1987, "The Cognitive Unconscious," *Science*, 237,1445-1452.
21. Weisenkrantz, L. (ed), 1988, *Thought Without Language*, Oxford:Clarendon.
22. Brentano, F., 1973, (ed. O. Kraus and L.C. McAlister, trans. A. Rancurelloet al) "Psychology from an Empirical Standpoint," Highlands, N.J.: Humanities.
23. * Tart, Charles (ed.), 1972. *Altered States of Consciousness*,N.Y.:Doubleday/Anchor
6. Belief, Faith, and Knowledge. Interpreting Reality Under Extraordinary Circumstances, Social and Cultural Factors in Cognition and Perception (various viewpoints, ranging from biological and physiological to social andcultural)
1. Sargant, William, 1957, *Battle for the Mind*, N.Y.: Harper and Row.
2. Sargant, William, 1969, "The Physiology of Faith," *British Journal of Psychiatry*, 115, pp. 505-518.
3. Sargant, William, 1975, *The Mind Possessed*, Baltimore:Penguin.
4. Ebon, Martin, (Jan-Feb, 1977), "The Occult Temptation," *TheHumanist*, 37, pp. 27-30.
5. * Luhrmann, T.M., 1989, "Persuasions of the Witch's Craft," CambridgeMass.: Harvard Univ. Press.
6. Evans, Christopher, 1973, *Cults of Unreason*, N.Y.: Farrar.

7. Jahoda, Gustav, 1969, *The Psychology of Superstition*, *Consistency: A Sourcebook*, Chicago: Rand McNally.
10. D'Andrade, R.G., 1981, "The Cultural Part of Cognition," *CognitiveScience*, 5, pp. 179-195.
11. Eister, A.W., 1972, "Outline of a Structural Theory of Cults," *Journal for the Scientific Study of Religion*, 11(4), pp. 319-333.
12. Geertz, C., 1983, *Local Knowledge*, N.Y.:Basic Books.
13. Gellner, E., 1974, *Legitimation of Belief*, Cambridge:Cambridge Univ. Press.
14. Griffiths, A.P. (ed), 1967, *Knowledge and Belief*, Oxford: OxfordUniv. Press.
15. Kahneman, D., P, Slovic, A. Tverski (eds), 1982, "Judgement Under Uncertainty: Heuristics and Biases," Cambridge: Cambridge Univ. Press.
16. * Ortony, A. (ed), 1979, *Metaphor and Thought*, Cambridge: Cambridge Univ. Press.
17. * Galanter, Marc. 1989, *Cults: Faith, Healing, and Coercion*,Oxford: Oxford Univ. Press.
18. Waton, Lawrence and Doxon Guthrie, 1972, "A New Approach to Psychopathology: The Influence of Cultural Meanings on Altered States ofConsciousness," *Journal for the Study of Consciousness*, 5, pp. 26-34.
19. Hollis, M. and S. Lukes (eds), 1982, *Rationality and Relativism*,Oxford: Blackwell.
20. Sapir, J.D. and J.C. Crocker (eds), 1977, *The Social Use ofMetaphor*, Philadelphia:U of P Press.
21. * Foucault, M., 1970, *The Order of Things: An Archaeology of the Human Sciences*, Vintage/Random House.
22. * James, William, (1958), *The Varieties of Religious Experience*,N.Y.: New American Library/Mentor.
23. Underhill, Evelyn, (1972), *Mysticism*, N.Y.:World/Meridian.
24. Zusne, Leonard and Warren Jones, 1982, *Anomalistic Psychology*,Hillsdale, N.J.:Erlbaum.

7. Perceptual anomalies and unusual experiences

1. Hilgard, E., 1965, Hypnosis section of Vol. 16 of the *Annual Review ofPsychology*, pp. 157-180.
2. Hilgard, E., 1975, Hypnosis section of Vol. 26 of the *Annual Review ofPsychology*, pp. 19-44.
3. Kihlstrom, J.R. 1985, Hypnosis section of Vol. 36 of the *Annual Reviewof Psychology*, pp. 385-418.
4. Walker, Garrett, and Wallace, 1976, "Restoration of Eidetic Imagery viaHypnotic Age Regression: A Preliminary Report," *Journal of Abnormal Psychology*,

85, 335-337.
5. Wallace, 1978, "Restoration of Eidetic Imagery via Hypnotic AgeRegression: More Evidence," *Journal of Abnormal Psychology*, 87,673-675.
6. Gray, Cynthia, and Kent Gummerman, 1975, "The Sensory Environment," *American Psychologist*, 8, p. 366.
8. Purdy, D.M., 1936, "Eidetic Imagery and the Plasticity of Perception,"*Journal of General Psychology*, 15.
9. Rosett, Joshua, 1939, "The Mechanism of Thought, Imagery, and Hallucination," N.Y.:Columbia Univ Press
10. Zubek, John, (ed), 1969, *Sensory Deprivation*, N.Y.:Appleton
11. * Blackmore, Susan, 1983, *Beyond the Body*, Vermont:David
12. Gabbard, Glen, and Stuart Twemlow, 1984, *With The Eyes of the Mind*,N.Y., Praeger.
13. Irwin, Harvey, 1985, *Flight of Mind: A Psychology Study of the Out of Body Experience*, N.J.:Scarecrow Press
14. Black, Perry (ed), 1970, *Physiological Correlates of Emotion*,N.Y.:Academic Press, pp. 229-243 ("The perception and labelling of bodilychanges as determinants of emotional behavior")
15. Merleau-Ponty, M., 1962, *The Phenomenology of Perception*, trans. C. Smith, Routledge and Kegan Paul.
16. Spiegel, D. et al, 1989, "Hypnotic Alteration of Soma to sensory Perception," *American Journal of Psychiatry*, 146:752.
17. Lukianowicz, N., 1958, "Autoscopic Phenomena," *Archives of Neurology and Psychiatry*, 80, pp. 199-220.
18. * Ellson, Douglas, 1941, "Hallucinations Produced by Sensory Conditioning," *Journal of Experimental Psychology*, 28, pp. 1-20.
19. * Spanos, Nicholas P. (1986) "Hypnotic Behavior: A Social-Psychological Interpretation of Amnesia, Analgesia, and 'Trance Logic'," Behavioral andBrain Sciences 9:449-502.
20. * Spiegel, Cutcomb, Ren, and Pribram, (1985) "Hypnotic HallucinationAlters Evoked Potentials." *Journal of Abnormal Psychology*, 94:249-255.
21. * Spanos, Nicholas P., H.P. de Groot, D.K. Tiller, J.R. Weekes, and L.D.Bertrand, "'Trance logic' duality and hidden observer responding in hypnotic,imagination control, and simulating subjects," *Journal of AbnormalPsychology*, 94(1985):611-623.

22. W. Wells, 1940, "The extent and duration of posthypnotic amnesia,"*Journal of Psychology*, 9:137-151.
23. Edwards, 1963, "Duration of post-hypnotic effect," *British Journal ofPsychiatry*, 109: 259-266.
24. Dixon, Norman, 1981, *Preconscious Processing*, Wiley.
25. Bryant and McConkey, 1989, "Hypnotic Blindness: A Behavioral and Experimental Analysis," *Journal of Abnormal Psychology*, 98, 71-77, and also p. 443-447, "Hypnotic Blindness, Awareness, and Attribution."
27. Borgeat F. Goulet J. Psychophysiological changes following auditorysubliminal suggestions for activation and deactivation. Perceptual &Motor Skills. 56(3):759-66, 1983 Jun.
28. Schuyler BA. Coe WC. A physiological investigation of volitional and nonvolitional experience during posthypnotic amnesia. Journal of Personality& Social Psychology. 40(6):1160-9, 1981 Jun.
29. Barabasz AF. Gregson RA. Antarctic wintering--over, suggestion andtransient olfactory stimulation: EEG evoked potential and electrodermalresponses. Biological Psychology. 9(4):285-95, 1979 Dec.
30. Aladzhalova NA. Rozhnov VE. Kamenetskii SL. Human hypnosis and super-slow electrical activity of the brain. [RUSSIAN] Zhurnal NevropatologiiI Psikhiatrii Imeni S - S - Korsakova. 76(5):704-9, 1976.
8. Psychosomatics, "Mind-Body" effects, Biofeedback, Misc. Physiological Effects in "Altered States," physiological correlates of hypnotic effects.
1. Bass, M.J., 1931, "Differentiation of the hypnotic trance from normalsleep," *Journal of Experimental Psychology*, 14:382-399.
2. Harary, Keith, 1992, "The trouble with HYPNOSIS. Whose power is it,anyway?" March/April *Psychology Today*.
3. June 1989 issue of *Gastroenterology*, "Hypnosis and the Relaxation Response," and "Modulation of gastric acid secretion by hypnosis"
4. * Barber, T.X., 1961, "Physiological effects of 'hypnosis,'*Psychological Bulletin*, 58: 390-419.
5. * Barber, T.X., 1965, "Physiological effects of 'hypnotic suggestions': acritical review of recent research (1960-1964)," *PsychologicalBulletin*, 63: 201-222.
6. Ulman + Dudek, 1960, "On the Psyche and Warts: II. Hypnotic Suggestion andWarts," *Psychosomatic Medicine*, 22:68-76.
7. Rulison, 1942, "Warts, A Statistical Study of Nine

Hundred and Twenty One Cases," *Archives of Dermatology and Syphilology*, 46:66-81.
8. * Johnson, R.F.Q., and T.X. Barber, 1976, "Hypnotic Suggestions forBlister Formation: Subjective and Physiological Effects," *American Journalof Clinical Hypnosis*, 18:172-182.
9. Ulman, M., 1947, "Herpes Simplex and Second Degree Burn Induced UnderHypnosis," *American Journal of Psychiatry*, 103:828-830.
10. Mandler, G., 1984, *Mind and Body: Psychology of Emotion and Stress*,N.Y.:Norton.
11. * Ader, Robert (ed.), 1981, *Psychoneuroimmunology*, SanDiego:Academy Press.
14. Brown, Barbara, 1974, "New Mind, New Body," N.Y.:Harper
15. * Green, Elmer, Alyce Green, and E. Dale Walters, 1970, "Voluntary Controlof Internal States," *Journal of Transpersonal Psychology*, 2, pp. 1-26.
16. * Kamiya, Joe, 1972, "Operant Control of the EEG Alpha Rhythm and Some ofits Reported Effects on Consciousness," in Charles Tart (ed.) *Altered States of Consciousness*, N.Y.:Doubleday/Anchor, pp. 519-529.
17. Lewis, Howard amd Martha Lewis, 1975, *Psychosomatics*, N.Y.,Pinnacle Books.
18. Abse, D. Wilfred, 1966, "Hysteria and Related Mental Disorders,"Bristol:John Wright.
19. Fields, Howard, (Nov. 1978), "Secrets of the Placebo," *PsychologyToday*, 12, 172.
20. O'Connell DN. Orne MT. Endosomatic electrodermal correlates of hypnotic depth and susceptibility. Journal of Psychiatric Research. 6(1):1-12,1968Jun.
21. Serafetinides EA. Electrophysiological responses to sensory stimulationunder hypnosis. American Journal of Psychiatry. 125(1):112-3, 1968 Jul.
22. Pessin M. Plapp JM. Stern JA. Effects of hypnosis induction andattention direction on electrodermal responses. American Journal of Clinical Hypnosis. 10(3):198-206, 1968 Jan.
23. Hoenig J. Reed GF. The objective assessment of desensitization. BritishJournal of Psychiatry. 112(493):1279-83, 1966 Dec.
24. Brende JO. Electrodermal responses in post-traumatic syndromes. A pilotstudy of cerebral hemisphere functioning in Vietnam veterans. Journal ofNervous & Mental Disease. 170(6):352-61, 1982 Jun.
25. Morse DR. Martin JS. Furst ML. Dubin LL. A

physiological and subjective evaluation of meditation,
hypnosis, and relaxation. Journal Psychosomatic
Medicine. 39(5):304-24, 1977 Sep-Oct.
26. Aladzhalova NA. Rozhnov VE. Kamenetskii SL.
Hypnosis in man and veryslow brain electrical activity.
Neuroscience & Behavioral Physiology.9(3):252-6,
1978 Jul-Sep.
27. Tebecis AK. Provins KA. Further studies of
physiological concomitants of hypnosis: skin
temperature, heart rate and skin resistance. Biological
Psychology. 4(4):249-58, 1976 Dec.
9. Hypnosis and Pain Control
1. Hilgard, Hilgard, Macdonald, Morgan, and Johnson,
1978, "The reality of hypnotic analgesia: a comparison
of highly hypnotizables with simulators."
2. Hilgard and Hilgard, 1983, "Hypnosis in the relief of
pain" (book)
4. Stern, Brown, Ulett, and Sletten, 1977, 'A comparison of
hypnosis, acupuncture, morphine, Valium, aspirin, and
placebo in the management ofexperimentally induced
pain,' *Annals of the New York Academy ofSciences*, 296,
175-193.
5. Van Gorp, Meyer, and Dunbar, 1985, 'The efficacy of
direct versus indirecthypnotic induction techniques on
reduction of experimental pain,'*International Journal of
Clinical and Experimental Hypnosis*, 33,319-328.
6. Tripp and Marks, 1986, 'Hypnosis, relaxation, and
analgesia suggestionsfor the reduction of reported pain
in high-and low-suggestible subjects,'*Australian Journal
of Clinical and Experimental Hypnosis*, 33, 319-328.
7. Crasilneck, H.B. et al., 1955, "Use of hypnosis in the
management ofpatients with burns," *Journal of the
American Medical Association*, 158:103-106.
8. Turk, D., D.H. Meichenbaum, and M. Genest, (1983),
*Pain and behavioralmedicine: a cognitive-behavioral
perspective*, New York: Guilford Press.
9. Larbig W. Elbert T. Lutzenberger W. Rockstroh B.
Schnerr G. BirbaumerN. EEG and slow brain potentials
during anticipation and control of painfulstimulation.
Electroencephalography & Clinical Neurophysiology.
53(3):298-309, 1982 Mar.
10. Lloyd MA. Appel JB. Signal detection theory and the
psychophysics ofpain: an introduction and review.
Psychosomatic Medicine. 38(2):79-94, 1976Mar-Apr.
10. The Role of Imagination and Fantasy in Hypnosis and Altered
States

1. * Wilson, S. and T.X. Barber, 1982,"The Fantasy Prone Personality:Implications for understanding imagery, hypnosis, and parapsychologicalphenomena," *Imagery, Current Theory, Research, and Application*, N.Y.John Wiley and Sons, A.A. Sheikh (ed).
2. Yuille, J.C. (ed), 1983, *Imagery, Memory, and Cognition*, Hillsdale,N.J.:Lawrence Erlbaum.
3. Sheikh, A.A., and T.T. Shaffer (eds.), 1979, *The Potential of Fantasyand Imagination*, N.Y.: Brandon House.
4. Sheehan. P.W. (ed), 1972, *The Function and Nature of Imagery*,N.Y.:Academic Press.
5. Block, N. (ed.), 1981, *Imagery*, Cambridge: MIT Press.
6. Barber, T.X., 1970, *LSD, Marihuana, Yoga, and Hypnosis*, Chicago:Aldine.
7. Klinger, E. (ed), 1981, *Imagery: Concepts, Results, and Applications*, Plenum. (Wilson and Barber, "Vivid Fantasy andHallucinatory Abilities in the Life Histories of Excellent Hypnotic Subjects('Somnambules'): Preliminary Report with Female Subjects.")
8. Diamond, M., 1974, "Modification of hypnotizability: A approach to thesuccesful modification of hypnotic susceptibility," *Journal of Personality and Social Psychology*, 50: 1004-1012. (A non-imagination alernative view of hypnotic suggestibility).
11. Lynn, S. and J. Rhue, 1988, "Fantasy Proneness," *AmericanPsychologist*, 45:1-43.
12. Barabasz AF. Restricted environmental stimulation and the enhancement of hypnotizability: pain, EEG alpha, skin conductance and temperature responses.International Journal of Clinical & Experimental Hypnosis. 30(2):147-66,1982 Apr.
13. Holroyd JC. Nuechterlein KH. Shapiro D. Ward F. Individual differencesin hypnotizability and effectiveness of hypnosis or biofeedback. InternationalJournal of Clinical & Experimental Hypnosis. 30(1):45-65, 1982 Jan.
14. Kunzendorf, Robert. Hypnotizability: correlations with daydreaming andsleeping. Psychological Reports v. 53 (Oct. '83) p. 406
15. * Kunzendorf, Robert (ed), 1990, "The Psychophysiology of Mental Imagery",Amityville, NY: Baywood Publishing. Especially the chapter by Spiegel onhypnotic hallucination.
11. The Reliability of Hypnotic Recall
1. Loftus and Loftus, (May, 1980), "On the permanence of

stored informationin the human brain," *American Psychologist*, 35(5):409-420
2. * Klatzky and Erdely, 1985, "The response criterion problem in tests ofhypnosis and memory," *International Journal of Clinical and ExperimentalHypnosis*, 33, 246-257.
3. Ofshe, Richard, 1992, "Inadvertent Hypnosis During Interrogation,"*International Journal of Clinical and Experimental Hypnosis*,11:125-155.
4. Goldstein, Eleanor, 1992, *Confabulations*, Boca Raton, Fla:SocialIssues Research Series
5. Loftus, Elizabeth, June 27,1993, "You Must Remember This ... ... or doyou? How Real are Repressed Memories?" *Washington Post*.
6. Ofshe, Richard and Ethan Watters, (March, 1993), "Making Monsters,"*Society*.
7. Tavris, Carole, (Jan 3,1993), "Beware the Incest-Survivor Machine," N.Y.Times Book Review.
8. Luria, Alexander, 1968, *The Mind of a Mnemonist*, N.Y., Basic Books.
9. DePiano FA. Salzberg HC. Hypnosis as an aid to recall of meaningfulinformation presented under three types of arousal. International Journal ofClinical & Experimental Hypnosis. 29(4):383-400, 1981 Oct.
10. Corcoran JF. Lewis MD. Garver RB. Biofeedbackhttp://


## Evil Hypnosis

"Evil" hypnosis is what I call the popular view of hypnosis as something that is used by devious agencies or individuals to control people's minds surreptitiously. Mind control or behavior control are possible with hypnosis only temporarily, and only to a similar degree as with other forms of psychotherapy. Roughly the same forces of influence apply in and out of hypnosis. Individual differences and personal psychological needs are much more important in determining our capacity to be lastingly influenced than our state of consciousness in hypnosis. The roles we play under hypnosis are temporary. Permanent change to our personality occurs only when our core self-image is altered., which requires more than just superficial exposure to hypnosis.

Hypnosis can be used to some extent as a tool for gaining influence by someone who betrays our trust in them. It might be slightly easier to take advantage of someone with hypnosis, since they are relaxed, they are not evaluating ideas critically, and they are very sensitive to social cues. Increased vulnerability to persuasion is not an intrinsic characteristic of hypnosis, however. It takes time and skill to turn the hypnotic situation into one of profound persuasion by altering the self-image.

The qualities of hypnosis that make it useful as part of an influence technology are the capacity to create vivid, realistic fantasies, and the capacity of a very skillful hypnotist to make these fantasies seem as if they actually happened (pseudomemories). We are also temporarily less critical during hypnosis, and more willing to consider ideas that would otherwise seem unorthodox. These are traits that many people (particularly certain highly hypnotizable people) have *without* hypnosis, however. Hypnosis may only increases these factors by a relatively small amount and cannot be considered the only or even the most important reason for people accepting bizarre new ideas.

Simply going through hypnosis does not leave you vulnerable to having your core values or beliefs altered. Beliefs, values, and attitudes shift slightly over time, and hypnosis can provide fertile ground for new experiences that help to shift them. This is particularly true when we are already vulnerable to the influence of strong social forces such as trusted authority or the need to be immersed in a group identity. Advertisers use various methods of influencing our buying behavior, and religious groups have their own kind of tactics of persuasion. Not only do these not require hypnosis, but many are actually more powerful than hypnosis at influencing us. The power of social influence techniques might increase somewhat under hypnosis, because we are less critical, but the influence does not originate with the hypnosis.

nearly impossible to change by any means. In order to make profound and lasting changes to someone's personality, their sense of identity would need to be destabilized, and a new additional sense of identity created to replace it. Even with this extreme process, without constant reinforcement of the new identity, we tend to revert to the original identity. Analysis of the results of extreme conditions of "brainwashing" and thought reform show us that spectacular temporary success is sometimes achieved if total environmental control of the person is available for an extended time. There is much less success is achieving longer term changes in personality, even after years of continuous reinforcement is undertaken. This is not to say that years of thought reform do not change people, only that many people do not conform permanently to the desired ideal even after years of forced indoctrination.

Experiments have shown that it is actually possible to mimic the symptoms of dissociative identity disorder by building multiple identity senses over time with the help of hypnosis. Some have claimed that this process could be used to create the "Manchurian Candidate," a person with an assassin personality that is unknown to their other personalities. This is quite a bit beyond what was demonstrated, however, and is not consistent with what has been observed so far about the process. The identity senses built over time are not as distinct or autonomous as this extreme scenario would require.

"Mind control," to the extent that it actually occurs, is rarely a matter of simple technology applied to an individual by another individual. It is much more likely to be the result of our dependence upon an organization in a rigidly controlled physical, intellectual, and social environment. An example intended to be used for healing is a psychiatric hospital. A negative example would be a totalitarian religious cult or prisoner of war camp. Other, less extreme examples of the use of social pressures to help change us are addiction recovery groups. In perhaps the most extreme example, the prisoner of war camp, one analysis found that only one in a hundred prisoners exposed to Korean communist indoctrination attempts actually showed much acceptance of communist doctrine after repatriation. (Segal, 1956). This helps put the potential for easy and complete mind control into a little more realistic perspective.

**Can I be hypnotized without my knowledge ?**

Yes, we can be in "trance" without realizing it. Our consciousness shifts constantly, most of the time without any recognition on our part that anything is changing. Certainly we can drift in and out of absorption without realizing it, and a skillful hypnotist may well be able to perform an induction that doesn't seem at all like an induction. Some of the usual elements of hypnosis would be missing, such as the elaborate set of expectations that are normally provided by the patter of an induction. The "trance logic," and other elements of hypnosis may be there nonetheless.

**Can I be hypnotized without my consent ?**

No. You don't need to formally consent to hypnosis for it to happen, but you do need to cooperate at some level. Cooperation is one of the essential elements of hypnosis. It is even more important than relaxation or vivid imagery. If you do not cooperate, there can be no hypnosis. You don't need to explicitly recognize that you are cooperating, you just have to have enough trust to relax and focus on the voice of the hypnotist, allowing their words to capture your imagination.

The only things approaching "involuntary" hypnosis would be conditions in which you are drugged, or those where you are confused or distracted, and the need to understand what is going on becomes stronger than your desire to resist hypnosis. Under these conditions, you might temporarily cooperate with a hypnotist, and this temporary cooperation could conceivably be built into a stronger trust under the right conditions. Stage hypnotists make extensive use of confusion and distraction tactics to gain temporary compliance. Their tactics only work with a subset of people, however, and only up to a point. There is a critical moment with such "shock" inductions when the client either complies or breaks trust with the hypnotist. In order for them to comply, they must still be willing to cooperate to some degree at that critical point.

Under the influence of drugs strong enough to reduce our critical abilities, hypnosis is also very difficult because it requires some concentration. Drugs are sometimes used by hypnotists with "resistant" clients who are unable to relax, but this also of limited effectiveness since it reduces our ability to concentrate and follow instructions. Such drugs also reduce our arousal level and change our biochemical state, making it more difficult to transfer hypnotic suggestions to the waking condition outside of hypnosis. Much of the interesting work done under such "narcohypnosis" is lost when the client comes out of the effect of the drug. Posthypnotic suggestions sometimes remain after narcohypnosis, but they are generally not as effective as those given with full attention during normal hypnosis. The most powerful posthypnotic effect of narcohypnosis is amnesia for hypnosis, and that is probably because of state-dependent memory related to the drug.

### Can I be forced to do horrible things under hypnosis ?

Hypnosis is a cooperative process. However, if you are comfortable cooperating with a fantasy about something you would normally find horrible, you might act it out under hypnosis, or under posthypnotic suggestion. In the same sense that we might do something unusual and then later blame alcohol, even if we didn't drink enough to actually lose control, we might also blame hypnosis for our loss of inhibitions. Even under "deep" hypnosis, under the influence of a dramatic fantasy role, we are still in some If you are very uncomfortable, you will resist the suggestion, or modify it to make it more acceptable. The same is true of suggestion outside of hypnosis. Hypnosis does not operate at the low reflex level of behavior, it functions at a high level of centralized mental function. The involuntary nature of responding to hypnotic suggestion does not extend to complex behaviors that violate your deep values. These type of suggestions will break trust with the hypnotist, and you will find your own way to deal with them. People often find very creative ways of reinterpreting unacceptable suggestions and sometimes for punishing the hypnotist for their attempts to take advantage of them.

### Can I be "brainwashed" to change my beliefs and attitudes under hypnosis ?

To the extent that this happens outside of hypnosis, it can also happen with the help of hypnosis. Hypnosis isn't generally the critical factor in this kind of change, it is at best a catalyst in the process. A possible interpretation of such a process will be described below. The general drift is that hypnosis itself is not neccessarily used in this process, but that total and complete control of the physical, social, emotional, and intellectual environment permit the use of something resembling hypnosis over an extended period of time.

### The potential role of hypnosis in dramatic personality change in an isolated group

In order to help understand the complex relationship between hypnosis and potential "mind control," I have included this section as a composite of various views of how dramatic personality change occurs from psychological forces. It should be noted that the principles of personality change are basically the same, whether we are talking about forced indoctrination ("brainwashing") or psychotherapy. The attitude and ethics of the people attempting the change are the primary difference. The primary elements are breaking down current sense of identity by various means, followed by solidifying a new sense of identity through active participation. Our capacity to resist personality change comes from the strength of our sense of identity, and our attitude in refusing to cooperate in a change process in order to gain rewards or avoid punishments.

Our deep beliefs and core values are part of our sense of who we are. In order to change these, we would have to change our sense of identity. Our sense of identity is normally maintained by constant reinforcement provided by our friends, family, and environment. Personality is normally very stable over our lifetime. It is extremely rare to find significant aspects of personality change permanently, short of organic brain damage or unusually traumatic experience, which change personality in unpredictable ways.

usually remains intact. This most often means removing the person from the physical and social environment that helps maintain their attachment to their current sense of identity. Hypnosis can provide psychological and sensory isolation, though only temporary, and can encourage enactment of alternate roles or personalities. Lasting real personality change requires control of our environment, the breakdown of existing identity sense, replacement by a new identity sense, and continued reinforcement of the new identity sense. Not only is such complete control of the environment very difficult, but breaking down existing identity sense is next to impossible if someone has a strong sense of who they are.

Part of how hypnosis may sometimes play a role in personality change is that it can very effectively **promote extraordinary experiences that may be interpreted as significant spiritual experiences**. These serve as pivotal experiences that allow our worldview to shift in new directions. This may manifest in any of a number of ways, from a personal spiritual renewal to a commitment to a totalitarian religious cult. This is to a great extent the basis for the belief by some religious groups that hypnosis is inherently evil. This requires expectations to be carefully set so that the individual will interpret their experience in the desired way.

Hypnosis can also be a catalyst in significant changes by **providing a relief of anxiety**. As our anxiety is relieved by the relaxation aspect of hypnosis, participation in consciousness altering practices is reinforced, as is identification with the group. This is an important part of the process of becoming immersed in a new group identity.

Finally, selective amnesia and other effects can be carefully used in hypnosis to help build separate identity senses within the same person. This is in effect practicing playing multiple roles that are distinct from each other.

### Three stages of building a new identity

Personality change was modeled by Kurt Lewin as a three stage process : unfreezing the current worldview, changing the worldview, and refreezing the new worldview (Schein, 1961).

The **first stage** involves reducing our alertness and forcing on us various kinds of sensory or information overload, confusion, or distraction. This builds a tremendous psychological and physiological tension that needs to be released. This is roughly analogous to the first step in a stage hypnosis induction, creating confusion or distraction by means of a sudden shock. When longer term effects are desired, the means of destabilizing people include inducing anxiety and terror, physical and social isolation, sleep deprivation, nutritional deprivation, infantilizing treatment, and sexual frustration. Shame and guilt are always central elements in destabilizing the current identity sense. The extreme psychological pressures needed to break down our identity sense cannot be continued for more than a few days. thinking in a magical, wishful way (Holt, 1964). They become unable to distinguish fantasy from reality, dependent upon authority, basically to regress to a childlike state. In some ways, hypnosis is similar to regression to a childlike state. In fact, some psychoanalytic theorists have claimed that hypnosis is a kind of regression. This provides a distinct relief from the psychological stresses imposed in the first stage.

Other ways of manifesting or utilizing an altered state at this point to reduce anxiety include meditation, marching, repetitive slogans or movements, monotonous musical rhythms, body manipulations, or hyperventilation. At this point, we are cooperative and focused on the leader of the process, and may well be hypnotically responsive. At this point, elaborate fantasy may also be used to help create novel experiences, and to reinforce the belief system of the group. By controlling behavior, information, thought, and emotions to some extent, experience both within and outside of hypnosis will begin to be interpreted in a new way, causing a shift to the new belief system (Hassan, 1990). These latter elements are missing from simple hypnosis, which is why hypnosis alone cannot be considered a mind control technique. Personality change is made possible by the extension of the "trance" (by imposing more severe stresses), and the use of the "trance" to help create additional changes that will be reinforced by the environment.

The **third stage** involves reinforcing the new beliefs and new sense of identification with the group. This involves immersion in the shared symbol system of the group, isolation from reminders of the previous identity, increasing dependence on the group, new role models, continued control of behavior, thought, information and emotions, and immersion in new activities. This stage is also missing from normal hypnosis. Physical isolation is usually needed for this kind of control. In addition, the new identity sense usually reverts if the person is removed from the isolated group and returned to their former environment. The active participation of the individual in new activities for the group is a key element.

Personality factors which allow some people to be influenced more permanently than others by these kinds of pressures include :

- Lack of assertiveness
- Low intelligence
- Reliance on external supports for perception and belief
- Lack of self-confidence
- Valuing conformity above independence
- Moralism
- Black and white thinking
- Identity confusion
- History of embracing outside influences in unconditional surrender ("True Believer")

● Other-directedness vs. Inner-directedness
These are entirely different from the traits even loosely associated with hypnotic suggestibility, such as "fantasy proneness." This reflects the

1. role expectations
2. role perception
3. role demands
4. role-taking aptitude or skill
5. self-role congruence
6. reinforcement properties of the audience

Self-role congruence is probably the most important factor determining whether forced compliance will lead to permanent change. It is the lack of self-involvement that prevents prisoners of war from being fully indoctrinated by "brainwashing" attempts.

Also, the personality factors alone are not enough to allow for personality change. The people who are best at resisting change often have very similar personality traits to those who are most influenced. A major difference is their initial willingness to cooperate in the process : "desire for preferential treatment," or "need to avoid threat and abuse" (Holt, 1964). This roughly parallels the case in hypnosis. Many people appear incapable of making use of hypnosis because they are unable to trust the hypnotist enough to cooperate in the induction.

Article by Todd I. Stark

From the Hypnosis FAQ by Todd I. Stark

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*****What is Unique to Hypnosis?** by Todd I. Stark [305 words]

## What is Unique to Hypnosis?[credits]
## by Todd I. Stark

There is nothing that we can do under hypnosis that we cannot do under other conditions. A long series of laboratory experiments by T.X. Barber and colleagues compared a wide variety of abilities under hypnosis with abilities under conditions of non-hypnotic motivational instructions. Similar experiments since then have all confirmed his results. Any differences found between our abilities under hypnosis and our abilities when motivated without hypnosis are extremely subtle. There does not seem to be very much that is

unique about the hypnotic induction, although it is a very convenient way to create the desired effects in some people.
The thing that is unique to hypnosis is not so much what we are able to do, but the experience we have while doing it. While there are other conditions under which we have similar experiences, few can be controlled and maintained as easily as hypnosis.
The point about hypnosis is that, at least for some people, it provides a reliable way of making use of our normal capacities in a more controlled way. Hypnosis does not provide any special abilities. It provides a cooperative setting for experiencing things in response to suggestion that we experience spontaneously under other conditions.
On the other hand, the simple capacity to make use of various normal abilities at will can be of extraordinary usefulness. For example, we have a natural ability to suppress pain and other sensations, but with hypnosis we are able to reliably make use of this talent. As another example, we have a natural ability to imagine things vividly as if they were real, but we can potentially make more effective use of this talent under hypnosis.
Things sometimes claimed unique to hypnotic responding :
1. Hypnosis and memory
2. Amnesia
3. Effects on the skin
4. Effects on the immune system
5. Pain control
6. Hallucinations
7. Time distortion
8. Posthypnotic suggestions

### Hypnosis References

Bower, G. (1990). Awareness, the unconscious and repression : An experimental psychologist's perspective. In J.L. Singer (Ed.), *Repression and Dissociation: Implications for personality, theory, psychopathology, and health*. (Pp, 209-222). Chicago: University of Chicago Press.
Bremner, J.D. et al. (1995). MRI-Based Measurement of Hippocampal Volume in Patients with Combat-Related Posttraumatic Stress Disorder, *American Journal of Psychiatry*, Vol. 152. No. 7, July, 1995. P. 973-98.
Capafons, Antonio & Amigo, Salvador, (1995). Emotional Self-Regulation Therapy For Smoking Reduction. *International Journal of Clinical and Experimental Hypnosis,* 43: 1, p. 7-19.
Coe, W.C. & Ryken, K. (1979). Hypnosis and risks to human subjects. *American Psychologist*, 34, 673-681.
Dywan, Jane, (1995). The Illusion of Familiarity: An Alternative to the Report-Criterion Account of Hypnotic Recall. *International Journal of Clinical and Experimental Hypnosis*, 43:2, p. 194-211.
Erdelyi, Matthew Hugh (1994). Hypnotic Hypermnesia: The Empty Set of Hypermnesia. *International Journal of Clinical and Experimental Hypnosis*,

42:4, p. 379-390.
Erickson, M.H., (1938). A study of clinical and experimental findings o hypnotic deafness: II. Experimental findings with a conditioned response technique. *J. Gen. Psychol.*, 19 : 151-167.
Frauman, D., Lynn, S. & Brentar, J. (1993). Prevention and therapeutic management of "negative effects" in hypnotherapy. In J. Rhue, S. Lynn & I. Kirsch (Eds.) *Handbook of Clinical Hypnosis* (pp. 95-120). Washington, D.C. American Psychological Association.
Gabbard, Glen O. (1995). Trauma may have significant impact on structure of affected person's brain. *The Menninger Letter*. Vol 3, No. 9, September, 1995.
Garry, Maryanne, & Elizabeth Loftus, (1994). Pseudomemories Without Hypnosis. *International Journal of Clinical and Experimental Hypnosis*, 42:4, p. 363-378.
Glisky, M, Tataryn, D. & Kihlstrom, J., (1995). Hypnotizability and Mental
Hilgard, E.R., (1965). Hypnosis. *Annual Review of Psychology*. Edited by Farnsworth, McNemar, & McNemar.
Hilgard, E.R., (1971). Hypnotic phenomena: The struggle for scientific acceptance. *American Scientist* 59 (Sept.-Oct.):567-577.
Hilgard, J.R. (1974). Sequelae to hypnosis. *International Journal of Clinical and Experimental Hypnosis*, 22, 281-298.
Hilgard, J.R., Hilgard, E.R. & Newman, M. (1961). Sequelae to hypnotic induction with special reference to earlier chemical anesthesia. *Journal of Nervous and Mental Disorders*, 133 : 461-78.
Holt, Robert R., (1964). Forcible indoctrination and personality change. In *Personality Change*, edited by Phillip Worchel and Donn Byrne, John Wiley and Sons.
Judd, F., Burrows, G., Dennerstein, L., (1985). The dangers of hypnosis : a review. *Australian Journal of Clinical and Experimental Hypnosis*, 13: 1-15.
Kihlstrom, John F. (1994). Hypnosis, Delayed Recall, and the Principles of Memory. *International Journal of Clinical and Experimental Hypnosis*, 42: 4, p. 337-345.
Kleinhauz, M., & Beran, B. (1984). Misuse of hypnosis : a factor in psychopathology. *American Journal of Clinical Hypnosis*, 26: 283-290.
Kleinhauz, M. & Eli, I. (1987). Potential deleterious effects of hypnosis in the clinical setting. *American Journal of Clinical Hypnosis*, 29 : 3, 133-159.
Levitt, Eugene E. (1995). Some Additional Light on the Childhood Sexual Abuse-Psychopathology Axis. *International Journal of Clinical and Experimental Hypnosis*, 43: 2, p. 145-162.
Lundholm, H. (1928). An experimental study of functional anesthesia as induced by suggestion in hypnosis. *J. Abnorm. (Soc.) Psych.*, 23 : 337-355.
MacHovec, F.J. (1986). *Hypnosis complications : Prevention and risk management.* Springfield, Il. : Charles C. Thomas.
Meares, A. (1961). An evaluation of the dangers of medical hypnosis. *Am. J. Clin. Hypnosis* 4 : 90-97.
Nash, Michael R. (1994). Memory Distortion and Sexual Trauma: The Problem of False Negatives and False Positives. *International Journal of*

*Clinical and Experimental Hypnosis*. 42: 4, p. 346-362
Rosen, H. (1957). Hypnosis, emental hygiene and the dentist-hypnotist. A psychiatric discussion of dangers and potentialities of hypnosis in dental practice. *J. Am. Dental Assoc.*, 54 : 808-818.
Rosen, H. & Bartemeier, L.H., (1961). Hypnosis in medical practice. *JAMA*, 175 : 976-79.
Sarbin, T.R. (1964). Role Theoretical Interpretation of Psychological Change. In *Personality Change*, edited by Phillip Worchel and Donn Byrne, John Wiley and Sons.
Schein, Edgar, (1961). *Coercive Persuasion.* Norton.
Segal, J. (1956). Testimony. In *Communist interrogation, indoctrination and exploitation of American military and political prisoners.* Washington, D.C. : U.S. Government Printing Office.
Spanos, Nicholas P., Burgess, Cheryl A., and Burgess, Melissa Faith, (1994). Past-Life Identities, UFO Abductions, and Satanic Ritual Abuse : The Social Construction of Memories. *International Journal of Clinical and Experimental Hypnosis*. 42: 4, p. 433-446.
Wallace, Benjamin & Andrzej Kokoszka, (1995). Fluctuations in Hypnotic Susceptibility and Imaging Ability Over A 16-Hour Period. *International Journal of Clinical and Experimental Hypnosis,* 43: 1, p. 20-33.
Whittelsea, B.W.A., Jacoby, L.L., & Girard, K., (1990). Illusions of immediate memory : Evidence of an attributional basis for feelings of familiarity and perceptual quality. *Journal of Memory and Language*, 29, 716-732.
Williams, G.W., (1953). Difficulty in dehypnotizing. *Journal of Clinical and Experimental Hypnosis*, 1, 3-12.
Zamansky, Harold S. & Ruehle, Beth L., (1995). Making Hypnosis Happen: The Involuntariness of the Hypnotic Experience, *International Journal of Clinical and Experimental Hypnosis*, 43: 4, p. 386-398.
Article by Todd I. Stark
From the Hypnosis FAQ by Todd I. Stark
Web version, revision 2. Last update: February 16, 1997.

## How reliable are things remembered under hypnosis?[credits]

**by Todd I. Stark**

This has often arisen as both a legal issue (as in the reliability oftestimony obtained during or after hypnotherapy) and also a social issue(regarding the use of hypnotherapy to establish evidence of early child abuse,for example).
It is entirely true that subjects under hypnosis frequently recall pastforgotten events (or 'repressed' memories in the jargon of psychoanalysisindicating an active role of the individual in forgetting as a defensemechanism).
It is also true that people under hypnosis often 'remember' things quitevividly that never actually happened, but which have great personalsignificance nonetheless. Psychiatrist William Sargent was one of the firstto document the therapeutic benefit of emotionally charged experience, orabreaction, of fantasized life events.

This is one of defining characteristics of deep trance hypnosis in fact, theintensity of fantasies as well as memories, and the inability to distinguishthe two. This characteristic of trance is what makes is possible to usehypnotherapy to alter personal history in order to reduce the traumaticeffects of past events on an individual's functioning. Not simply a relivingor 'catharsis' of the trauma, but a sometimes a lasting modification of theinterpretation of the memory can and does occur in many cases.

This apparent violability and fallibility of human memory is frequentlydownplayed in discussions of hypnotic recall because of the already difficulttime that legitimate victims of abuse have in proving what happened to them.It's not the intention here to make life more difficult for abuse victims,only to point out that hypnosis doesn't neccessarily solve their problem ofdigging out facts from old memories as neatly as we'd like it to.

The illusion of unusual veracity of hypnotic recall appears to come from atleast two main sources:

1. Older models of human memory as a simple recording and playback mechanismwhich preserved extreme details of everything perceived, and which could beplayed back in an enhanced way under certain conditions, like hypnosis.
2. The vividness and subjective meaningfulness often attributed toexperiences under hypnosis partly as a result of the unique characteristics ofhypnotic imagery.

In 1985, a committee commissioned by the American Medical Associationcautioned against the systematic use of hypnosis for recollection for both itsunreliability (the possibility for example of 'confabulation,' the creation ofstories out of whole cloth to help fill in missing memories) and its potentialto create vivid false memories with an artificially induced sense ofcertainty.

In addition to the previously provided references for hypermnesia, here aresome more specifically devoted to the limitations of hypnotic recall:

- D. Spiegel et al, 1989, "Hypnotic alteration of somatosensory perception,"*American Journal of Psychiatry*.
- Loftus and Loftus, "On the permanence of stored information in the humanbrain," *American Psychologist*, 35(5):409-420 (May,1980), criticallyevaluates the data gathered by neurologist Wilder Penfield who had oncebelieved he had discovered during the probing of the brains of epilepticpatients a 'sequential record of consciousness' similar to the oldtape-recorder model of human memory.

No one yet knows exactly how human memory works in all its details, but theview of hypnotic recall as potentially highly fallible is also supported byclinical experience and experimental data.

Milton Erickson called the vivid experiences under hypnosis 'vivification,'and describes how a vivified image is experienced, regardless of whetherremembered or constructed:

"... They are subjectively experienced as external events rather than asinternal processes, with a consequent endowment of

them as realityexperiences."
"... They identified it with actual past experiences and thus endowed it witha subjective validity."
"... They 'created a reality' that permitted a responsive functioning inaccord with the demands of the experiment."
Are there identified physiological correlates for such vivid recollections orrecreations of past events? One controversial researcher, Michael Persinger,has written hundreds of articles on the subject of neurophysiologicalcorrelates of extraordinary experiences of all kinds. He has reportedlyreproduced something like ecstatic mystical states with the help ofelectromagnetic stimulation of the cortical temporal lobes of human subjects,and facilitated vivid imagery akin to UFO abduction experiences. He is notalone in the observation of what is sometimes known as 'clinical mysticism,'which is seen in some forms of temporal lobe epilepsy and in mechanicalstimulation of areas of the temporal lobes, but he is somewhat unique in hisrepeatedly published insistence that all or virtually all unexplainedpheonomena and seemingly false memories can be traced to electromagneticeffects on the claims of sex abuseand alien visitation/abduction experiences.
Perceptual & Motor Skills.75(1):259-66, 1992 Aug.
"Six adults, who had recently experienced sudden recall of preschool memoriesof sex abuse or alien abduction/visitation, were given completeneuropsychological assessments. All experiences "emerged" when hypnosis wasutilized within a context of sex abuse or New Age religion and were followedby reduction in anxiety. As a group, these subjects displayed significant (Tgreater than 70) elevations of childhood imaginings, complex partialepileptic-like signs, and suggestibility. Neuropsychological data indicatedright frontotemporal anomalies and reduced access to the right parietal lobe.MMPI profiles were normal. The results support the hypothesis that enhancedimagery due to temporal lobe lability within specific contexts can facilitatethe creation of memories; they are strengthened further if there is alsoreduction in anxiety." (Taken from an on-line abstract).
If there is anything to this 'temporal lobe lability' hypothesis, it seemswell worthwhile investigating its relationship to hypnotic suggestibility, andthe hypothetical 'Fantasy Prone Personality' of Barber and Wilson.
As for recall under hypnosis, the experimental observation seems to be thatthe subject is uniquely motivated to remember details, but also uniquelycapable of making up details and experiencing them as if they were remembered.
In Lynn and Rhue's 1991 *Theories of Hypnosis*, Robert Nadon et al.discuss a representative example of experiments in eyewitness recall with theaid of hypnosis. Subjects were shown a videotape of a mock armed robbery.They were then asked to recall specific aspects 6 times:

- Twice immediately after seeing the film.
- Twice a week after seeing the film.

- Once during hypnosis.
- Once after hypnosis.

The result was that high hypnotizability subjects (SHSS:C) recalled morecumulative items in hypnosis than they did just before hypnosis. Lowhypnotizability subjects did *not* remember more during hypnosis. Thismatches our expectation of hypermnesia, that hypnosis facilitates recall forgood hypnotic subjects.

Most interestingly, *both* high and low hypnotizability subjects alsomade more cumulative **errors** during hypnosis than just before hypnosis,though the effect was stronger with highly hypnotizable subjects.

One explanation of this kind of result from experiments is that the hypnoticcontext causes subjects to adopt a looser reporting criterion, and they furtherdiscussion of this report criterion issue

Article by Todd I. Stark

From the FAQ regarding the scientific study of hypnosis by Todd I. Stark



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## What are the risks or dangers of hypnosis?[credits]
**by Todd I. Stark**

The risks of using hypnosis for change are roughly the same as those for other forms of psychotherapy. Competently performed hypnosis in itself has virtually no risk or danger. Even incompetently performed hypnosis usually has only a very minimal risk. Skillfully utilized suggestion by a malicious or unethical hypnotist, or hypnosis used with a particularly vulnerable person has some possible real psychological dangers associated.

Hypnotists in the process of psychotherapy (hypnotherapy) sometimes momentarily lose control during hypnosis because they encounter psychological needs or problems in their clients that catch them by surprise. If they are not well trained to deal with such events, there is a possible risk of exacerbating existing problems, or a remote chance of creating new problems. Hypnosis often involves vivid imagery which seems very real to the client, and intense emotion which *is* very real to the client. The hypnotist may even get caught up in the fantasy, or at least the emotion of it. One leading medical hypnotist (Meares, 1961) listed the following potential areas of difficulty that the *untrained* or *poorly trained* hypnotist may confront, most of which are common to all forms of psychotherapy :

1. The situation may be deliberately misused to meet ulterior needs (e.g. seduction of trusting female clients)
2. The interaction may enhance negative aspects of the hypnotist's personality, or create dependence of the client on the hypnotist
3. Traumatic confrontation with previously unacknowledged memories
4. Precipitation of a latent psychosis
5. Substitution of one symptom for another
6. Panic reaction, or creation of traumatic fantasy
7. Complications due to misunderstandings
8. Difficulty in arousing the client, and problems caused by incomplete alerting.

The last category is an interesting example, because it is unique to hypnosis, and sounds like the sometimes voiced fear of "getting stuck in a trance." The media inspired scenario is that the hypnotist dies during hypnosis and their client never wakes up because they never get the commands to awaken.
No, you can't possibly get stuck in a hypnotic trance. However, a hypnotist can (rarely) get stuck trying to end a hypnosis session ! This is not because the client has lost control of hypnosis, but because the hypnotist has lost control **to** the client, who has decided that they need to stay "out of it" for a
The hypnotic "trance" is passive simply because hypnotized people find it

more comfortable to remain still, not because they are immobilized by forces outside their control. They are fully capable of waking at any time, or moving at any time, if they are uncomfortable with what the hypnotist is suggesting to them. Hypnotized people do what they feel they need to do at the moment, which usually means cooperating with the hypnotist. However, this cooperation, or trust, can be broken during hypnosis, without ending the hypnotic session. The relaxed state of passivity will remain as long as the client is comfortable with it.

Hypnotic trance, like all "states of consciousness" is not turned on and off as if by a switch, it is a dynamic experience maintained by a number of continuously changing psychological and physiological variables. Left alone, without instructions to end hypnosis, we naturally either rouse fully or fall asleep. Like other psychological states, hypnotic trance varies continuously over time due to changing physiological and psychological factors.
What of the valid concern that it may be temporarily difficult to alert someone from hypnosis ? I say temporarily, although this has been reported to last as long as 12 days (Williams, 1953). It is important for the hypnotist to realize that that their client is attempting to control their own behavior. Understanding the reason for this kind of defensive reaction may be a key step in their therapy.

For those interested, a good list of "horror stories" about dangers in hypnosis is available (MacHovec,1986). Robert Baker ("They Call It Hypnosis") calls MacHovec's book "*a collection of cases of individuals who suffered from various sorts of personality and emotional disorders prior to hypnotherapy, and then after hypnotherapy blamed the therapy for their problems.*" The object lesson here seems to be that hypnosis is safe when the hypnotist is properly trained to deal with the problem at hand. To help people recover from bad habits or improve their golf swing requires less specialized psychological training than dealing with more acute problems.

Even a safe procedure like hypnosis can help precipitate a serious problem in some people, if used for generally psychotherapy without adequate knowledge of both psychotherapy and hypnosis (Frauman, Lynn, & Brentar, 1993; Kleinhauz & Eli, 1987; Judd, Burrows, Dennerstein, 1985; Kleinhauz & Beran, 1984; Orne, 1965; Rosen, 1957; Rosen & Bartemeier, 1961). Clinical data on hundreds of inductions gathered by E.R. Hilgard showed that hypnosis is a safe procedure, and that there are virtually no negative consequences associated specifically with hypnosis (Hilgard, Hilgard, & Newman, 1961). The only adverse effects found were temporary headaches or discomfort reactions upon attempting induction. These seemed to be correlated with previous negative experiences with general anesthesia.

In spite of the safety of hypnotic induction, there are strong psychological Hilgard added that :

"On the whole, hypnosis is not at all dangerous ... Still, there are some people who have a very slight hold on reality and for whom too much playing with fantasy might conceivably release tendencies toward psychotic behavior that they have shown under other circumstances as well. If such discordant behavior follows hypnosis, the hypnotist is likely to be blamed for it, even though there can usually be found many instances of similar behavior by the subject prior to any attempted hypnosis." (Hilgard, 1971)

This is why hypnosis should not be considered a casual interaction, but an intimate communication that should be used with some respect. Just as it would be irresponsible to do other sorts of psychotherapy without training, hypnosis used irresponsibly can have unexpected and even unfortunate results with people who already have underlying serious problems (Coe and Ryken, 1979) (Hilgard, 1974). Since these sorts of problems sometimes go undiagnosed for years, they sometimes arise quite surprisingly in therapy. The general rule is : **don't let someone treat something with hypnosis, if they aren't qualified to treat it without hypnosis.** In other words, training in hypnosis alone does not qualify someone to treat psychological problems. Treating psychological problems involves inherent risk, and the capacity of hypnosis to reproduce a variety of psychological conditions makes it possible that a hypnotist can trigger a problem that they never suspected exists

## Who can use hypnosis effectively

Nearly anyone can make use of hypnosis in some sense. However, there are distinct differences in how easily people can respond to suggestion in a way that seems involuntary or effortless. This is in important aspect of induction. The most dramatic and consistent result in hypnosis has been the discovery of "hypnotizability." This refers to an ability to experience the classic hypnotic phenomena. Hypnotizability is remarkably stable over time although it can sometimes be modified by various means with some effort. About ten percent of the population is naturally "highly hypnotizable," and a few percent find classic hypnotic responses almost impossible to produce no matter what they try. The remainder of the population, most of us, are capable of experiencing some of the hypnotic phenomena fairly easily but have difficulty with others. Since most uses of hypnosis involve imagination and fantasy rather than primary suggestibility per se, hypnosis of a sort is still possible even with "low hypnotizable" clients, but it may not be the best choice of technique for therapy with them.

The closest thing that hypnotizability is related to is the quality of **imaginative absorption**. The correlation with imaginative absorption is not nearly strong enough to call them the same thing as hypnotizability. Absorption is the ability to become particularly involved in something, such that things that would normally be very distracting are not even noticed. Absorption is believed to be a personality trait, likely a sub-scale of the trait of **openness** from the "Big Five" personality model. Openness measures our willingness to explore and to consider unusual alternatives. Some of the most effective methods of improving hypnotic responsiveness involve engaging in behaviors that are most typical of people high in the **openness** trait.

A strong talent for imaginative absorption is not enough to guarantee hypnotizability. Hypnosis-relevant attitudes and the relationship between the hypnotist and the client also play an important role, as does a capacity to respond in an automatic way to language. While hypnotic suggestions often involve compatible images, or **goal directed fantasies**, these are not essential for response. In fact, research has shown that hypnotic responses to verbal suggestions occur even when we are concentrating on goal directed fantasies that are incompatible with the suggestion. For example, a suggestion that the hand is light might be combined with imagery of a heavy weight pulling the hand down. The hand still rises. So we know that while vivid imagery is a big part of making use of hypnosis, it is not the sole explanation for or cause of hypnotic responding.

# HIGH PERFORMANCE BIOCOMPUTATION

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This section summarizes the conclusions and recommendations of the 2004 JASON summer study commissioned by the Department of Energy (DOE) to explore the opportunities and challenges presented by applying advanced computational power and methodology to problems in the biological sciences. JASON was tasked to investigate the current suite of computationally intensive problems as well as potential future endeavors. JASON was also tasked to consider how advanced computational capability and capacity could best be brought to bear on bioscience problems and to explore how different computing approaches such as Grid computing, supercomputing, cluster computing or custom architectures might map onto interesting biological problems
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# 1 EXECUTIVE SUMMARY

This section summarizes the conclusions and recommendations of the 2004 JASON summer study commissioned by the Department of Energy (DOE) to explore the opportunities and challenges presented by applying advanced computational power and methodology to problems in the biological sciences. JASON was tasked to investigate the current suite of computationally intensive problems as well as potential future endeavors. JASON was also tasked to consider how advanced computational capability and capacity1 could best be brought to bear on bioscience problems and to explore how di.erent computing approaches such as Grid computing, supercomputing, cluster computing or custom architectures might map onto interesting biological problems.

The context for our study is the emergence of information science as an increasingly important component of modern biology. Major drivers for this include the enormous impact of the human genome initiative and further large-scale investments such as DOE's GTL initiative, the DOE Joint Genomics Institute, as well as the e.orts of other federal agencies as exemplified by the BISTI initiative of NIH. It should be noted too that the biological community is making increasing use of computation at the Terascale level (implying computational rates and dataset sizes on the order of Teraflops and Petabytes, respectively) in support of both theoretical and experimental endeavors.

Our study confirms that computation is having an important impact at every level of the biological enterprise. It has facilitated investigation of computationally intensive tasks such as the study of molecular interactions that

1Our definition of capability and capacity follows that adopted in the 2003 JASON report "Requirements for ASCI"[36]. That report defines capability as the maximum processing power possible that can be applied to a single job. Capacity represents the total processing power available from all machines used to solve a particular problem.

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a.ect protein folding, analysis of complex biological machines, determination of metabolic and regulatory networks, modeling of neuronal activity and ultimately multi-scale simulations of entire organisms. Computation has also had a key role in the analysis of the enormous volume of data arising from activities such as high-throughput sequencing, analysis of gene expression, high-resolution imaging and other data-intensive endeavors. Some of these research areas are highly advanced in their utilization of computational capability and capacity, while others will require similar capability and capacity in the future.

JASON was asked to focus on possible opportunities and challenges in the application of advanced computation to biology. Our findings in this study are as follows:

Role of computation: Computation plays an increasingly important role in modern biology at all scales. High-performance computation is critical to progress in molecular biology and biochemistry. Combinatorial algorithms play a key role in the study of evolutionary dynamics. Database technology is critical to progress in bioinformatics and is particularly important to the future exchange of data among researchers. Finally, software frameworks such as BioSpice are important tools in the exchange of simulation models among research groups.

Requirements for capability: Capability is presently not a key limiting factor for any of the areas that were studied. In areas of molecular biology and biochemistry, which are inherently computationally intensive, it is not apparent that substantial investment will accomplish much more than an incremental improvement in our ability to simulate systems of biological relevance given the current state of algorithms. Other areas, such as systems biology will eventually be able to utilize capability computing, but the key issue there is out lack of understanding of more fundamental aspects, such as the details of cellular signaling

processes.
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Requirements for capacity: Our study did reveal a clear need for additional capacity. Many of the applications reviewed in this study (such as image analysis, genome sequencing, etc.) utilize algorithms that are essentially “embarrassingly parallel” algorithms and would profit simply from the increased throughput that could be provided by commodity cluster architecture as well as possible further developments in Grid technology.
Role of grand challenges: In order to elucidate possible applications that would particularly benefit from deployment of enhanced computational capability or capacity, JASON applied the notion of “grand challenges” as an organizing principle to determine the potential benefit of significant investment in either capability or capacity as applied to a given problem. JASON criteria for such grand challenges are as follows:
• they must be science driven;
• they must focus on a di.cult but ultimately achievable goal;
• there must exist promising ideas on how to surmount existing limits;
• one must know when the stated goal has been achieved;
• the problem should be solvable in a time scale of roughly one decade;
• the successful solution must leave a clear legacy and change the field in a significant way.
These challenges are meant to focus a field on a very di.cult but imaginably achievable medium-term goal. Some examples are discussed below in this summary as well as in the body of the report. It is plausible (but not assured) that there exist suitable grand challenge problems (as defined above) that will have significant impact on biology and which require high performance capability computing.
Future challenges: For many of the areas examined in this study, significant research challenges must be overcome in order to maximize the
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potential of high-performance computation. Such challenges include overcoming the complexity barriers in current biological modelling algorithms and understanding the detailed dynamics of components of cellular signaling networks.
JASON recommends that DOE consider four general areas in its evaluation of potential future investment in high performance bio-computation:
1. Consider the use of grand challenge problems, as defined above, to make the case for present and future investment in high performance computing capability. While some illustrative examples have been considered in this report, such challenges should be formulated through direct engagement with (and prioritization by) the bioscience community in areas such as (but not limited to) molecular biology and biochemistry, computational genomics and proteomics, computational neural systems, and systems or synthetic biology. Such grand challenge problems can also be used as vehicles to guide investment in focused algorithmic and architectural research, both of which are essential to achievement of grand challenge problems.
2. Investigate further investment in capacity computing. As stated above, a number of critical areas can benefit immediately from investments in capacity computing, as exemplified by today’s cluster technology.
3. Investigate investment in development of a data federation infrastructure. Many of the “information intensive” endeavors reviewed here can be aided through the development and curation of datasets utilizing community adopted data standards. Such applications are ideally suited for Grid computing.
4. Most importantly, while it is not apparent that capability computing is, at present, a limiting factor for biology, we do not view this situation as static and, for this reason, it is important that the situation
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be revisited in approximately three years in order to reassess the potential for further investments in capability. Ideally these investments would be guided through the delineation of grand challenge problems as prioritized by the biological research community.

We close this executive summary with some examples of activities which meet the criteria for grand challenges as discussed above. Past examples of such activities are the Human Genome Initiative and the design of an autonomous vehicle. It should be emphasized that our considerations below are by no means exhaustive. They are simply meant to provide example applications of a methodology that could lead to identification of such grand challenge problems and thus to a rationale for significant investment in highperformance capability or capacity. The possible grand challenges considered in our study were as follows:

1. The use of molecular biophysics to describe the complete dynamics of an important cellular structure, such as the ribosome;
2. Reconstructing the genome sequence of the common ancestor of placental mammals;
3. Detailed neural simulation of the retina;
4. The simulation of a complex cellular activity such as chemotaxis from a systems biology perspective.

We describe briefly some of the example challenges as well as their connection to opportunities for the application of advanced computation. Further details can be found in the full report.

A grand challenge that has as its goal the use of molecular biophysics to describe, for example, the dynamics of the ribosome would be to utilize our current understanding in this area to simulate, on biologically relevant time

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scales, the dynamics of the ribosome as it executes its cellular function of translation. The community of researchers in the area relevant to this grand challenge can be characterized as highly computationally-savvy and fully capable of e.ectively exploiting state-of-the-art capability. However, there remain significant challenges regarding the ability of current algorithms deployed on present-day massively parallel systems to yield results for time scales and length scales of true biological relevance. For this reason, significant investment in capability toward this type of grand challenge would, in our view, lead to only incremental gains given our current state of knowledge relevant to this problem. Instead, continuing investment is required in new algorithms in computational chemistry, novel computational architectures, and, perhaps most importantly, theoretical advances that overcome the challenges posed by the enormous range of length and time scales inherent in such a problem.

The second grand challenge considered by JASON is directed at large scale whole genome analysis of multiple species. The specific computational challenge is to reconstruct an approximation to the complete genome of the common ancestor of placental mammals, and determine the key changes that have occurred in the genomes of the present day species since their divergence from that common ancestor. This will require substantial computation for assembly and comparison of complete or nearly complete mammalian genomic sequences (approximately 3 billion bases each), development of more accurate quantitative models of the molecular evolution of whole genomes, and use of these models to optimally trace the evolutionary history of each nucleotide subsequence in the present day mammalian genomes back to a likely original sequence in the genome of the common placental ancestor. The computational requirements involve research in combinatorial algorithms, deployment of advanced high-performance shared memory computation as well as capacity computing in order to fill out the missing mammalian genomic data. A focused initiative in this area (or areas similar to this) in principle fulfills the JASON requirements for a grand challenge.

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In the area of neurobiology, JASON considered the simulation of the retina as a potential grand challenge. Here a great deal of the fundamental functionality of the relevant cellular structures (rods, cones, bipolar and ganglion cells) is well established. There are roughly 130 million receptors in the retina but only 1 million optic nerve fibers, implying that the retina performs precomputation before processing by the brain via the optic nerve. Models for the various components have been developed and it is conceivable that the entire combined network structure could be simulated using today's capability platforms with acceptable processing times. Taken together, these attributes satisfy the requirements for a grand challenge, although it should be noted that current capability is probably su.cient for this task.

The final potential grand challenge considered in our study is the use of contemporary systems biology to simulate complex biological systems with mechanisms that are well-characterized experimentally. Systems biology attempts to elucidate specific signal transduction pathways and genetic circuits and then uses this information to map out the entire "circuit/wiring diagram" of a cell, with the ultimate goal of providing quantitative, predictive computational models connecting properties of molecular components to cellular behaviors. An important example would be the simulation of bacterial chemotaxis, where an enormous amount is currently understood about the cellular "parts list" and signaling network that is used to execute cellular locomotion. A simulation of chemotaxis that couples external stimuli to the signaling network would indeed be a candidate for advanced computational capability. At present, however, the utility of biological "circuits" as a descriptor of the system remains a topic for further research. Indeed, some recent experimental results indicate that a definite circuit topology is not necessarily predictive of system function. Further investigation is required to understand cellular signaling mechanisms before a large scale simulation of the locomotive behavior can be attempted. For this reason the chief impediment comes not from lack of adequate computing power, but from the need to understand better the signaling mechanisms of the cell.

## 2 INTRODUCTION

In this report we summarize the considerations and conclusions of the 2004 JASON summer study on high performance biocomputation. The charge to JASON (from DOE) was to

"...explore the opportunities and challenges presented by applying advanced computational power and methodology to problems in the biological sciences... (JASON) will investigate the current suite of computationally intensive biological work, such as molecular modeling, protein folding, and database searches, as well as potential future endeavors (comprehensive multi-scale models, studies of systems of high complexity...). This study will also consider how advanced computing capability and capacity could best be brought to bear on bioscience problems, and will explore how di.erent computing approaches (Grid techniques, supercomputers, commodity cluster computing, custom architectures...) map onto interesting biological problems."

The context for this study on high performance computation as applied to the biological sciences originates from a number of important developments:

• Achievements such as the Human Genome Project, which has had a profound impact both on biology and the allied areas of biocomputation and bioinformatics, making it possible to analyze sequence data from the entire human genome as well as the genomes of many other species. Important algorithms have been developed as a result of this e.ort, and computation has been essential in both the assimilation and analysis of these data.

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• The DOE GTL initiative, which uses new genomic data from a variety of organisms combined with high-throughput technologies to study proteomics, regulatory gene networks and cellular signaling pathways, as well as more complex processes involving microbial communities. This initiative is also currently generating a wealth of data. This data is of intrinsic interest to biologists, but, in addition, the need to both organize and analyze these data is a current challenge in the area of bioinformatics.

• Terascale computation (meaning computation at the rate of ˜ 109 operations per second and with storage at the level of ˜ 1012 bytes) has become increasingly available and is now commonly used to enable simulations of impressive scale in all areas of computational biology. Such levels of computation are not only available at centralized supercomputing facilities around the world, but are also becoming available at the research group level through the deployment of clusters assembled from commodity technology.

2.1 The Landscape of Computational Biology

The landscape of computational biology includes almost every level in the hierarchy of biological function, and thus the field of computational biology is almost as vast as biology itself. This is figuratively illustrated in Figure 2-1. Computation impacts the study of all the important components of this hierarchy:

1. It is central to the analysis of genomic sequence data where computational algorithms are used to assemble sequence from DNA fragments. An important example was the development of "whole genome shotgun sequencing" [20] which made it possible for Venter and his colleagues to rapidly obtain a rough draft of the human genome.

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Figure 2-1: A pictorial representation of the landscape of computational biology which includes almost every level in the hierarchy of biological function. Image from briefing of Dr. M. Colvin.

2. Via the processes of transcription and translation, DNA encodes for the set of RNAs and proteins required for cellular function. Here computation plays a role through the ongoing endeavor of annotation of genes which direct and regulate the set of functional macromolecules.

3. The function of a protein is tied not only to its amino acid sequence, but also to its folded structure. Here computation is essential in attempting to understand the relationship between sequence and fold. A variety of methods are applied ranging from so-called ab initio approaches using molecular dynamics and/or computational quantum chemistry to homology-based approaches which utilize comparisons with proteins with known folds. These problems continue to challenge the biocomputation research community.

4. Once the structure of a given protein is understood, it becomes important to understand its binding specificity and its role in cellular funct ion.

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5. At a larger scale are cellular "machines" formed from sets of proteins which enable complex cellular activities. Simulation of these machines via computation can provide insight into cellular behavior and its regulation.

6. The regulation of various cellular machines is controlled via complex molecular networks. One of the central goals of the new area of "systems biology" is to quantify and ultimately simulate these networks.

7. The next levels comprise the study of cellular organisms such as bacteria and ultimately complex systems such as bacterial communities and multicellular organisms.

To cope with this vast landscape, the JASON study described in this report was focused on a selected set of topics where the role of computation is viewed as increasingly important. This report cannot be viewed therefore as exhaustive or encyclopedic. We note that an NRC report with much greater coverage of the field will be available in the near future [49]. During the period of June 28 through July 19, 2004 JASON heard briefings in the areas of

• Molecular biophysics
• Genomics
• Neural simulation
• Systems biology

These subfields are themselves quite large and so, again, our study represents a specific subset of topics. The complete list of briefers, their a.liations, and

their topics can be found in the Appendix.
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2.2 Character of Computational Resources
In assessing the type of investment to be made in computation in support of selected biological problems, it is important to match the problem under consideration to the appropriate architecture. In this section we very briefly outline the possible approaches. Broadly speaking we can distinguish two major approaches to deploying computational resources: capability computing and capacity computing.
Capability computing is distinguished by the need to maintain high arithmetic throughput as well as high memory bandwidth. Typically, this is accomplished via a large number of high performance compute nodes linked via a fast network. Capacity computing typically utilizes smaller configurations possibly linked via higher latency networks. For some tasks (e.g. embarrassingly parallel computations, where little or no communication is required), capacity computing is an e.ective approach. A recent extension of this idea is Grid computing, in which computational resources are treated much like a utility and are aggregated dynamically as needed (sometimes coupled to some data source or archive) to e.ect the desired analysis. The requirements as regards capability or capacity computing for biocomputation vary widely and depend to a large measure on the type of algorithms that are employed in the solution of a given problem and, in particular, on the arithmetic rate, memory latency and bandwidth required to implement these algorithms e.ciently.
It is useful at this point to review the basic approaches in support of these requirements. We quote here the taxonomy of such machines as presented in the recent JASON report on the NNSA ASCI program [36]:
Custom: Custom systems are built from the ground-up for scientific computing. They use custom processors built specifically for scientific
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Figure 2-2: Hardware design schematic for IBM's Blue Gene/L.
computing and have memory and I/O systems specialized for scientific applications. These systems are characterized by high local memory bandwidth (typically 0.5 words/floating point operation (W/Flop), good performance on random (gather/scatter) memory references, the ability to tolerate memory latency by supporting a large number of outstanding memory references, and an interconnection network supporting inter-node memory references. Such systems typically sustain a large fraction (50%) of peak performance on many demanding applications. Because these systems are built in low volumes, custom systems are expensive in terms of dollars/peak Flops. However, they are typically more cost e.ective than cluster-based machines in terms of dollars/ random memory bandwidth, and for some bandwidth-dominated applications in terms of dollars/sustained Flops. An example of custom architecture is IBM's recently introduced BlueGene computer. The architecture is illustrated in Figure 2-2. Such systems are typically viewed as capability systems.
Commodity-Cluster: Systems are built by combining inexpensive o.-theshelf workstations (e.g., based on Pentium 4 Xeon processors) using
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a third-party switch (e.g., Myrinet or Quadrics) interfaced as an I/O device. Because they are assembled from mass-produced components, such systems o.er the lowest-cost in terms of dollars/peak Flops. However, because the inexpensive workstation processors used in these clusters have lower-performance memory systems, single-node performance on scientific applications su.ers. Such machines often sustain only 0.5% to 10% of peak FLOPS on scientific applications, even on just a single node. The limited performance of the interconnect can further reduce peak performance on communication-intensive applications. These systems are widely used in deploying capacity computing.
SMP-Cluster: Systems are built by combining symmetric multi-processor (SMP) server machines with an interconnection network accessed as

an I/O device. These systems are like the commodity-cluster systems but use more costly commercial server building blocks. A typical SMP node connects 4—16 server microprocessors (e.g., IBM Power 4 or Intel Itanium2) in a locally shared-memory configuration. Such a node has a memory system that is somewhat more capable than that of a commodity-cluster machine, but, because it is tuned for commercial workloads, it is not as well matched to scientific applications as custom machines. SMP clusters also tend to sustain only 0.5% to 10% peak FLOPS on scientific applications. Because SMP servers are significantly more expensive per processor than commodity workstations, SMP-cluster machines are more costly (about 5×) than commoditycluster machines in terms of dollars/peak FLOPS. The SMP architecture is particularly well suited for algorithms with irregular memory access patterns (e.g., combinatorially based optimization methods). Small SMP systems are commonly deployed as capacity machines, while larger clusters are viewed as capability systems. It should be noted too that the programming model supported via SMP clusters, that is, a single address space, is considered the easiest to use in terms of the transformation of serial code to parallel code.

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Hybrid: Hybrid systems are built using o.-the-shelf high-end CPUs in combination with a chip set and system design specifically built for scientific computing. They are hybrids in the sense that they combine a commodity processor with a custom system. Examples include Red Storm that combines an AMD “SledgeHammer” processor with a Cray-designed system, and the Cray T3E that combined a DEC Alpha processor with a custom system design. A hybrid machine o.ers much of the performance of a custom machine at a cost comparable to an SMPcluster machine. Because of the custom system design, a hybrid machine is slightly more expensive than an SMP-cluster machine in terms of dollars/peak FLOPS. However, because it leverages an o.-the-shelf processor, a hybrid system is usually the most cost e.ective in terms of dollars/random memory band width and for many applications in terms of dollars/sustained FLOPS. Due to the use of custom networking technology and other custom features such systems are typically viewed as being capability systems.

## 2.3 Grand challenges

From the discussion in Section 2.1 it is not di.cult to make a case for the importance of computation. However, our charge focused on the identification of specific opportunities where a significant investment of resources in computational capability or capacity could lead to significant progress. When faced with the evaluation of a scientific program and its future in this context, JASON sometimes turns to the notion of a “Grand Challenge”. These challenges are meant to focus a field on a very di.cult but imaginably achievable medium-term (ten-year) goal. Via these focus areas, the community can achieve consensus on how to surmount currently limiting technological issues and can bring to bear su.cient large-scale resources to overcome the hurdles. Examples of what may be viewed as successful grand challenges are the Hu-

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man Genome Project, the landing of a man on the moon and, although, not yet accomplished, the successful navigation of an autonomous vehicle in the Mojave desert. Examples of what, in our view, are failed grand challenges include the “War on Cancer” (circa 1970) and the “Decade of the Brain” in which an NIH report in 1990 argued that neurobiological research was poised for a breakthrough, leading to the prevention, cure or alleviation of neurological disorders a.ecting vast numbers of people.

With the above examples in mind, JASON put forth a set of criteria to assess the appropriateness of a grand challenge for which a significant investment in high-performance computation (HPC) is called for. In the following sections of this report we then apply these criteria to various proposed grand challenges to assess the potential impact of HPC as applied to that area. It should be emphasized that our considerations below are by no means exhaustive.

Instead, they are simply meant to provide example applications of a methodology that could lead to identification of such grand challenge problems and thus to a rationale for significant investment in high-performance capability or capacity.

The JASON criteria for grand challenges are

• A one-decade time scale: Everything changes much too quickly for a multi-decadal challenge to be meaningful.

• Grand challenges cannot be open-ended: It is not a grand challenge to “understand the brain”, because it is never quite clear when one is done. It is a grand challenge to create an autonomous vehicle that can navigate a course that is unknown in advance without crashing.

• One must be able to see one’s way, albeit dimly, to a solution. When the Human Genome Project was initiated, it was fairly clear that it was, in principle, doable. The major issue involved improving sequencing throughput and using computation (with appropriate fast algorithms) to facilitate the assembly of sequence reads. While underscoring the

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tremendous importance of these advances, they are not akin to true scientific breakthroughs. Thus, one could not have created a grand challenge to understand the genetic basis of specific diseases in 1950 before the discovery of the genetic code. This is independent of how much data one might gather on inheritance patterns, etc. With some important exceptions, data cannot, in general, be back-propagated to a predictive “microscopic” model. One must therefore view with some caution the notion that we will enter a data-driven era when scientific hypotheses and model building will become pass´e.

• Grand challenges must be expected to leave an important legacy. While we sometimes trivialize the space program with jokes about drinking Tang, the space program did lead to many important technological advances. This goes without saying for the human genome project. This criteria attempts to discriminate against one-time stunts.

The remaining sections of this report provide brief overviews of the role of computation in the four areas listed in section 2.3. At the end of each section we consider possible grand challenges. Where a grand challenge seems feasible we describe briefly the level of investment of resources that would be required in order to facilitate further progress. Where we feel the criteria of a grand challenge are not satisfied we attempt to identify the type of investment (e.g. better data, faster algorithms, etc.) that would enable further progress.

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## 3 MOLECULARBIOPHYSICS

Molecular biophysics is the study of the fundamental molecular constituents of biological systems (proteins, nuclei acids and specific lipids) and their interaction with either small molecules or each other or both. These constituents and their interactions are at the base of biological functionality, including metabolism, gene expression, cell-cell communication and environmental sensing, and mechanical/chemical response. Reasons for studying molecular biophysics include:

1. The design of new drugs, enabled by a quantitatively predictive capability in the area of ligand-binding and concomitant conformational dynamics.
2. The design and proper interpretation of more powerful experimental techniques. We briefly discuss in this section the role of computation in image analysis for biomolecular structure, but this is only one aspect of this issue[2].
3. A better understanding of the components involved in biological networks. Current thinking in the area of systems biology posits that one can think of processes such as genetic regulatory networks as akin to electrical circuits[3]. The goal here is to find the large scale behavior of these networks. But recent experiments have provided evidence that

this claim, that we know enough of the constituents and their interactions
to proceed to network modeling, may be somewhat premature.
2A notable development discussed during our briefings was a recent case where quantum chemistry calculations helped in the design of a green fluorescent protein (GFP) fusion, in which attaching GFP to a functional protein and carefully arranging the interaction led to the capability of detecting changes in the conformational state of the protein — these probes will o.er a new window on intra-cellular signaling, as information is often transmitted by specific changes (such a phosphorylation) in proteins, not merely by their presence or absence.
3This metaphor is responsible for attempts to create programs such as BioSpice, modeled after the SPICE program for electrical circuits
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Issues such as the role of stochasticity, the use of spatial localization to prevent cross-talk, the context-dependent logic of transcripts factors etc. must be addressed via a collaboration of molecular biophysics and systems biology. Further discussion of these issues can be found in Section 6.
4. Development of insight into the unique challenges and opportunities faced by machines at the nano-scale. As we endeavor to understand how biomolecular complexes do the things they do, undeterred by the noisy world in which they live, we will advance our ability to design artificial nano-machines for a variety of purposes.
In the following, we will briefly survey three particular research areas in which computation is a key component. These are imaging, protein folding, and biomolecular machines. We will see specific instantiations of the aforementioned general picture. We then consider a possible grand challenge related to this area - the simulation of the ribosome.
3.1 Imaging of Biomolecular Structure
One of the areas where computational approaches are having a large e.ect is in the development of more powerful imaging techniques. We heard from W. Chiu (Baylor College of Medicine) about the specific example of the imaging of viral particles by electron microscopy. Essentially, a large number of di.erent images (i.e. from di.erent viewing perspectives) can be merged together to create a high resolution product. To get some idea of the needed computation, we focus on a 6.8 °A structure of the rice dwarf virus. This required assembling 10,000 images and a total computation time of ~ 1500 hours on a 30 CPU Athlon (1.5 GHz) cluster (a very conventional cluster from the viewpoint of HPC). This computation is data-intensive but has modest memory requirements (2 GByte RAM per node is su.cient).
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Figure 3-3: An image of the outer capsid of the Rice Dwarf Virus obtained using cryo-electron microscopy. The image originates from a briefing of Dr. Wah Chiu.
A typical result is shown in Figure 3-3. Remarkably, the accuracy is high enough that one can begin to detect the secondary structure of the viral coat proteins. This is facilitated by a software package developed by the Chiu group called Helix-Finder, with results shown in Figure 3-4. The results have been validated through independent crystallography of the capsid proteins.
One of the interesting questions one can ask relates to how the computing resource needs scale as one moves to higher resolution. Dr. Chiu provided us with estimates that 4°A resolution would require 100,000 images and about 10,000 hours on their existing small cluster. If one imagines a cluster which is ten times more powerful, the image reconstruction will require a year's worth of computation as this is an embarrassingly parallel task. This is enough to put us (marginally) in the HPC ball park, but there is no threshold here — the problem can be done almost equally well on a commodity cluster, or potentially via the Grid, and this will lead to only a modest degradation in the resolution achievable by a truly high-end machine. Because the type of image reconstruction as described by Dr. Chiu is an embarrassingly parallel
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Figure 3-4: Identification of helical structure in the outer coat proteins of the rice dwarf virus. Image from briefing of Dr. Wah Chiu (Baylor College

of Medicine.
computation, one can make a cogent argument for deployment of capacity computing and, indeed, the development of on-demand network computing, a signature feature of Grid computing, would be a highly appropriate approach in this area.
Imaging in biological systems is a field which certainly transcends the molecular scale; its greatest challenges are at larger scales where the concerted action of many components combine to create function. These topics are not part of molecular biophysics and so are not discussed here. For some more information one can consult a recent JASON report [39] on this topic.
3.2 Large-scale molecular-based simulations in biology
We next assess several aspects of molecular-based simulation that are relevant to high performance computation. There has been major progress in mole-
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cular scale simulations in biology (i.e., including biophysics, biochemistry, and molecular biology) since the first molecular dynamics (MD) calculations from the early 1970's. The field has evolved significantly with advances in theory, algorithms, and computational capability/capacity.
Simulations include a broad range of energetic calculations that include MD, Monte Carlo methods (both classical and quantum), atomic/electronic structure dynamics optimization, and other statistical approaches. In MD, the trajectories of the component particles are calculated by integrating the classical equations of motion. The simplest renditions are based on classical force fields that use parameters (e.g., force constants) derived from fitting to experimental data or to theoretical (quantum mechanical) calculations. These can be supplemented by explicit quantum mechanical calculations of critical components of the system [45, 14, 26]. These calculations are particularly important for modeling chemical reactions (i.e., making and breaking bonds). At the other end of the scale are continuum approaches that ignore the existence of molecules. In fact, it has been fashionable to use hybrid approaches involving quantum mechanical, classical molecular, and continuum methods to model the largest systems. In addition to the intrinsic accuracy problems with each of the component parts (discussed below), there are important issues on how to appropriately describe and treat the interfaces between the quantum, classical, and continuum regimes [40].
It is a truism from physics that a full quantum mechanical treatment of a biological system would yield all necessary information required to explain its function if such a treatment were tractable [10]. The reality of course, is that existing methods for the quantum mechanical treatment of even a small piece of the problem (e.g. the active site of an enzyme) are still approximate and the accuracy of those methods needs to be carefully examined in the context of the problem that one is trying to solve. Some feel for the size of the problem can be obtained from Figure 3-5 where typical simulation approaches for molecular biophysics are put in context. As can be seen from the Figure, the applicability of a given method is linked to the number of
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Figure 3-5: A plot of typical simulation methodologies for molecular biophysics plotted vs number of atoms and the relevant time scale. Figure from presentation of Dr. M. Colvin.
atoms in the system under consideration as well as the required time scale for the simulation. The larger the number of atoms or the longer is the required simulation time, the further one moves away from "ab initio" methods.
Quantum approaches break down into either so-called quantum chemical (orbital) or density functional methods. The quantum chemical methods have intrinsic limitations in terms of the number of electrons that can be simulated and the trade-o. in basis set size versus system size impacts accuracy.
The most accurate methods (including configuration interaction or coupled cluster approaches) typically scale as N5 to N7, where N is the number of electrons in the system. As a result of these limitations, there has been increasing interest in the use of density functional methods [23, 40], which have been used extensively in the condensed-matter physics community because of their reasonable accuracy in reproducing the ground-state properties of many

semiconductors and metals. Despite the name “first-principles”, there is an arbitrariness in the choice of density functionals (e.g. to model exchange-
24
correlations) and there has been extensive e.ort to extend the local density approximation (e.g., with gradient corrections) or using other alternatives such as Gaussian Wave bases (e.g. [16]). While these extensions may more accurately represent the physics of the problem, the extensions can result in poorer agreement between theory and experiment. Following the Born-Oppenheimer approximation, the dynamics is treated separately from the forces (i.e. using the Hellman-Feynman theorem) and usually in the quasiharmonic approximation.

The advent of first-principles MD has been an important breakthrough [7] and is being applied to a range of chemical and even biological problems [40]. Here the electronic structure is calculated on the fly as the nuclei move (classically), with the coe.cients of the single-particle wave functions treated as fictitious zero-mass particles in the Lagrangian. The much larger size of the simulation relative to the classical case results in limitations to the basis set convergence, k-point sampling, choice of pseudopotentials, and system size. Moreover, these techniques are still based on density functional approximations, so the problems discussed above apply here as well. Because of this, the accuracy needs to be carefully examined. There are a number of problems to be surmounted before these methods can be fully implemented for biological systems (cf. for example [26, 3]). A full ab initio calculation of a small protein has been reported (1PNH, a scorpion toxin with 31 residues and 500 atoms; [3]). Hybrid classical and first-principles MD calculations have also been applied to heme [35].

One can step back from the problem of treating biomolecules, by considering the problem of accurately describing and calculating the most abundant molecules in biological systems: water. After years of e.ort, the proper treatment of water in condensed phase is still challenging. The most accurate representations of the physical properties of the molecule (i.e., with the proper polarizability) in condensed phase and in contact with solutes is often too time consuming to compute, so simple models are used. Indeed, the full first-principles approaches still fail to reproduce the important phys-
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ical and chemical properties of bulk H2O [17]. Studies of aqueous interface phenomena with these techniques are really only beginning [8].

In principle, the most accurate methods would be those that take the full quantum mechanical problem, treating the electrons and atoms on the same quantum mechanical footing. Such methods are statistical (e.g., various formulations of quantum Monte Carlo) or use path integral formulations for the nuclei [15]. In quantum Monte Carlo, the problem scales as N3. Because of this, the treatment of heavy atoms (beyond H or He) has generally been problematic. But there are also fundamental problems. In the case of quantum Monte Carlo there is the fermion sign problem. Linear scaling methods have been developed so that systems of up to 1000 electrons can be treated (e.g., Fullerene [48]). These methods have not been applied directly to biomolecular systems to our knowledge.

Several additional points need to be made. The first is that biological function at the molecular level spans a broad range of time scales, from femtosecond scale electronic motion to milliseconds if not seconds. Independently of the intrinsic accuracy of the calculations (from the standpoint of energetics), the time-scale problem is beyond conventional molecular-based simulations. On the other hand, stochastic methods can bridge the gap between some time scales (i.e., molecular vibrations, reaction trajectories and large scale macromolecular motion [50, 13, 38]). This is also important for the protein folding problem [44]. Finally, the above discussion concentrates on the use of simulations for advancing our understanding of biological function from the standpoint of theory, essentially independent of experiment. On the other hand, there is a growing need for large-scale molecular-based simulations as an integral part of the analysis of experimental data. Classical MD and Monte Carlo (including reverse Monte Carlo) simulations can be used

in interpreting data from di.raction, NMR, and other kinds of spectroscopy experiments [3]. These examples include chemical dynamics experiments carried out with sub-picosecond synchrotron x-ray sources. The needs here for high-performance computing appear to be significant. The computational
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chemistry community, however, has been very successful in articulating these requirements and will be able to make a cogent case for future resources required to support this work. The above discussion also underscores once again the need for basic research that can then lead to future consideration of larger systems of biological interest.

In order to provide some context for the scale of applications that one envisions, we close this section with a brief discussion of the computational resources required for a very basic protein folding calculation using a simple and conventional classical MD approach. In order to try to capture the interatomic interactions, use is typically made of various potentials with adjustable parameters that are used to fit data acquired from more accurate calculations on smaller systems. A typical set of such potentials (quoted from [2]) is expressed below:

UTotal = UStretch + UBend + UTorsion + ULJ + UCoulomb where
UStretch = bonds(ij)
Kij rij - requil
ij 2
UTorsion = torsions(ijkl) n=1,2,...
Vijkn [1 + cos(nöijkl - ãijkl)] (3-1)
ULJ = nonbonded(ij),i<j)
Aij
r12
ij -
Bij
r6
ij
UCoulomb = nonbonded(ij)
qij
rij

The total interaction is comprised of bonded and nonbonded interactions. The bonded interactions account for bending, stretch and torsion in the protein structure. Nonbonded interactions account for the electrostatic as well as Lennard-Jones interactions. Equation 3-1 represents the forces typically taken into account in MD simulations of protein and water systems. The accuracy of this expression is directly related to how the choice of the parameters (for example interaction strengths such as Kij) is made. It is here that more accurate quantum chemical approaches might be used to create a valid “force field”. The MD approach simply computes all the forces on all atoms of the protein (and solvent) and then adjusts the positions of the
27
atoms in response to these forces. However, several aspects of this calculation are extremely challenging. They are summarized in the table below:

Physical time for simulation 10-4 seconds
Typical time step size 10-15 seconds
Typical number of MD steps 1011 steps
Atoms in a typical protein and water simulation 32000 atoms
Approximate number of interactions in force calculation 109 interactions
Machine instructions per force calculation 1000 instructions
Total number of machine instructions 1023 instructions

The estimates come from [2]. As shown in the table, a typical desired simulation time might be on the order of 10-100 microseconds although it is known that folding timescales can be on the order of milliseconds or longer. The second entry illustrates one of the most severe challenges: in the absence of any implicit time integration approach the integration must capture the vibrational time scales of the system which are in the femtosecond range. The number of interactions required in the force calculation is derived from the most simple estimate wherein all O(N2) interactions are computed for

a system of size N. This can be in principle be reduced through the use
of methods based on multipole expansions; this entails significant programming
complexity when one contemplates implementing such algorithms on
parallel architectures and improvement over the simple approach will not be
seen until N is su.ciently large. As a result the estimate provided above is
probably not far o.. In total, such folding calculations require 1023 operations
to compute one trajectory. For a computer capable of a Petaflop such
a calculation will still require O(108) seconds or roughly three years.
A computer capable of arithmetic rates of a Petaflop is today only feasible
through the use of massive parallelism. It is envisioned that computers
capable of peak speeds of roughly a Petaflop will be available in the next
few years. An example is the recently announced BlueGene/L machine from
IBM which represents today the ultimate capability platform. The largest
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Figure 3-6: Scaling for the molecular dynamics code NAMD on the ASCI
Red massively parallel computer.
configuration of this machine is 64000 processors each capable of roughly 3
Gflops. Thus, present-day configurations of BlueGene are capable of peak
speeds of roughly .2 Petaflop and it is anticipated that through improvements
in processor technology it will be possible to achieve peak speeds of a
Petaflop in the very near future.
However, as discussed in section 2.2, it is di.cult to achieve the ideal
peak speed on a single processor. This is typically because of the inability to
keep the processor's arithmetic units busy every clock cycle. Even without
massive parallelism processors will perform at perhaps 0.5 to 10% of their
peak capabilities. Further latency results when one factors in the need to
communicate across the computer network. Communication is typically quite
a bit slower than computation even in capability systems and so for some
algorithms there can be issues of scalability as the number of processors are
increased. Computations such as those required for protein folding exhibit
significant nonlocality in terms of memory access and so the development of
scalable algorithms is crucial. A example of this (based on rather old data)
29
is shown in Figure 3-6. The figure shows the number of time steps that
can be completed in one second of wall clock time using a modern protein
simulation code NAMD. The data come from the ASCI Red platform which
is now almost 10 years old. Nevertheless the trends are reflective of what can
be expected to happen on more modern platforms. It can be seen that as
the number of atoms is held fixed and the number of processors increased.
the computational rate eventually saturates implying the existence of a point
of diminishing returns. The performance can be improved by increasing the
number of atoms per processor or by reducing network latency.
To conclude, it is seen that the computational requirements for highly
accurate molecular biophysics computations are significant. The challenge
of long time integration is particularly severe. We discuss in more detail the
particular problem of protein folding in the next section.

## 3.3 Protein Folding

One of the most computation-limited problems currently being vigorously
pursued is that of protein folding. Actually, there are two separate folding
problems that should not always be lumped together. The first is the determination
of protein structure from the underlying amino acid sequence;
there is a corresponding nucleic acid problem of determining the structure
of single-stranded RNA from nucleotide sequence. This problem has its final
goal an atomic level picture of the folded-state conformation but does not
necessarily care about the folding kinetics. The second problem is the time
evolution of protein folding, determining the exact set of trajectories that enable
the system to fold from an initially unfolded ensemble. Here one cares
about the folding kinetics and the nature of the transition states. This information
can be crucial, as in for example the problem of protein aggregation
disease due to the clumping together of proteins that have gotten trapped in
misfolded non-native states.
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The “holy grail” in this field is being able to directly simulate the folding process of a typically-sized single domain protein (say 100 residues) starting from a random initial state. This would presumably be done by classical MD with a well-established force field and in the presence of explicit water molecules (i.e. solvation). This simulation would of course directly address the structure problem and would demonstrate at least one kinetic trajectory; presumably multiple runs would be needed to determine the full range of possible kinetic pathways. A first step towards the direct realization of this capability was made by Duan and Kollman [11], who simulated the folding of the 36 residue Villin head piece (see Figure 3-7) for one microsecond. The Villin head piece subdomain that was simulated is one of the most rapidly folding proteins and this calculation represented a new level of capability in this area. To give some idea of the resources required for these studies, their computation ran for several months on a 256 node cluster at the Pittsburgh Supercomputer Center. Despite the impressive scale of this type of computations there is, in our opinion, no compelling argument that brute force calculations enabled by a state-of-the-art capability machine are really going to break open this problem. It is not as if there is a well-defined force field that will give us the correct answer every time if only we had enough cycles. Such an approach is valid in some other fields (e.g. computational hydrodynamics, lattice quantum chromodynamics, etc.) but appears wholly inappropriate here as pointed out earlier in Section 3.2. Instead, the refinement of force fields must go hand in hand with a broad spectrum of computational experiments as discussed in the previous section. Furthermore, there is no one unique protein of interest and it is quite likely that models that su.ce for one protein of one class will need to be modified when faced with a di.erent structural motif — this has been seen when standard programs such as CHARMM and AMBER, usually calibrated on proteins that have significant á-helix secondary structure, are used for mostly â-sheet structures. The fact that one model will not do for all proteins is a consequence of assuming that the problem can be addressed by classical MD with fewbody potentials. This is only approximately true as previously discussed in
31
Figure 3-7: Representations of various stages of folding of the 36 residue Villin head piece. (A) represents the unfolded state; (B) a partially folded state at 980 nsec and (C) a native structure. (E) is a representative structure of the most stable cluster. (D) is an overlap of the native (red) and the most stable cluster (blue) structures indicating the level of correlation achieved between the simulation and a native fold. (Figure from [11]).
section 3.2; the real interactions are quantum mechanical and many-body in nature, and hence empirical adjustments must be made on a case-by-case basis. Of course, the idea of going beyond classical MD to a more “realistic” ab initio treatment (using density functional theory, for example) would appear to be totally out of the question using present computational techniques given the considerations discussed in section 3.2

Even in the absence of a direct path to the answer, the molecular biophysics community continues to make excellent progress by using a variety of approximations, simplifying assumptions and, of primary concern here, computational resources and paradigms. It is not useful to give a comprehensive review, but it is worth presenting some of the highlights of these alternate
32
Figure 3-8: A free energy plot of a 16 residue segment of some specific protein; the axes refer to distance away from an alpha helix (y-axis) versus a beta hairpin (x-axis), and blue is low free energy (i.e. a probable configuration). Here, the number of atoms being simulated is 8569 and the calculation is done using 42 replicas.
approaches:

Simplified models: If one retreats from all-atom simulations, one can get longer runs of the folding time-course. One can eliminate the water molecules (going to “implicit solvent” models), eliminate the side chains (so-called Cá models) and even restrict the overall conformational space by putting the system on a lattice. These have been used to great e.ect to study folding kinetics. These simulations run quite e.ectively on existing clusters which have become the standard resource for the community.

Thermodynamics: If one is willing to give up on folding kinetics and merely study the thermodynamics of the system, advanced sampling techniques enable rapid exploration of the conformational space. For example, the replica exchange method uses a set of replicas that evolve at di.ering temperatures. Every so often, configurations are swapped between replicas, preventing the low temperature system of interest from getting trapped for long periods of time. Because of limited com-
33
munication between the replicas, this algorithm is close to being embarrassingly parallel. As an example, we show in Figure 3-8 the free energy plot of a 16 residue segment of some specific protein; the axes refer to distance away from an á-helix (y-axis) versus a â-hairpin (xaxis), and blue is low free energy (i.e. a probable configuration). Here, the number of atoms being simulated is 8569 and the calculation is done using 42 replicas. These data are based on a 6 nanosecond MD simulation, which took 96 hours on the SDSC Teragrid machine with 168 CPU's.

Folded State: If one is interested only in the native state, one can dispense with kinetics altogether and focus on finding the minimal energy structures. This can be tackled by a whole set of possible optimization algorithms. Many of the practitioners of these techniques compete in the CASP competition to predict structures which have been measured but as yet not-released. As we heard from one of our briefers, Peter Wolynes, progress is being made on structure prediction by "folding in" theoretical ideas such as the relative simplicity of the energy landscape for natural proteins.

Grid-based methods Several groups are exploring the distributed computing paradigm for performing folding computations. One interesting idea is due to Pande [33] who noted that for simple two-state folding kinetics, the folding is a Poisson process (i.e. has an exponential waiting time distribution). This means that one can run thousands of totally independent folding simulations and that a small percentage (~ t/tfolding) will fold after a small time t. They have demonstrated how this simplifying assumption can be used to harness unused computational capacity on the Internet to actually get folding paths. Other groups are also beginning to explore distributed computer applications (see, for example, the work of the Brooks group [6] at Scripps Research on structure determination for the CASP6 competition). These application are being facilitated by the increasing availability of Grid mid-
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dleware (cf., for example the Berkeley Open Infrastructure for Network Computing project [1]).

We should mention in passing that most of the work to date has focused on soluble proteins. An additional layer of complexity occurs when proteins interact directly with membranes, such as for example when the parts of the protein repeatedly traverse the lipid bilayer. Additional attention is being paid to this topic, but progress remains sporadic, especially since the structural data upon which the rest of the folding field is directly reliant, is much harder to come by.

In summary, the protein folding problem will use up all the cycles it can and will do so with good e.ect. Progress is being made by using a whole suite of computational platforms together with theoretical ideas which motivate simplifying assumptions and thereby reduce the raw power needed. This mix appears to us to be the most promising direction; a single dedicated facility for protein folding (as was advertised initially for Blue Gene) will be useful but would not on its own break the field open. We elaborate on this issue further in the next section.

3.4 A Potential Grand Challenge - The Digital Ribosome

The understanding of biomolecular structure, while clearly important in

its own right, is but a step towards the more essential area of biomolecular function, that is, how the dynamic three dimensional structure of biomolecules and biomolecular complexes enable critical steps in the life-cycle of organisms to be carried out. The simplest of these possibilities is the catalyzing of a specific reaction by a single component enzyme; other “simple” functions include the capture of a photon by a light-sensitive pigment embedded in a
35
protein photoreceptor. More complex possibilities include the transduction of chemical energy into mechanical work, the transfer of molecules across membranes, and the transfer of information via signaling cascades (often with the use of sca.olds for spatial organization of the reactions). At the high end of complexity one has incredibly intricate multi-component machines which undergo large scale conformational motions as they undertake tasks. A classic example is the ribosome, consisting of roughly 50 proteins and associated RNA molecules. Its job, of course, is to translate the sequence of messenger RNA into the amino acid sequence of a manufactured protein.

Typically, studies of biomolecular function of the underlying structure are advanced via X-ray crystallography, cryo-electron microscopy or NMR. Often, one can obtain several static pictures of the complex, perhaps with bound versus unbound ligand for example. The challenge is then to understand the sequence of events comprising the actual functioning of the machine. The complexity arises from the need to keep track of a huge number of atoms (millions, for the ribosome) and from the need to do some sort of quantum mechanical treatment of any of the actual chemical reactions taking place.

Let us again focus on the quantum chemistry aspects of the problem (as discussed in Section 3.2). It is clear that one cannot hope to do justice to any of the quantum aspects of the problem for more than a tiny fraction of the biomolecular complex, and for more than a tiny fraction of the time involved an entire functional cycle. This part of the problem has to then be coupled to the rest of the dynamics in space and time which presumably are being treated by classical MD simulations. This task falls under the general heading of “multi-scale computation” where part of the problem needs to be done at a very much finer resolution than others. Our impression is that there remains much room for algorithmic improvement for this interfacing task.

We heard about progress on quantum algorithms from various briefers. This community is rather mature and is making steady progress, but again, it did not appear from our briefings that deployment of HPC would at this point
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create a “sea-change” in our current understanding of biological function. Instead, we see a mix of platforms being applied in valuable ways to various problems with achievement of incremental progress.

The biggest problem in this area appears to be the “serial time” bottleneck. HPC can, in principle, allow us to consider bigger systems although there are issues of scalability, but cannot directly address the di.culty of integrating longer in time if one uses conventional “synchronous” integration methods. The mismatch in time scale between the fundamental step in a dynamical simulation (on the order of femtoseconds) and the time-scale of the desired functional motions (milliseconds or longer) is depressingly large and will remain the biggest problem for the foreseeable future. Of course, there are ways to make progress. One familiar trick is driving the system so hard that the dynamics speeds up; the extent to which these artificial motions are similar to the ones of interest needs to be carefully investigated on a case by case basis. Finding some analytic method which allows for integrating out rapid degrees of freedom is obviously something to aim at, but again any proposed method should be carefully evaluated.

Within the context of biological machines, we consider the notion of the “Digital Ribosome” as a possible grand challenge in computational biology. Exactly how uniquely important the ribosome is as compared to other critical biological machines is somewhat subjective, but it is fair to say that it does represent a first-order intellectual challenge for the biology community. Namely, one wants to understand how the structure allows for the function,

what is the purpose of all the layers of complexity, which pieces are the most constrained (and hence have the hardest time changing from species to species over evolutionary time) and, of course how did the ribosome (with all the attendant implications for cell biology) come to be. This problem has come to the fore mostly because of the remarkable recent successes in imaging of ribosomal structure (see for example Figure 3-9). The existence of structural information as well as the long history of using ribosomal RNA to track evolution seems to allow us to converge to a set of coherent tasks that
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Figure 3-9: Views of the three dimensional structure of the ribosome including three bound tRNA's. (a) and (b) Two views of the ribosome bound to the three tRNAs. (c) The isolated 50S subunit bound to tRNAs - peptidyl transfer center is circled (d) Isolated 30S subunit bound to tRNAs- the decoding center is circled. The figure above is taken from [46]
.
would enable us to formulate this challenge. This would have a high payo., one of our challenge criteria, and would actually energize the community. But, is it doable?

Our basic conclusion is that, at present, the serial bottleneck problem as well as our lack of fully understanding how to create classical force fields (as well as understanding when one needs to go to full ab initio methods) makes the digital ribosome project premature. We do not see a path to full simulation capability and, although there are promising approximate methods based on a sort of normal mode analysis, we do not yet understand how to do reliable dynamics without such a capability. This is only a weak
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conclusion, however, and we think that this issue should perhaps be put to the molecular biophysics community in a more direct fashion. Further, it is our opinion that the total decoupling of molecular biophysics calculations from evolutionary information is possibly holding back progress. After all, one can get some ideas of the most relevant residues by using comparative genomics and conversely one can make better sense of the variations observed in the ribosome in di.erent species in"tree of life" if one has some handle on the functional robustness of the protein structure via direct calculations. Again, this underscores that progress can be made by coupling highly targeted and smaller scale computations with experimental information.

3.5 Conclusion

In the course of our study, we heard briefings from many di.erent areas of computational biology. It was clear that the area of molecular biophysics is the most computationally sophisticated, the field in which computational methods have become of age. In areas ranging from the computer-aided analysis of advanced imaging methods to medium-scale solution of model equations to full-up simulations of the equations of motions for all the atoms using high performance computing assets, this field is moving forward and making impressive gains. So, there is every reason to continue work on the challenges facing this field. As we heard from our briefers and as we thought through the issues among ourselves, our primary question related to computation was one of investment strategy. Simply put, what mix of computational resources provides the best fit to today's research community and conversely, how would investment in high performance computing impact the progress to be made in the future?

Our basic conclusion is that an e.ective model for computational resource needs is an approach currently adopted by Klaus Schulten (Univ. Illinois) of attempting to provide a cluster per graduate student. In his lab,
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each student is given complete control of a commodity cluster (roughly 50 processors) for his/her research. Similarly, we heard from Dr. Chiu that clusters of this scale are the right tool for current imaging applications. The logic behind this is that

• there are many important problems to be worked on, not a single unique challenge (contrast this to QCD, for example).
• almost all problems require significant computation. There is a sort of

"minimum complexity principle" at work, which means that even the simplest biologically meaningful systems are much more complex than most physicists care to admit. This tips the balance of simple soluble models/intermediate models requiring some simulation/detailed models requiring significant computation to the right of what is standard in most basic physics areas. A single workstation is clearly inadequate.

• We are far away from any very specific "threshold" of understanding. Our understanding of specific systems will continue to increase incrementally and no one set of "super-calculations" doable in the foreseeable future will have a first order e.ect on the field. Thus, there is limited utility in providing a very small number of researchers access to more computational cycles in the form of a HPC capability machine - this type of machine would be e.ectively utilized, but would probably not lead to breakthrough results.

• Conversely, there could be breakthroughs based either on algorithmic improvements or conceptual advances. One might argue, for example, that the idea of a "funneled landscape" (discussed above in 3.3) has led to useful simplified models and indeed to constraints on "realistic models" which have enhanced our ability to predict protein structure. New ideas for electrostatic calculations might fit into this category. These algorithms and/or ideas will only come from having many researchers trying many things, another argument for capacity over capability.

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We comment here at this point on the deployment of software. We were struck by the fact that this community is quite advanced when it came to developing and maintaining useful software packages which can then be shared worldwide. These packages include codes which provide force fields (CHARMM, AMBER), those which do quantum chemistry calculations (NWCHEM, for example), those which organize molecular dynamics calculation for cluster computing (e.g. NAMD) and those which do image analysis (HELIX-FINDER for Cryo-EM data, for example). These packages are all research-group based and hence can both incorporate new ideas as they emerge in the community and remain usable by new scientists as they become trained in the field. There are organized community e.orts to train new users, such as summer schools in computational methods in biophysics being run at various universities, for example. Alternative approaches to software development such as having a group of software developers work in relative isolation on a set of modules that a limited set of people have formulated at some fixed time-point is not appropriate in our view for a rapidly advancing, highly distributed yet organized, research community.

After repeated badgering of our briefers and after repeated attempts to look through the computational molecular biophysics literature, no truly compelling case emerged for HPC as deployed, for example, by the NNSA ASC program. The di.culties are the mismatch between scales at which we can be reasonably confident of the fundamental interactions (here atoms and electrons, at scales of angstroms and femtoseconds) and scales at which we want to understand biomolecular structure and function (tens to hundreds of nanometers, milliseconds and longer). This means that large scale ab initio simulations are most likely not going to dominate the field and that it will be di.cult for massive capability platforms to make a huge di.erence.

Instead, we recommend vigorously supporting research in this area with something like the current mix of computation resources. There needs to be a continuing investment in algorithms and in machine architecture issues so that we can overcome the "serial bottleneck" and can seamlessly accomplish

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multi-scale modeling, as informed by the scientific need. The digital ribosome is not feasible today as a computation grand challenge, but is su.ciently close to deserve further scrutiny as our understanding improves.

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# 4 GENOMICS

In this section we provide some perspectives on the role of HPC in genomics. We conclude this section with an assessment of a potential grand challenge that connects developments in genome sequencing with phylogenetic analysis: determination of the genome of the last common ancestor of placental mammals.

## 4.1 Sequence Data Collection

Presently, raw DNA sequence information is deposited in an international trace archive database managed by US National Center for Biotechnology Information. Each "trace" or "read" represents about 500-800 bases of DNA [31]. Most reads are produced by "shotgun" sequencing, in which the genome of interest is randomly fragmented into pieces of a few thousand bases each, and the DNA sequence at the ends of these pieces is read. The Joint Genome Institute (JGI) at DOE is one of the top four producers of DNA reads in the world. The other three are NIH funded labs. JGI contributed roughly 20 million DNA traces in the three months ending July 2004, which is about 25% of the worldwide production that quarter. The cumulative total JGI contribution to the trace archive as of July 2004 was approximately 46 million traces, representing about 10% of total worldwide contributions. Approximately 80% of the DNA in the trace archive was generated by the top four labs.

Beyond its great biomedical importance, extensive DNA sequencing has the potential to give us significantly greater depth in understanding the biodiversity on this planet and how it has evolved. In addition to sequencing the (nearly) complete genomes of hundreds of individual species, the shotgun

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sequencing methods have been applied to the analysis of environment samples, where genome fragments from a complex mixture of species living in a given ecosystem are all obtained at once from a single experiment [42, 41]. It is anticipated that in the near future these methods will generate significant amounts of genome data from organisms very broadly distributed over the tree of life. Data from environmental sequencing e.orts could be used to identify new species and new members of gene families, with potential applications in medicine, ecology and other areas.

Venter et al. [42] report obtaining more then 1 million new protein sequences from at least 1800 prokaryotic species in a single sample from the Sargasso Sea. The method is remarkably successful for species that are abundant in the sample and exhibit little polymorphism, i.e. DNA di.erences between individuals.

The polymorphism issue is an important one. In the Sargasso Sea study, some species had as little as 1 single nucleotide polymorphism (SNP) in 10,000 bases. A length-weighted average of 3.6 SNPs per 1000 bases was obtained for all species from which they could assemble genomic DNA into large contiguous regions ("contigs"). A relatively low SNP rate such as this is necessary if one is to reliably assemble individual reads into larger contigs without crossing species or getting confused by near duplicated sequence within a single species. Larger contigs are useful for many types of analysis.

It is unclear how many species are not analyzable in an environmental sample of this type because of high polymorphism rates. Polymorphism rates as high as 5 SNPs per 100 bases can occur in neutrally evolving sites in eukaryotes such as the sea urchin (Eric Davidson, personal communication). Such a high rate of polymorphism makes it di.cult to correctly assemble contigs across neutral regions even in a pure diploid sample from a single eukaryotic individual. The situation is much worse in an environmental sample. Still, there is some hope of assembling somewhat larger contigs in regions that are protein coding or produce structural RNA if strong purifying selection within the species is constraining the DNA su.ciently (e.g. in ribosomal

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Figure 4-10: A depiction of the tree of life indicating the complications caused by reticulated evolution.

RNA genes, which are typically used to identify species). Because there will nearly always be some neutral polymorphic sites intermingled with the constrained sites, better, more "protein-aware" or "RNA-aware" methods of sequence assembly will be needed to fully exploit environmental sequence data by producing the largest possible contigs.

There is significant synergy with the DOE sequencing programs and
the NSF "Tree of Life" initiative, whose goal is to catalog and sort out
the phylogenetic relationships among the species present on our planet. This
project is even harder than one might expect, because contrary to the original
picture of Darwin, it is clear that species relationships are complicated by
reticulated evolution, in which DNA is passed horizontally between species,
creating a phlyogenetic network instead of a simple tree (see Figure 4-10).
While rare in animals, this is especially prevalent in the bacterial kingdom,
an area where DOE has significant opportunity in light of NIH's focus on
metazoan genomes and NSF's focus on plant genomes. Significant sequencing
of bacterial genomes is needed to sort this issue out. Simple analysis based on
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sequencing of a few common functional elements from each species' genome,
such as the ribosomal RNA genes, will not su.ce.

## 4.2 Computational Challenges

There are a number of computational challenges related to the e.orts
described in the previous section.

### 4.2.1 DNA read overlap recognition and genome assembly

As discussed above, individual DNA reads must be assembled into larger
genome regions by recognizing overlaps and utilizing various kinds of additional
constraints. This has been challenging even for DNA reads from a single
species. In environmental sequencing, this must be done without mixing
DNA from di.erent species. As mentioned above, sparse sampling of DNA
from many species in the more complex environmental samples, coupled with
high rates of polymorphism within specific species presents a significant obstacle
here.

### 4.2.2 Phylogenetic tree reconstruction

There have been potentially significant algorithmic advances for reconstructing
phylogenetic trees, including meta-methods for improving the performance
of current algorithms. But the data sets on which this development
can take place are still limited and there does not yet seem to be su.cient
understanding the nature of real world problems to create useful synthetic
data sets. The current assessment is that reconstructing large phylogenetic
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trees will require potentially large parallel machines at some point in the
future and further the more e.cient algorithms may require more conventional
supercomputer architectures. One should monitor the developments
here closely over the next two or three years. More specific challenges include
finding improved techniques for the major hard optimization problems
(maximum parsimony and maximum likelihood) in conventional phylogenetic
inference, as well as dealing with higher level analysis of whole genome evolution,
with insertions, deletions, duplications, rearrangements and horizontal
transfer of DNA segments.

### 4.2.3 Cross-species genome comparisons

Orthologous genomic regions from di.erent species must be detected and
aligned in order to fully identify functional genomic elements (protein-coding
exons, non-coding RNA sequences, and regulatory sequences) and to study
their evolution from a common ancestor. In evolutionarily close species, e.g.
for the human and mouse genomes, genomic alignment and comparison can
be done solely at the DNA level, although further analysis of the robustness of
these alignments is warranted. As an example of the computational capacity
required to do this, running on the 1000 CPU commodity hardware cluster
at David Haussler's laboratory at UCSC, it takes Webb Miller's BLASTZ
program 5 hours to compare and align the human and mouse genomes. Note
that the requirements here are for capacity. Typically, these computations
are "embarrassingly parallel".

In more distant species comparisons, e.g. human to fly, too much noise
has been introduced by DNA changes to reliably recognize orthologous DNA
segments by direct matching of DNA sequences. In this case it is common
to first identify the protein coding regions in each species' DNA and then
compare these as amino acid sequences, which exhibit many fewer changes
than does the underlying DNA due to the redundancy of the genetic code.

In principle, these protein level alignments could be projected back onto the
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DNA sequences and even extended some (perhaps short) distance into the nearby non-coding DNA. This would be a useful algorithmic and software development. Production of alignments anchored o. conserved non-coding elements, such as non-coding RNA genes would also be of great value. This presents a significant computational challenge and depends greatly on obtaining a better understanding of the molecular evolution of some of the various classes of functional non-coding genomic elements. Finally, in species with introns, which includes virtually all multicellular organisms, the identification of protein coding genes is significantly more complicated, and it appears that combined methods of comparative alignment and exon detection are needed [27]. an area of active research. At present, code developed in Haussler's lab using phylogenetic extensions of hidden Markov models is used to identify likely protein coding regions. It takes days to run on the human, mouse and rat genomes on their 1000 CPU cluster. Again, the challenge here is to deploy su.cient capacity.

4.2.4 Data Integration

To give genome sequences maximum utility, other types of biomolecular data must be mapped onto them, and made available in a common database. These types of data include cDNA sequences (a more direct window into the RNA sequences made by the species), gene expression levels under various conditions, evidence of protein-DNA interactions at specific sites (e.g. ChIPchip data), etc. Web-based, interactive distribution of these data provides an opportunity to reach a large research audience, including labs less proficient in software development. This need for data federation and searchability appears in several other contexts in this report.
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4.3 A Potential Grand Challenge - Ur-Shrew

An example of a grand challenge in computational genomics would be the reconstruction of the genome of the common ancestor of most placental mammals, a shrew-like animal that lived more than 75 million years ago. The idea would be to infer the DNA sequence of this ancestral species from the genomes of living mammals. This challenge involves a number of the areas mentioned above, including genome sequence assembly, whole genome sequence alignment and comparison, and inference of phylogenetic relationships from sequence, as well as areas not discussed, such as the detailed inference of specific molecular changes in the course of evolution. Recent work by Blanchette, Miller, Green and Haussler has indicated that with complete genomes for 20 well-chosen living placental mammals, it is likely that at least 90% of an ancestral placental genome could be computationally reconstructed with 98% accuracy at the DNA level [5]. Combined with the identification of the functional elements in mammalian genomes, including the protein-coding genes, RNA genes, and regulatory sequences, a reconstructed ancestral genome would provide a powerful platform for the study of mammalian evolution. In particular, it would allow us to identify the core molecular features that are common to and conserved in placental mammals, as well as the features have evolved to define the separate lineages, including the human lineage.

There are between 4000 and 5000 species of mammals currently identi-fied, with the exact number still being the subject of debate. Mammals are not the most speciose animal even among vertebrates, where several groups have greater species counts according to present estimates; reptiles (~ 7000 species), birds (~ 104 species) and fishes (~ 2.5 · 104 species). Of course numbers for various groups of invertebrates are much larger, such as molluscs (~ 8 × 104 species) and insects (~ 106 species). The more living descendant species that are available, the more accurately one can reconstruct the ances-
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Figure 4-11: Base-level error rates in reconstruction of DNA from di.erent placental ancestors. These are estimated from simulations in [5]. The numbers in parentheses are fraction of incorrect bases not counting repetitive DNA. Scale of branch lengths is in expected base substitutions per site. The arrow indicates the Boreoeutherian ancestor.

tral genome. However, the number of living species is not the only relevant parameter in determining how accurately one can reconstruct an ancestral genome. The time (or more specifically, the time multiplied by evolutionary rate) back to the common ancestor is very important, as is the topology of

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the phylogenetic tree. Better reconstructions are usually obtainable for collections whose last common ancestor existed at a time just before a period of rapid species diversification [5]. The rapid radiation of placental mammals (3800 species), right after the extinction at the Cretaceous-Tertiary boundary approximately 65 million years ago, makes a placental ancestor an attractive candidate. The target ancestor would be one that lived some time before this event, e.g. at the primate-rodent split, estimated at 70 million years ago [12], or earlier. One attractive choice is the boreoeutherian ancestor [5], a common ancestor of a clade that includes primates, rodents, artidactyls (including, e.g. cows, sheep, whales and dolphins), carnivores and other groups, which may have lived up to 100 million years ago (see Figure 4-11). In contrast, the last common ancestor of all mammals, including marsupials and monotremes, is thought to date back to the Triassic Period (195-225 million years) [12].

The Cretaceous-Tertiary extinction event is estimated to have killed about 50% of all species. However, it was not as severe as the Permian-Triassic extinction event of 252 million years ago, during which about 95% of all marine species and 70% of all land species became extinct. This is considered to be worst mass extinction on Earth so far. It would be an even greater challenge to attempt reconstruction of an ancestral genome from this time, but the magnitude of DNA change since this time is likely to be such that much necessary information will have been irrevocably lost.

To test the accuracy of a reconstructed genome, it would desirable to obtain actual DNA samples from ancestral species, hopefully from most major subclades and ideally from the most ancient ancestors possible. There have been claims made that DNA may be found in preserved ancient bacteria or even in dinosaur bones, but these claims remain highly controversial at best. The pre-fossil forests of Axel Heiberg Island in the Canadian Arctic yield mummified samples of bark and wood from trees which date back over 48 million years. The samples are organic. The unusual environmental history that created these samples could well have created samples of organic matter

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in similar stages of preservation from other organisms. However, whether any useful DNA sequence data can be obtained from these remains open. On the other hand, there is a credible claim by a team of Danish scientists for plant and animal DNA dating between 300,000 and 400,000 years ago, obtained from drilling cores collected in Siberia. However, others have argued that no reliable DNA can be obtained from remains more than 50-100 thousand years old [4, 25]. Given that the most recent evolutionary branch point with a living species related to humans, namely the chimpanzee, occurred more than 5 million years ago, this means that options for testing the accuracy of the computationally reconstructed genome sequence of a species ancestral to us by recovering a sample of that or a closely related species' DNA are limited.

Another approach to experimentally validating the ancestral sequence would be to synthesize individual genes from it, clone them into a mouse model, and test their activity in vivo. This will require advances in DNA synthesis technology, but is not out of the question. However, such a test could never prove that the reconstructed gene was correct, only that it is functional. Further, there may be problems due to the fact that the other genes, including those that have close interactions with the reconstructed ancestral gene, would still be murine genes. Nevertheless, the information gained from such tests would be useful.

Our conclusion is that the "Ur-Shrew" grand challenge may be one that is worthwhile and could be pursued quite soon. Assuming that NIH's plans to sequence a broad sampling of placental mammals are carried out, and the

estimates from [5] hold up, the data required to get a reasonably useful reconstructed ancestral placental mammalian genome will soon be available. The most pressing need will then be for more powerful computational comparative genomics and phylogenetic analysis methods, as discussed in the sections above. The HPC requirements for this project seem to be for increased computational capacity, not computational capability. In other words, if this project, or a related project with species sequenced by DOE were to be
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undertaken, DOE should encourage the acquisition and use of commodity clusters, either by individual labs or as part of a national facility. This holds for many other challenges one might consider in the areas of genomics as well.
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5 NEUROSCIENCE
5.1 Introduction
The field of neuroscience encompasses a large number of scales of interest. This is illustrated in Figure 5-12 as described to us by briefer T. Sejnowski. The figure displays a length scale hierarchy starting at the most basic level with the molecules that form neural synapses. At the next level of organization are neurons. One can then formulate higher levels of organization composed of networks of neurons which then map to regions of the brain. Ultimately, the goal is to understand how all these interacting scales come together to dictate the behavior of the central nervous system. Contributions to computational neurobiology occur at every level of this hierarchy.
Given the breadth of the area, it is impossible to cover throughly the field in this report. Instead, we describe here briefly several aspects of computational neuroscience as briefed to us by Mayank Mehta, Terrence Sejnowski, and Garret Kenyon. Each of these briefings raise important issues relative to requirements for high performance computation. We close this section with a discussion of a potential grand challenge in computational neuroscience that attempts to model the retina.
A central issue raised in the briefing of Terry Sejnowski is the understanding of the mechanisms by which signaling takes place within the synapses connecting neurons. Neurons communicate through firing events between synapses. These firing events represent the release of various chemical transmitters which then activate a target neuron. The transmitters can also dynamically alter the operating characteristics of the signaling machinery itself. It is through this dynamic mechanism that various brain functions such as memory are accomplished. For example, in the formation of new
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Figure 5-12: The neural hierarchy (from the briefing of Dr. T. Sejnowski.
memories it is thought that various synapses among the associated neurons are strengthened through this dynamic mechanism so as to encode the new memory for later retrieval. This dynamic updating of synaptic strength is referred to as "synaptic plasticity". Sejnowski described in his briefing recent work by Mary Kennedy and her coworkers on a complex of signaling proteins called the post-synaptic density which is located underneath excitatory receptors in the central nervous system. Kennedy's group has used a variety of techniques to elucidate the structure of these proteins and is now examining the interaction among these proteins in controlling transmission in the synapse and in e.ecting the phenomenon of plasticity. Some of the identified proteins are shown in figure 5-13. Sejnowski argues that such com-
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Figure 5-13: Signaling proteins in the post synaptic density. The figure is taken from work of Prof. Mary Kennedy as briefed to us by Prof. T. Sejnowski.
plex dynamics cannot be adequately modeled via a classical reaction-di.usion based model of the reaction dynamics. Instead it becomes necessary to take into account the complex geometry and the stochastic fluctuations of the various biochemical processes. In this approach, di.usion is modeled via a Monte Carlo approach applied to the individual molecules that participate

in the biochemical reactions. Reactions are also treated stochastically using a binding rate. As the random walk proceeds, only molecules that are in close proximity will react and then only if the binding rates are favorable. The contention is that this flexibility in the ability to prescribe the general in-vivo geometry and the more detailed approach to the reaction dynamics is essential to properly describing the reaction dynamics. Kennedy and her group are able to provide estimates to the Sejnowski group of the average numbers of each molecule that is present as well as anatomical data of various neurons in portions of the brain. The computational requirements here certainly require high performance computation and the Sejnowski group has developed the MCell program as a tool to numerically perform the required stochastic simulation in a prescribed geometry of interest. There is great value in such studies as they can either point the way to obtaining better "continuum models" of plasticity or can help in the development of more sophisticated synaptic modeling strategies. It should be pointed out, however,

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Figure 5-14: (a) Tetrode configuration to study multi-neuron measurements in rats. (b) Activation of various neurons as a function of the location of the rat.

that this simulation is at the subcellular level and so the path to integrating this detailed knowledge to the cellular level (or even beyond to the network level) is unclear at present. Thus, while HPC is clearly helpful here, we do not see that this approach could be the basis for large scale simulation of neural processing which is presumably the ultimate goal. As in the case of protein folding, some sort of "mesoscopic" approach must be developed (possibly with the assistance of tools like MCell). If such an approach can be developed, then large scale computation of neural networks informed by such modeling becomes possible and at this point a large investment in HPC capability may well be required, at the present time, however, we see this area as being better served by deployment of capacity platforms so that a number of simulation approaches can be investigated.

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The phenomenology of synaptic plasticity can also be explored experimentally and in this regard we were briefed by Prof. Mahank Mehta who described the use of multi-neuron measurements by simultaneous recording of EEG signals from over 100 neurons in freely-behaving rats over a period of several months using tetrodes. An example of this approach is shown in Figure 5-14. The benefit of this approach is that is it possible to understand correlations among neurons as learning occurs. Mehta's results show that the activity of various hippocampal neurons depend on the rat's spatial location, that is, that the rat hippocampus apparently has "place cells" to help it reason about its spatial location. The main implication for our study of HPC is that such measurements require the ability to store, manipulate and ultimately to reason about an enormous amount of data. The neurophysics community has understood this and a number of Grid-based projects have been initiated.

## 5.2 A Potential Grand Challenge — The Digital Retina

In this section we will consider the case for large scale simulation of the retina as a possible grand challenge in the area of neuroscience. As we will argue, the retina in primates and other animals meets the criteria for a grand challenge quite well. As noted in the overview, to qualify for our category of grand challenge a problem should have the following features:

- A one decade time scale
- Grand challenges cannot be open-ended
- One must be able to see one's way, albeit murkily, to a solution.
- Grand challenges must be expected to leave an important legacy.

We begin by considering our understanding of the current state of knowl-

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Figure 5-15: Architecture of the retina from [24]. Cells in the retina are arrayed in discrete layers. The photoreceptors are at the top of this rendering, close to the pigment epithelium. The bodies of horizontal cells and bipolar cells compose the inner nuclear layer. Amacrine cells lie close to ganglion cells near the surface of the retina. Axon-to-dendrite neural connections make up the plexiform layers separating rows of cell bodies.

edge as regards the retina. Our assessment is that the state of understanding is rather well advanced. As explained article of Kolb [24], many of the detailed cellular structures in the retina are well established. In the figure from Kolb's article (Figure 5-15) we see the layered structure of the retina which takes light input to the rods (senses black and white) and cones (senses red, green, and blue in primates) and through modulation through the bipolar cells and ganglion cells transforms the input to spike trains propagated to the brain along the optic nerve. There are roughly 130 million receptors and 1 million optic nerve fibers. Kolb notes that we can say we are halfway to

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the goal of understanding the neural interplay between all the nerve cells in the retina. We interpret this as meaning that experimental scientists are well along in collecting, collating, and fusing data about the structure and interaction of the neurons in the retina.

The next step in our outline is also reasonably well established. There seems to be general agreement about the structure of many retinas in various animals, and there is the beginning of a web based documentation on retinal genes and disorders: (see for example [21]). We could not find a database of neural structures in various animals along with details about the electrophysiology of the neurons in the circuits. So, this step in the development of useful models requires further development. This aspect of the grand challenge certainly does not need high performance computing. A database in this arena could be assembled consisting of experimentally observed spike trains propagating along optical nerve fibers associated with some class of agreed-upon test scenes presented to experimental animals.

We next address the issue of simulation. Here, one can find many models for a few photoreceptors and associated bipolar, horizontal, amacrine, and ganglion cells, and even excellent work building small pieces of the retina in silicon. The paper in [9] is a recent example of this. We have not found any really large scale model of the retina in software or in hardware. If one wishes to simulate the whole human retina with 125 million receptors and associated processing neural circuitry leading to 1 million nerve fibers carrying spike visual information trains down the optical fiber, then to represent one minute of retinal activity with one hour of computing time one will need approximately 7-10 TFlops. This resolves the behavior of realistic neurons at a temporal resolution of 50 microseconds. The problem is eminently parallelizable as the computing units in the retina are similar in structure, not in actual physical density. Equivalently, for model development and parameter exploration, one could use the same computational power for a second of retinal activity realized in one minute. This level of computing power is commercially available today in a 1024 (dual processor) node IBM e1350.

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This is somewhat beyond conventional clusters found in many laboratories, but requires no specialized computer development. Delivery of a 128 node 1.1 TFlop system was taken recently by NCAR and performance at the level of 7-10 TFlops has been achieved by several groups including the national laboratories several years ago. At this stage there is nothing we can say about prediction and design, though recent work (see [9]) may provide a start in this direction.

What is it that the DOE would need to do the develop the Retinal Decade (the 10 year period for the Digital Retina grand challenge)? The key ingredients go well beyond the required computational facility which would be achievable using present-day HPC resources. It would require an organization with extensive experimentation, as emphasized in the outline of a grand challenge in life sciences, that is well-coupled to the numerical modeling. The JGI is perhaps a model for this in that the sequencing machines were a critical part of the story but not the only critical part. The organization, training, well-defined goal setting, and a long term e.ort were critical.

It is appropriate to ask why one ought to consider the retina and not, for example, the entire visual system or, even, the cortex? The latter systems are simply not "ready for prime time" as a grand challenge in our view. Item one on the list of grand challenge criteria is drastically incomplete; the knowledge of the anatomy of the full visual system is reasonably known, though certainly not as well as the retina alone, and the detailed electrophysiology needed to make realistic models is absent. A similar situation holds for the cortex as a whole, though even there the anatomy is not fully developed.

The retina is a processing system which dissects a visual scene and transforms it into spike trains propagated along the optic nerve. If we can understand, in simulation and predictive models, how this is done in detail and through perturbations on that model why it is done the way nature does it and what other variations on this theme might exist, we will have for the first time fully characterized a neural circuit more complex than collections

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of tens to perhaps a few thousand neurons in invertebrate systems.

Further, we will have provided the basis for design principles for other visual processing systems using the ingredients of the model system. Our ability to go from the modeling, and reverse engineering of the retina, to designing new systems using the principles discovered, would constitute an important understanding of a critical circuit in ourselves. This would surely have implications for treatment of disease which we do not attempt to draw here. In addition, it would have equally important uses in the design of optical sensing systems for robots useful in commercial and military environments.

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# 6 SYSTEMS BIOLOGY

In this section we review some of the work that was briefed to us on systems biology. This is an important area now in its developmental stages. Although systems biology means di.erent things to di.erent people, most would agree that it concerns the functioning of systems with many components. Practitioners of systems biology today are working primarily on subcellular and cellular systems (as opposed to, say, ecological systems, which are in themselves also very interesting biologically as well as from a systems perspective). Articulated goals of this field include elucidating specific signal transduction pathways and genetic circuits in the short term, and mapping out a proposed circuit/wiring diagram of the cell in the longer term. The essential idea is to provide a systematic understanding andmodeling capability for events depicted in Figure 6-16: when a cell interacts with some agent such as a growth factor or a nutrient gradient, a complex series of signaling events take place that ultimately lead to changes in gene expression which in turn results in the cellular response to the stimulus. An example may be the motion of a cellular flagellum as the cell adjusts its position in response to the gradient.

The information leading to the reconstruction of the wiring diagram that describes the cellular response programs includes

1. data from various high throughput technologies (e.g., DNA microarray, CHiP-on-chip, proteomics),
2. results from the vast literature of traditional experimental studies,
3. homology to related circuits/networks worked out for di.erent organisms.

The desired output of these approaches is a quantitative, predictive compu-

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Figure 6-16: Cellular signaling - figure from presentation of Prof. Subramanian (UCSD).

tational models connecting properties of molecular components to cellular behaviors. Given this scope, a large part of systems biology being practiced today is centered on how to integrate the vast amount of the heterogeneous input data to make computational models. We were briefed by Prof. Shankar Subramanian who described the work of the Alliance for Cellular Signaling. This program aims to determine quantitative relationships between inputs and outputs in cellular behavior that vary temporally and spatially. The ultimate goal of this program is to understand how cells interpret signals in

a context-dependent manner. One very important aspect is organizing the vast amount of data that arise in investigations of cellular signaling phenomena. As we comment later, quantifying the function and topology of cellular signaling networks is challenging. In order to assist with this goal, the Alliance has organized an enormous amount of data that can then be used by
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the community to test hypotheses on network structure and function. The computational requirements here are dictated mainly by the need to store and interrogate the data. We anticipate that over time there will be a need to make this type of data centrally available to researchers so that it can be easily obtained and assessed. This argues for a network-based information infrastructure linking searchable databases. In our briefings we heard several times about the need for such a facility - a “bioGoogle”. Such a facility would be a significant undertaking and would certainly require multi-agency cooperation.

Other software development e.orts include the M-Cell project (briefed to us by Dr. Terry Sejnowski) which focuses on modeling of neural synapses and the Biospice program as briefed to us by Dr. Sri Kumar of DARPA/IPTO. The goal of BioSpice is to provide a software platform to explore network dynamics as inferred from high throughput gene expression data. The major computational needs in these endeavors are

• bioinformatic processing of the high throughput data
• detailed stochastic simulation of network dynamics

There is little question that significant HPC requirements emerge in this endeavor even for bacterial systems such as E. Coli. Experiments indicate that, as the cell responds to a stimulus, the interconnection networks can become quite complex leading to complex optimization problems as one attempts to infer the network topology and system parameters from the data. If one then couples a predictive network model with a spatially and temporally realistic model of a cellular organism this will easily require HPC resources. Extrapolating in this way, the simulation requirements for multicellular organisms are even more daunting.

This would imply a ready arena for significant investment in HPC. It is, however, worthwhile to question the premise on which much of the above-
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mentioned program on systems biology is built upon. That is, that circuits and networks are, in fact, appropriate system-level descriptors that will enable quantitative, predictive modeling of biological systems. We discuss this in the section below and then close this section with discussion of a potential HPC grand challenge of simulating bacterial chemotaxis utilizing current approaches to systems biology.

### 6.1 The Validity of the Circuit Approach

To be sure, a network-based perspective beyond the single-gene paradigm of traditional molecular biology is crucial for understanding biology as a system. However, circuit diagrams are not necessarily the appropriate replacement. To appreciate this issue, it is instructive to examine the key ingredients that make circuit diagrams such a powerful descriptor for engineered electrical/electronic systems, e.g., integrated circuits:

• Components of an integrated circuit, e.g., transistors, are functionally simple. In digital circuits for example, a typical transistor (when properly biased) performs simple Boolean operations on one or two inputs. Moreover, the physical characteristics of a component relevant to its function can be summarized by a few numbers, e.g., the threshold voltage and gain. Thus, each component of a circuit can be quantitatively described by a standard model with a few parameters.
• These components operate in a well-insulated environment such that it is possible to specify only a few designated connections between the components; this property allows a clear definition of the connectivity of the component, i.e., the “circuit”.
• Complexity of an integrated circuit arises from the iterated cascades of a large number of fast and similar components (e.g., 107 transistors
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switching at rates of typically a GHz). As the properties of the components are well characterized, the connectivity of these components is the principle determinant of system function.

• Even with the knowledge of a circuit diagram and the properties of the components, a complex circuit with various levels of feedback is still di.cult to model quantitatively ab initio because circuits with cycles generally exhibit time-dependent behavior with unstable/unknown outputs. The proper function of a complex circuit generally requires its inputs to satisfy certain constraints. It is only with the knowledge of these constraints and the intended functions of the system can a complex circuit be understood and modeled quantitatively4

At present, it appears that few of the above features that make electronic circuits amenable to quantitative modeling are available today for evolved bio-molecular networks. We will illustrate the situation by examining the regulation of the lac operon [28], perhaps the best-characterized molecular control system in biology. The lac operon of E. coli encodes genes necessarily for the transport and metabolism of lactose, a carbon source which E. coli utilizes under the shortage of the default nutrient, glucose. The expression of the lac operon is under the control of the Plac promoter, whose apparent function is the activation of the operon in the presence of lactose, the "inducer". This is achieved molecularly via a double-negative logic as illustrated in Figure 6-17.

In the absence of the inducer, the transcription factor LacI binds strongly to Plac and prevents the access of the RNA polymerase required for transcription initiation. The inducer binds to LacI and drastically reduces its a.nity for the specific DNA sequences contained in Plac, thereby opening up the promoter for transcription. The positive e.ect of lactose on the expression of the lac operon can be easily detected by modern DNA microarray

4In this context, we were briefed by Prof. Shuki Bruck of Caltech on possible principles for design of reliable circuit function even in the presence of feedback cycles. This work is in an early state and is reflective of the need to understand better biological "circuitry".

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Figure 6-17: Schematic of the lac operon and its control by LacI and the inducer lactose.

experiments [47]. With some work, it is likely that the binding of LacI to Plac and its repressive e.ect on gene expression can also be discovered by high throughput approaches such as the ChIP-on-chip method [34]. Thus, the qualitative control scheme of Figure 6-17 is "discoverable" by bioinformatics analysis of high-throughput data. However, this information is far short of what is needed to understand the actual e.ect of lactose on the lac operon, nor is it su.cient to understand how the LacI-Plac system can be used in the context of large genetic circuits. We list below some of the key issues:

Di.culty in obtaining the relevant connectivity A key ingredient of the control of Plac by lactose is the fact that lactose cannot freely di.use across the cell membrane. The influx of lactose requires the membrane protein lactose permease which is encoded by one of the genes in the lac operon [29]. Hence there is a positive feedback loop in the lactose-control circuit (cf. Figure 6-18). A small amount of lactose leaking into the cell due to a basal level of the lac permease will, in the presence of glucose shortage, turn on the lac operon which results in the infusion of more lactose. The positive feedback, coupled with a strongly nonlinear dependence of the promoter activity on intracellular lactose concentration, gives rise to a bistable behavior where individual cells switch abruptly between states with low and high promoter activities [32]. However, the onset of the abrupt transition is dependent on stochastic events at the transcriptional and translational level [43],

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Figure 6-18: Influx of lactose requires the lac permease encoded by lacY.

so that at the population level, one finds instead a gradual increase of gene expression upon increase in extracellular lactose levels [22]. It is unclear how this positive feedback loop could have been determined by automated methods. It would require the knowledge of the intracellular lactose concentration and of the function(s) of the genes in the lac operon, which in turn require detailed biochemistry and genetics experiments. Without appreciating these issues, blindly fitting the smooth population-averaged behaviors to simple models of transcriptional initiation certainly will not generate reliable, predictive results. It should be noted that the function of the gene lacA in the lac operon is still not clear even today, and other mechanisms exist to change the intracellular lactose concentration (e.g., other di.usible inducers and the lactose e.ux pump). Thus, further feedback control may well exist and the above circuit may still be incomplete.

Di.culty in reliable quantitation There are also problems with the characterization of the Plac promoter independent of the lactose transport problem. The gratuitous inducer isopropyl-b-D-thiogalactopyranoside (IPTG) can di.use freely across cell membrane and bind to LacI, thereby activating transcription. The IPTG dependence of Plac activity has been studied by many groups. However, the results vary widely. For instance, reported values of fold-activation between no IPTG and 1mM IPTG can range from several tens to several thou-

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sands (see e.g., [37, 32, 47, 30]) on the same wild-type strain, and even more varied outcomes are obtained for di.erent strains, under di.erent (glucose-free) growth media, for di.erent inducers and reporters. Biologists are usually aware of these di.erences, and the quantitative fold-changes are typically not taken seriously except that the promoter is “strongly activated” by the inducer. Thus, the problem of quantitation is not simply a “cultural issue” - that is, that biologists are not su.ciently quantitative. Rather, it is the complexity of the system that often makes reliable quantitation di.cult. Also illustrated in this example is the danger of extracting quantitative results using automated literature search tools. Given the sensitive dependence of the systems on the details of the experiments, it is crucial to obtain the precise context of an experiment.

Di.culty in predicting function of a given circuit While dissecting real gene circuits in vivo is complicated by all sorts of unknown interactions, it is possible to set up artificial gene circuits and study their properties in vivo [19]. Given that the synthetic systems are constructed with reasonably well-characterized components which have clearly designated connections, they become a natural testing ground for quantitative computational modeling. A successful experiment in synthetic biology typically begins with a theoretically motivated circuit topology. It then takes several rounds of tweaking to make the construct behave in the designed manner. This is of course a standard practice for engineering of any man-made systems. However, the process also underscores how the behavior of the system depends on details, such that circuit topology is not a su.cient determinant of system properties.

An explicit illustration of how the same circuit topology can give rise to di.erent system-level behaviors is the experiment of [18] examining circuits consisting of the same 3 repressors but connected in a variety of di.erent ways. They looked for the ability of these circuits to perform Boolean operations on two input variables (the concentrations of two ligands IPTG and aTc). What they found was that the same

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Figure 6-19: An explicit illustration of how the same circuit topology can give rise to di.erent behaviors.

circuit topology can give rise to di.erent logic functions (cf. Figure 6-19). In fact, out of the 15 distinct promoter combinations possible for their system, every circuit topology for which they made multiple realizations exhibited more than one type of behavior. Thus, the property of a circuit depended not only on its topology, but also other details that the circuit designers do not know about or over which they have no control. Possible factors include the relative strengths of expression and repression, leakiness of the di.erent promoters, the turnover rates of the di.erent mRNA and proteins, the order of genes on the plasmid, etc. Given that the promoters and genes used in the experiment (LacI, TetR, the lCI) are among the best characterized in molecular biology and yet naive expectations are not always realized, we believe it will generally be di.cult to predict circuit properties based on connectivity information alone.

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6.2 A Possible Grand Challenge: Bacterial Chemotaxis

With the above considerations we can consider the possible grand challenge of simulating a complex process such as bacterial chemotaxis. The problem has a well defined set of inputs, namely, the concentration field impinging on a cell membrane. The desired prediction is the dynamic response of the bacterial organism as a function of time. As discussed above, high throughput analysis has provided a wealth of data on the relevant molecular biology as the cell encounters various inputs in the medium.

However, as discussed above, the critical issue is a predictive approach to modeling cellular signaling. The cellular signaling process is at present not satisfactorily modeled, in our opinion, via a "parts list" connected via a discoverable network. The discussion of section 6.1 implies that additional investigation is clearly required into the details of the chemical networks that govern cellular signaling making investment of HPC resources to support a grand challenge in this area premature at the present time. There is no question that such a study is science-driven and its success would leave a clear legacy in the field. Indeed, once an appropriate modeling approach is identified that deals correctly with the issues identified on the previous section, a full spatially accurate model of the cell governed by an appropriate chemotaxis model would certainly require HPC resources in order to track the three dimensional response of the cellular system and its resulting dynamics in the medium.

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7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

In this section we provide a set of findings and conclusions for this study. We begin with some general observations and impressions about biology and the role of computation. First, biology is a data rich subject that poses challenges to the creation of models. For example, experiments turn up surprises all of the time and many zeroth order questions remain to be answered. This was underscored in many of our briefings (particularly those on systems biology). As a result, experiment remains the primary guide and information resource. From the (admittedly limited) set of briefings we received, we could not identify a situation in biology for which capability computation is currently a key factor limiting progress.

For computational modeling to be successful, there must be a plausible paradigm or model. For example, in particle physics, there is a long history of experimental and theoretical work leading up to universal agreement that a particular non-Abelian gauge-theory Lagrangian was a useful model to solve precisely and there was (and still is) extensive work to devise the proper numerical discretization. This work was essential for the productive application of large-scale computation. In almost all of the biology we heard about, the paradigm did not seem to be su.ciently firm to warrant large capability computational e.ort at this point.

Another principle is that the "right problem should be tackled at the right time with the right tools." As noted above, immature paradigms are a widespread feature at this point. But, in addition, supporting data are often

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lacking. For example, there is little doubt that neuronal interactions are the basis of mammalian brains, but the details of synaptic interactions, plasticity, etc. will be needed before large-scale modeling can be maximally productive. We do note that some special subsystems like the retina may be ready for large scale computation, but overall this fields remains driven by experiment and data collection. Similarly, metabolic pathways alone are not su.cient for systems-biology modeling; plausible values (or estimates) for reaction rates, di.usion constants, etc. will be necessary. At the present time, the right set of computational tools for the ongoing investigations appears to be at the level of workstations or clusters as opposed to capability platforms. We do note the potential importance of Grid computation.

We can generally identify a hierarchy of tasks to which computers and computation can be applied.

Data collection, collation, fusion Because biology is a data-rich subject with few mature paradigms, data are the touchstone for understanding. These data take many forms, from databases of sequence and structure to text literature. Further, the data are growing exponentially, due in part to advances in technology (sequencing capability, expression arrays, etc.) Collecting, organizing, fusing such data from multiple sources and making them easily accessible both to the bench researcher and the theoretician in a convenient format is an important and non-trivial information-science task, although not within the realm of traditional computational science.

Knowledge extraction The automated (or assisted) identification of patterns in large datasets is another large-scale computational task. Examples include genomic sequence homologies, structural motifs in proteins, and spike-train correlations in multi-electrode recordings. At some level, this activity must be guided by paradigms.

Simulation Here, a physical model is typically used to embody experimen-

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tal knowledge. One obvious use to su.ciently encapsulate the existing phenomenological information. But more important is the understanding stemming from the construction and validation of the model.

Prediction With a validated model, one can make predictions. That is, what is the response of the system when it is changed or subject to external perturbation?

Design This is probably the highest level of computation. Here one investigates deliberate perturbations and/or combinations of existing systems to modify function. Validated models are essential at this level.

At present, our overall impression is that computation is playing an essential role in the first two aspects and increasing roles in the third. Given this emphasis, investments in capacity level and Grid-based computing seem most appropriate at this time. As modeling and understanding improve we expect to see much more utilization of computation to support simulation, prediction and ultimately, design.

7.2 Findings

Role of computation: Computation plays an increasingly important role in modern biology at all scales. High-performance computation is critical to progress in molecular biology and biochemistry. Combinatorial algorithms play a key role in the study of evolutionary dynamics. Database technology is critical to progress in bioinformatics and is particularly important to the future exchange of data among researchers. Finally, software frameworks such as BioSpice are important tools in the exchange of simulation models among research groups.

Requirements for capability: Capability is presently not a key limiting factor for any of the areas that were studied. In areas of molecular biol-

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ogy and biochemistry, which are inherently computationally intensive, it is not apparent that substantial investment will accomplish much more than an incremental improvement in our ability to simulate systems of biological relevance given the current state of algorithms and architecture. Other areas, such as systems biology will eventually be able to utilize capability computing, but the key issue there is our lack of understanding of more fundamental aspects, such as the details of cellular signaling processes.

Requirements for capacity: Our study did reveal a clear need for additional capacity. Many of the applications reviewed in this study (such as image analysis, genome sequencing, etc.) utilize algorithms that

are essentially "embarrassingly parallel" algorithms and would profit simply from the increased throughput that could be provided by commodity cluster architecture as well as possible further developments in Grid technology.
Role of grand challenges: It is plausible (but not assured) that there exist suitable grand challenge problems (as defined in section 2.3) that will have significant impact on biology and that require high-performance capability computing.
Future challenges: For many of the areas examined in this study, significant research challenges must be overcome in order to maximize the potential of high-performance computation. Such challenges include overcoming the complexity barriers in current biological modeling and understanding the detailed dynamics of components of cellular signaling networks.

7.3 Recommendations

JASON recommends that DOE consider four general areas in its evalu-
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ation of potential future investment in high performance bio-computation:

1. Consider the use of grand challenge problems to make the case for present and future investment in HPC capability. While some illustrative examples have been considered in this report, such challenges should be formulated through direct engagement with (and prioritization by) the bioscience community in areas such as (but not limited to) molecular biology and biochemistry, computational genomics and proteomics, computational neural systems, and systems or synthetic biology. Such grand challenge problems can also be used as vehicles to guide investment in focused algorithmic and architectural research, both of which are essential to successful achievement of the grand challenge problems.
2. Investigate further investment in capacity computing. As stated above, a number of critical areas can benefit immediately from investments in capacity computing, as exemplified by today's cluster technology.
3. Investigate investment in development of a data federation infrastructure. Many of the "information intensive" endeavors reviewed here can be aided through the development and curation of datasets utilizing community adopted data standards. Such applications are ideally suited for Grid computing.
4. Most importantly, while it is not apparent that capability computing is, at present, a limiting factor for biology, we do not view this situation as static and, for this reason, it is important that the situation be revisited in approximately three years in order to reassess the potential for further investments in capability. Ideally these investments would be guided through the delineation of grand challenge problems as prioritized by the biological research community.

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A APPENDIX: Briefers

Briefer A.liation Briefing title
David Haussler UC Santa Cruz Genomes primer
Mayank Mehta Brown University Neurophysics of learning
Terry Sejnowski Salk Institute Modeling mesoscopic biology
John Doyle Caltech Systems biology
Garrett Kenyon Los Alamos Nat'l Lab Computational neuroscience
Mike Colvin Livermore and UC Merced Molecular dynamics
Eric Jakobsson NIH The BISTI Initiative
Shankar Subramanian UCSD Alliance for cell signaling
David Dixon Univ. Alabama Computational biochemistry
Wah Chiu Baylor Univ. Imaging and crystallography
Dan Rohksar Lawrence Berkeley Lab Sequencing of Ciona
Peter Wolynes UCSD Protein folding
Steve Mayo Caltech Protein structure and design
Jehoshua Bruck Caltech Biological circuits

John Wooley UCSD Advanced computation for biology
Nathan Baker Washington Univ. Multiscale modeling of biological systems
Klaus Schulten Univ. Illiois Theoretical molecular biophysics
Sri Kumar DARPA DARPA Biocomputation
Tandy Warnow Univ. Texas (Austin) Assembling the tree of life
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References

[1] B. Allen et al. http://boinc.berkeley.edu.
[2] F. Allen et al. BlueGene: A vision for protein science using a petaflop supercomputer. IBM Systems Journal, 40(2):310—327, 2001.
[3] W. Andreoni, A. Curioni, and T. Mordasini. IBM J. Res. Dev., 45:397—407, 2001.
[4] J.J. Austin, A.J. Ross, A.B. Smith, R.A. Fortey, and R.H. Thomas. Problems of reproducibility - does geologically ancient dna survive in amber-preserved insects. Proc R Soc Lond B Biol Sci, 264:467—474, 1997.
[5] M. Blanchette, E.D. Green, W. Miller, and D. Haussler. Reconstructing large regions of an ancestral mammalian genome in silico. Genome Res., 2004.
[6] C Brooks et al. http://predictor.scripps.edu.
[7] R. Car and M. Parinello. Unified approach for molecular dynamics and density-functional theory. Phys. Rev. Lett., 55:2471—2474, 1985.
[8] G. Cicero, A. Catellani, , and G. Galli. Atomic control of water interaction with biocompatible surfaces: the case of sic(001). Phys. Rev. Lett., 93:016102, 2004.
[9] Delbruck and Liu. Vision Research, 2004.
[10] P. A. M. Dirac. Proc. R. Soc. London, Ser. A, 123:714.
[11] Y Duan and PA Kollman. Pathways to a protein folding intermediate observed in a 1-microsecond simulation in aqeous solution. Science, 282(5389):740—744, Oct. 1998.
[12] E Eizirik, WJ Murphy, and O'Brien SJ. Molecular dating and biogeography of the early placental mammal radiation. Journal of Heredity, 92:212—219, 2001.
83
[13] R. Elber, A. Ghosh, A. Cardenas, and H. Stern. Bridging the gap between reaction pathways, long time dynamics and calculation of rates. Adv. Chem. Phys., 126:93—129, 2003.
[14] M. J. Field, P. A. Bash, and M. Karplus. Combined quantum mechanical and molecular mechanical potential for molecular dynamics simulations. J. Comput. Chem., 11:700—733, 1990.
[15] W. M. C. Foulkes, L. Mitas, R. J. Needs, and G. Rajagopal. Quantum monte carlo simulations of solids. Rev. Mod. Phys., 73:33—83, 2001.
[16] J. C. Grossman, M. Rohlfing, L. Mitas, S. G. Louie, and M. L. Cohen. High accuracy many-body calculational approaches for excitations in molecules. Phys. Rev. Lett., 86:472, 2001.
[17] J. C. Grossman, E. Schwegler, E. W. Draeger, F. Gygi, and G. Galli. Towards an assessment of the accuracy of density functional theory for first principles simulations ofwater. Chem. Phys., 120:300—311, 2004.
[18] C. Guet et al. Combinatorial synthesis of genetic networks. Science, 296:1466—1470, 2002.
[19] J Hasty, D McMillen, and JJ Collins. Engineered gene circuits. Nature, 420:224—230, 2002.
[20] International Human Genome Sequencing Consortium (IHGSC). Initial sequencing and analysis of the human genome. Nature, 409:860—921, 2001.
[21] Retina International. http://www.retina-international.org/sci-news/anim-dat.htm.
[22] A Khlebnikov and JD Keasling. E.ect of lacy expression on homogeneity of induction from the p(tac) and p(trc) promoters by natural and synthetic inducers. Biotech Prog., 18:672—4, 2002.
[23] W. Kohn and L. J. Sham. Self consistent equations including exchange

and correlation e.ects. Phys. Rev. A, 140:1133—1138, 1965.
84
[24] H. Kolb. How the retina works. American Scientist, 91:28—35, 2003.
[25] I. Marota and F. Rollo. Molecular paleontology. Cell Mol Life Sci., 59:97, 2002.
[26] G. Monard and K. M. Merz Jr. Combined quantum mechanical/ molecular mechanical methodologies applied to biomolecular systems. Accts Chem. Res., 32:904—911, 1999.
[27] Brent MR and Guigo R. Recent advances in gene structure prediction. Curr Opin Struct Biol., 14, 2004.
[28] B. Muller-Hill. The lac operon: A short history of a genetic paradigm. 1996.
[29] A Novick and M Weiner. Enzyme induction as an all-or-none phenomenon. PNAS, 43:553—566, 2001.
[30] S. Oehler, E. R. Eismann, H Kramer, and B Muller-Hill. The three operators of the lac operon cooperate in repression. EMBO J, 9:973—979, 1990.
[31] National Institutes of Health. http://www.ncbi.nlm.nih.gov/traces.
[32] E M Ozbudak, Thattai M, H Lim, BI Shraiman, and A van Oudenaarden. Multistability in the lactose utilization network of Escherichia coli. Nature, 427:737—740, 2004.
[33] VS Pande. http://folding.stanford.edu.
[34] B Ren, F Robert, JJ Wyrick, O Aparicio, EG Jennings, I Simon, J Zeitlinger, J Schreiber, N Hannett, E Kanin, TL Volkert, CJ Wilson, SP Bell, and RA Young. Genome-wide location and function of dna binding proteins. Science, 290:2306—2309, 2000.
[35] C. Rovira and M. Parinello. Harmonic and anharmonic dynamics of fe-co and fe-o2 in heme models. Biophys. J., 78:93—100, 2000.
85
[36] R. Schwitters et al. Requirements for ASCI. Technical report, JASONMITRE, 2003.
[37] Y. Setty, A.E. Mayo, M.G. Surette, and U. Alon. Detailed map of a cis-regulatory input function. Proc. Natl. Acad. Sci., 100:7702—7707, 2003.
[38] K. Siva and R. Elber. Ion permeation through the gramicidinchannel: atomically detailed modeling by the stochastic di.erenceequation. Proteins Structure Function Genetics, 50:63—80, 2003.
[39] C. Stubbs et al. The computational challenges of medical imaging. Technical report, JASON-MITRE, 2004.
[40] J. Tse. Ab initio molecular dynamics with density functional theory. Annu. Rev. Phys. Chem., 53:249—290, 2002.
[41] J Tyson et al. Community structure and metabolism through reconstruction of microbial genomes from the environment. Nature, 428:37—34, 2004.
[42] J C Venter et al. Environmental genome shotgun sequencing from the sargasso sea. Science, 304:66, 2004.
[43] JM Vilar, CC Guet, and S Leibler. Modeling network dynamics: the lac operon, a case study. J Cell Biol., 161:471—6, 2003.
[44] M. Wagner, J. Meller, and R. Elber. Large-scale linearprogramming techniques for the design of protein folding potentials. Math. Program., in press.
[45] A. Warshel and M. Levitt. Theoretical studies of enzymatic reactions: dielectric electrostatic and steric stabilization of carbonium ion in the reaction of lysozyme. J. Mol. Bio., 103:227—249, 1976.
[46] J. Watson et al. Molecular Biology of the Gene. Pearson, Bejamin Cummings, 2004.
86
[47] Y Wei, J-M Lee, C Richmond, FR Blattner, JA Rafalski, and RA LaRossa. High-density microarray-mediated gene expression profiling of e. coli. J. Bacteriol., 183:545—56, 2001.
[48] A. J. Williamson, R. Q. Hood, and J. C. Grossman. Linear-scaling quantum monte carlo calculations. Phys. Rev. Lett., 87:246406, 2001.

[49] J. Wooley. Frontiers at the interface between computing and biology.
Technical report, NRC, Washington, DC, 2004.
[50] V. Zaloj and R. Elber. Parallel computations of moleculardynamics
trajectories using stochastic path approach. Comp. Phys. Commun.,
128:118—127, 2000.
87

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**PROCTER & GAMBLE -** *links with the US eugenics movement*

One of the most alarming of the Elite's doctrines is that of eugenics - controlling human reproduction in order to reduce the number of those that the Elite perceive as inferior to create a 'master race' with 'desirable' genetic characteristics. Eugenics had its highest public profile in Nazi Germany but the policies began a long time before Hitler and are continuing to the present day.

The philosophy was pioneered by Thomas Malthus in the 18th/19th centuries who sought to encourage disease and child mortality in the poor. So-called *Malthusianism* has since been adopted by different organisations for a variety of excuses. After various eugenics policies in the US states in the late 19th century, including the compulsory sterilisation of the mentally ill and 'undesirables' in Indiana, the Rockefellers established a eugenics research centre in New York. They were supported in this venture by the Harrimans, another family of manipulators.

The First International Congress of Eugenics was held in London in 1912 and was attended by a certain Winston Churchill. By 1917, fifteen US states had eugenics laws to sterilise epileptics, the mentally ill and regular criminals. On the agenda of the Third International Congress in 1932 was the 'problem' of African-Americans which, according to the delegates, revealed a need to sterilise to 'cut off bad stock'. At this meeting were several Nazis, including Dr Ernst Rudin, who had been enabled to attend by the Hamburg-Amerika Shipping Line, owned by the Harriman and Bush families. On returning to Germany, Rudin, who was funded by the Rockefellers, supervised the policy of sterilising those who were retarded, deaf, blind or alcoholics.

Between 1941 and 1943, at the same time as the 'master race' mentality in Hitler's Germany was being condemned by the rest of the world, 42,000 people were sterilised in the US. Five years later the Sterilisation League/ Birthright Inc. established a eugenics centre in North Carolina. This was part funded by the Gray family, close friends of the Bush's.

In 1946-1947, Gordon Gray founded the Bowman Gray (Memorial) Medical School in Winston Salem, North Carolina. This became the centre for eugenics. It kept records of children with "inherited" diseases and began a project to forcibly sterilise young children who were considered to have a low IQ.

Boydon’s great aunt, Alice Shelton Gray founded the Human Betterment League and was the official supervisor of the master race experiment at the Gray’s medical school. Others who were involved in this were Dr Claude Nash Herndon (assistant director at the school), and Dr Clarence Gamble (heir to the Procter & Gamble empire).

Children who enrolled in the Winston-Salem school district were given IQ tests and those who fell below desired levels were sterilised.

Dr Claude Nash Herndon (president of the Eugenics Society in 1953), in an interview in 1990 for the book *George Bush, The Unauthorised Biography* stated:

> *"...IQ tests were run on all the children in the Winston-Salem School system. Only the ones who scored really low* [were targeted for sterilisation], *the real bottom of the barrel, like below 70. Did we do sterilisations on young children? Yes. This was a relatively minor operation…It was usually not* [done] *until the child was eight or ten years old. For the boys, you just make an incision and tie the tube…We more often performed the operations on girls than with boys. Of course, you have to cut open the abdomen, but again, it is relatively minor."*

After the war, John D. Rockefeller III and John Foster Dulles campaigned against the extension of the non-white populations, and in 1952 launched the Population Council. This still exits and is still advocating zero population growth in the US, family planning in the developing sector and the expansion of the Club of Rome's 'Malthusianism'. (The Club of Rome was launched by the Freemason Aurelio Peccei in 1968. Its purpose is to issue propaganda about the environmental crisis to justify centralisation of power, the suppression of industrial development in the Third World and eugenics.)

Eugenics policies are funded by the World Bank which, at the Rio summit, pledged to double the money available to population control. Birth control is now forced on the developing countries through fear of economic sanctions.

The extent of the population control towards which the Elite are striving was revealed in the 1962/63 *'Report from Iron Mountain'* , a secret study group into controlling population without war. It sought completely artificial procreation to supersede the 'ecological function of war'. This was to include total control of contraception via water supplies and essential food stuffs so babies could only be conceived by those to whom a carefully controlled antidote had been administered. Such a system was apparently already under development… 35 years ago!

George Bush is a major voice in the eugenics movement and is surrounded by like-minded people - Boyden Gray (his legal advisor) and William Draper III (head of fund-raising for his 1980 presidential campaign). Draper's grandfather had unsuccessfully urged eugenics policies on Eisenhower before convincing Johnson to adopt them. In 1969 Bush was involved in hearings into the 'dangers of too many black babies' and when he became ambassador to the UN in 1972 he arranged for the Association of Voluntary Surgical Contraception (formerly the Sterilisation League) to extend its policy of sterilising young children with 'low' IQ to non-white countries. This was further extended when Bush became president in 1988.

Clarence Gamble's Pathfinder Fund was given funding from the USAID budget in order to infiltrate non-white societies and break down resistance to sterilisation.

# *Toward a Psycho-Civilized Society*

The background to the development of anti-personnel electromagnetic weapons can be traced by to the early-middle 1940's and possibly earlier. The earliest extant reference, to my knowledge, was contained in the U.S. Strategic Bombing Survey (Pacific Survey, Military Analysis Division, Volume 63) which reviewed Japanese research and development efforts on a "Death Ray."

Whilst not reaching the stage of practical application, research was considered sufficiently promising to warrant the expenditure of Yen 2 million during the years 1940-1945. Summarizing the Japanese efforts, allied scientists concluded that a ray apparatus might be developed that could kill unshielded human beings at a distance of 5 to 10 miles. Studies demonstrated that, for example, automobile engines could be stopped by tuned waves as early as 1943. (1) It is therefore reasonable to suppose that this technique has been available for a great many years. Research on living organisms (mice and ground hogs) revealed that waves from 2 meters to 60 centimeters in length caused hemorrhage of lungs, whereas waves shorter than two meters destroyed brain cells.

However, experiments in behavior modification and mind manipulation have a much more grisly past. Nazi doctors at the Dachau concentration camp conducted involuntary experiments with hypnosis and narco-hypnosis, using the drug mescaline on inmates. Additional research was conducted at Aushwitz, using a range of chemicals including various barbiturates and morphine derivatives. Many of these experiments proved fatal.

Following the conclusion of the war, the U.S. Naval Technical Mission was tasked with obtaining pertinent industrial and scientific material that had been produced by the Third Reich and which may be of benefit to U.S. interests. Following a lengthy report, the Navy instigated Project CHATTER in 1947. Many of the Nazi scientists and medical doctors who conducted hideous experiments were later recruited by the U.S. Army and worked out of Heidelberg prior to being secretly relocated to the United States under the Project PAPERCLIP program. Under the leadership of Dr. Hubertus Strughold, 34 ex-Nazi scientists accepted "Paperclip" contracts, authorized by the Joint Chiefs of Staff, and were put to work at Randolph Air Force Base, San Antonio, Texas. By 1953 the CIA, U.S. Navy and the U.S. Army Chemical Corps were conducting their own narco-hypnosis programs on unwilling victims that included prisoners, mental patients, foreigners, ethic minorities and those classified as sexual deviants. (2)

It was not until the middle or late 1970's that the American public became aware of a series of hitherto secret programs that had been conducted over the preceding two decades by the military and intelligence community. (3) Primarily focusing on narco-hypnosis, these extensive covert programs bore the project titles MKULTRA, MKDELTA, MKNAOMI, MKSEARCH (MK being understood to stand for Mind Kontrol), BLUEBIRD, ARTICHOKE and CHATTER. The principal aim of these and associated programs was the development of a reliable "programmable" assassin. Secondary aims were the development of a method of citizen control. (4)

Particularly relevant was Dr. Jose Delgado's secret work directed towards the creation of a "psycho-civilized" society by use of a "stimoceiver." (5) Delgado's work was seminal, and his experiments on humans and animals demonstrated that electronic stimulation can excite extreme emotions including rage, lust and fatigue. In his paper "Intracerebral Radio Stimulation and recording in Completely Free Patients," Delgado observed that: "Radio Stimulation on different points in the amygdala and hippocampus in the four patients produced a variety of effects, including pleasant sensations, elation, deep thoughtful concentration, odd feelings, super relaxation (an essential precursor for deep hypnosis), colored visions, and other responses."

With regard to the "colored visions" citation, it is reasonable to conclude he was referring to hallucinations -- an effect that a number of so-called "victims" allude to. (7) As far back as 1969, Delgado predicted the day would soon arrive when a computer would be able to establish two-way radio communication with the brain -- an event that first occurred in 1974. Lawrence Pinneo, a neurophysiologist and electronic engineer working for Stanford Research Institute (a leading military contractor), "developed a computer system capable of reading a person's mind. It correlated brain waves on an electroencephalograph with specific commands. Twenty years ago the computer responded with a dot on a TV screen. Nowadays it could be the input to a stimulator (ESB) in advanced stages using radio frequencies." (8)

In any event, narco-hypnosis was found, it is claimed, to be less than reliable, although some writers and observers dispute this. (9) Additional studies, conducted by Dr. Ewen Cameron and funded by the CIA, were directed towards erasing memory and imposing new personalities on unwilling patients. Cameron discovered that electroshock treatment caused amnesia. He set about a program that he called "de-patterning" which had the effect of erasing the memory of selected patients. Further work revealed that subjects could be transformed into a virtual blank machine (Tabula Rasa) and then be re-programmed with a technique which he termed "psychic driving." Such was the bitter public outrage, once his work was revealed (as a result of FOIA searches), that Cameron was forced to retire in disgrace.

Also of interest is Dr. John C. Lilly (10), who was asked by the Director of the National Institute of Mental Health to brief the CIA, FBI, NSA and military intelligence services on his work using electrodes to stimulate, directly, the pleasure and pain centers of the brain. Lilly said that he refused the request. However, as stated in his book, he continued to do "useful" work for the national security apparatus. In terms of timing this is interesting, for these events took place in 1953. Scientist Eldon Byrd, who worked for the Naval Surface Weapons Office, was commissioned in 1981 to develop electromagnetic devices for purposes including riot control, clandestine operations and hostage removal. (11)

From 1965 through to 1970, Defense Advanced Projects Research Agency (DARPA), with up to 70-80% funding provided by the military, set in motion operation PANDORA to study the health and psychological effects of low intensity microwaves with regard to the so-called "Moscow signal." This project appears to have been quite extensive and included (under U.S. Navy funding) studies demonstrating how to induce heart seizures, create leaks in the blood/brain barrier and production of auditory hallucinations. Despite attempts to render the Pandora program invisible to scrutiny, FOIA filings revealed memoranda of Richard Cesaro, Director of DARPA, which confirmed that the program's initial goal was to "discover whether a carefully controlled microwave signal could control the mind." Cesaro urged that these studies be made "for potential weapons applications." (12)

Following immense public outcry, Congress forbade further research and demanded that these projects be terminated across the board. But as former CIA agent Victor Marchetti later revealed, the programs merely became more covert with a high element of "deniability" built in to them, and that CIA claims to the contrary are a cover story. (13) Despite the fact that many of the aforementioned projects revolved around the use of narcotics and hallucinogens, projects ARTICHOKE, PANDORA and CHATTER clearly demonstrate that "psychoelectronics" were a high priority. Indeed, author John Marks' anonymous informant (known humorously as "Deep Trance") stated that beginning in 1963 mind control research strongly emphasized electronics.

An obscure District of Columbia corporation called Mankind Research Unlimited (MRU) and its wholly owned subsidiary, Systems Consultants Inc. (SCI), operated a number of classified intelligence, government and Pentagon contracts, specializing in, amongst other things: "problem solving in the areas of intelligence electronic warfare, sensor technology and applications." (14)

MRU's "capability and experience" is divided into four fields. These include "biophysics -- Biological Effects of Magnetic Fields," "Research in Magneto-fluid Dynamics," "Planetary Electro-Hydro-Dynamics" and "Geopathic Efforts on Living Organisms." The latter focuses on the induction of illness by altering the magnetic nature of the geography. Also under research were "Biocybernetics, Psychodynamic Experiments in Telepathy," "Errors in Human Perception," "Biologically Generated Fields," "Metapsychiatry and the Ultraconscious Mind" (believed to refer to experiments in telepathic mind control), "Behavioural Neuropsychiatry," "Analysis and Measurement of Human Subjective States" and "Human Unconscious Behavioural Patterns."

Employing some old OSS, CIA and military intelligence officers, the company also engages the services of prominent physicians and psychologists including E. Stanton Maxey, Stanley R. Dean Berthold Eric

Schwarz plus many more. MRU lists in its Company Capabilities "brain and mind control." (15) Despite vehement claims by MRU's chairman that it is not a "front organization for any branch of the United States Government..." (16) one must treat these claims with a great deal of skepticism.

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# *ROCKFELLER AND MASS MURDER*

by *Anton Chaitkin*

The Rockefeller Foundation is the prime sponsor of public relations for the United Nations' drastic depopulation program, which the world is invited to accept at the UN's scheduled September conference in Cairo, Egypt.

Evidence in the possession of a growing number of researchers in America, England, and Germany demonstrates that the Foundation and its corporate, medical, and political associates organized the racial mass murder program of Nazi Germany.

These globalists, who function as a conduit for British Empire geopolitics, were not stopped after World War II. The United Nations alliance of the old Nazi rightwing with the New Age leftwing poses an even graver danger to the world today than the same grouping did in 1941.

Oil monopolist John D. Rockefeller created the family-run Rockefeller Foundation in 1909. By 1929 he had placed $300 million worth of the family's controlling interest in the Standard Oil Company of New Jersey (later called "Exxon") to the account of the Foundation.

The Foundation's money created the medical specialty known as Psychiatric Genetics. For the new experimental field, the Foundation reorganized medical teaching in Germany, creating and thenceforth continuously directing the "Kaiser Wilhelm Institute for Psychiatry" and the "Kaiser Wilhelm Institute for Anthropology, Eugenics and Human Heredity." The Rockefellers' chief executive of these institutions was the fascist Swiss psychiatrist Ernst Rudin, assisted by his proteges Otmar Verschuer and Franz J. Kallmann.

In 1932, the British-led "Eugenics" movement designated the Rockefellers' Dr. Rudin as the president of the worldwide Eugenics Federation. The movement called for the killing or sterilization of people whose heredity made them a public burden.

**The Racial Laws**

A few months later, Hitler took over Germany and the Rockefeller-Rudin apparatus became a section of the Nazi state. The regime appointed Rudin head of the Racial Hygiene Society. Rudin and his staff, as part of the Task Force of Heredity Experts chaired by SS chief Heinrich Himmler, drew up the sterilization law. Described as an American Model law, it was adopted in July 1933 and proudly printed in the September 1933 Eugenical News (USA) with Hitler's signature. The Rockefeller group drew up other race laws, also based on existing Virginia statutes. Otmar Verschuer and his assistant Josef Mengele together wrote reports for special courts which enforced Rudin's racial purity law against cohabitation of Aryans and non-Aryans.

The "T4" unit of the Hitler Chancery, based on psychiatrists led by Rudin and his staff, cooperated in creating propaganda films to sell mercy killing (euthanasia) to German citizens. The public reacted antagonistically: Hitler had to withdraw a tear-jerker right-to-die film from the movie theaters. The proper groundwork had not yet been laid.

Under the Nazis, the German chemical company I.G. Farben and Rockefeller's Standard Oil of New Jersey were effectively a single firm, merged in hundreds of cartel arrangements. I.G. Farben was led up until 1937 by the Warburg family, Rockefeller's partner in banking and in the design of Nazi German eugenics.

Following the German invasion of Poland in 1939, Standard Oil pledged to keep the merger with I.G. Farben going even if the U.S. entered the war. This was exposed in 1942 by Sen. Harry Truman's investigating committee, and President Roosevelt took hundreds of legal measures during the war to stop the Standard-I.G. Farben cartel from supplying the enemy war machine.

In 1940-41, I.G. Farben built a gigantic factory at Auschwitz in Poland, to utilize the Standard Oil/I.G. Farben patents with concentration camp slave labor to make gasoline from coal. The SS was assigned to guard the Jewish and other inmates and select for killing those who were unfit for I.G. Farben slave labor. Standard-Germany president Emil Helfferich testified after the war that Standard Oil funds helped pay for SS guards at Auschwitz.

In 1940, six months after the notorious Standard-I.G. meeting, European Rockefeller Foundation official Daniel O'Brian wrote to the Foundation's chief medical officer Alan Gregg that "it would be unfortunate if it was chosen to stop research which has no relation to war issues" so the Foundation continued financing Nazi "psychiatric research" during the war.

In 1936, Rockefeller's Dr. Franz Kallmann interrupted his study of hereditary degeneracy and emigrated to America because he was half-Jewish. Kallmann went to New York and established the Medical Genetics Department of the New York State Psychiatric Institute. The Scottish Rite of Freemasonry published Kallman's study of over 1,000 cases of schizophrenia, which tried to prove its hereditary basis. In the book, Kallmann thanked his long-time boss and mentor Rudin.

Kallmann's book, published in 1938 in the USA and Nazi Germany, was used by the T4 unit as a rationalization to begin in 1939 the murder of mental patients and various "defective" people, perhaps most of them children. Gas and lethal injections were used to kill 250,000 under this program, in which the staffs for a broader murder program were desensitized and trained.

**Dr. Mengele...**

In 1943, Otmar Verschuer's assistant Josef Mengele was made medical commandant of Auschwitz. As wartime director of Rockefeller's Kaiser Wilhelm Institute for Anthropology, Eugenics and Human Heredity in Berlin, Verschuer secured funds for Mengele's experiments at Auschwitz from the German Research Council. Verschuer wrote a progress report to the Council: "My co-researcher in this research is my assistant the anthropologist and physician Mengele. He is serving as Hauptsturmfuehrer and camp doctor in the concentration camp Auschwitz.... With the permission of the Reichsfuehrer SS Himmler, anthropological research is being undertaken on the various racial groups in the concentration camps and blood samples will be sent to my laboratory for investigation."

Mengele prowled the railroad lines leading into Auschwitz, looking for twins -- a favorite subject of psychiatric geneticists. On arrival at Mengele's experimental station, twins filled out "a detailed questionnaire from the Kaiser Wilhelm Institute." There were daily drawings of blood for Verschuer's "specific protein" research. Needles were injected into eyes for work on eye color. There were experimental blood transfusions and infections. Organs and limbs were removed, sometimes without anesthetics. Sex changes were attempted. Females were sterilized, males were castrated. Thousands were murdered and their organs, eyeballs, heads, and limbs were sent to Verschuer and the Rockefeller group at the Kaiser Wilhelm Institute.

In 1946, Verschuer wrote to the Bureau of Human Heredity in London, asking for help in continuing his "scientific research."

**Facelift**

In 1947, the Bureau of Human Heredity moved from London to Copenhagen. The new Danish building for this was built with Rockefeller money. The first International Congress in Human Genetics following World War II was held at this Danish institute in 1956. By that time, Verschuer was a member of the American Eugenics Society, then indistingishable from Rockefeller's Population Council.

Dr. Kallmann helped save Verschuer by testifying in his denazification proceedings. Dr. Kallmann created the American Society of Human Genetics, which organized the "Human Genome Project" -- a current $3 billion physical multiculturalism effort. Kallmann was a director of the American Eugenics Society in 1952 and from 1954 to 1965.

In the 1950s, the Rockefellers reorganized the U.S. eugenics movement in their own family offices, with spinoff population-control and abortion groups. The Eugenics Society changed its name to the Society for the Study of Social Biology, its current name.

The Rockefeller Foundation had long financed the eugenics movement in England, apparently repaying Britain for the fact that British capital and an Englishman-partner had started old John D. Rockefeller out in his Oil Trust. In the 1960s, the Eugenics Society of England adopted what they called Crypto-eugenics, stating in their official reports that they would do eugenics through means and instruments not labeled as eugenics.

With support from the Rockefellers, the Eugenics Society (England) set up a sub-committee called the International Planned Parenthood Federation, which for 12 years had no other address than the Eugenics Society.

# Mind Control: The Current Situation

In July of 1991, two inmates died at the Vacaville Medical Facility. According to prison officials at the time, the two may have died as a result of medical treatment, that treatment was the use of mind control or behavior modification drugs. A deeper study into the deaths of the two inmates has unraveled a mind-boggling tale of horror that has been part of California penal history for a long time, and one that caused national outcries years ago.

In August of 1991, the Sentinel presented a graphic portrait of some of the mind control experiments that have been allowed to continue in the United States. On November 1974 a U.S. Senate Sub-committee on Constitutional Rights investigated federally-funded behavior modification programs, with emphasis on federal involvement in, and the possible threat to individual constitutional rights of behavior modification, especially involving inmates in prisons and mental institutions.
The Senate committee was appalled after reviewing documents from the following sources: The Neuro-Research Foundation's study entitled "The Medical Epidemiology of Criminals." The Center for the Study and Reduction of Violence at UCLA. The Closed Adolescent Treatment Center. Senate Investigations of the History of US Mind Control (Based on Testimony before the Senate Sub-Commmittee on Constitutional Rights).

A national uproar was created by various articles in 1974, which prompted the Senate investigation. But after all these years, the news that two inmates at Vacaville may have died from these same experiments indicates that though a nation was shocked in 1974, little was done to end the experimentations. In 1977, a Senate subcommittee on Health and Scientific Research, chaired by Senator Ted Kennedy, focussed on the CIA's testing of LSD on unwitting citizens. Only a mere handful of people within the CIA knew about the scope and details of the program. To understand the full scope of the problem, it is important to study its origins. The Kennedy subcommittee learned about the CIA Operation MK.-Ultra through the testimony of Dr. Sidney Gottlieb. The purpose of the program, according to his testimony, was to "investigate whether and how it was possible to modify an individual's behavior by covert means". Claiming the protection of the National Security Act, Dr. Gottlieb was unwilling to tell the Senate subcommittee what had been learned or gained by these experiments. He did state, however, that the program was initially engendered by a concern that the Soviets and other enemies of the United States would get ahead of the U.S. in this field. MK-ULTRA Past and Present (From testimony and files obtained under Freedom Of Information Act) Through the Freedom of Information Act, researchers are now able to obtain documents detailing the M.K.-Ultra program and other CIA behavior modification projects in a special reading room located on the bottom floor of the Hyatt Regency in Rosslyn, VA.

The most daring phase of the M.K.-Ultra program involved slipping unwitting American citizens LSD in real life situations. The idea for the series of experiments originated in November 1941, when William Donovan, founder and director of the Office of Strategic Services (OSS), the forerunner of the CIA during World War Two. At that time the intelligence agency invested $5000 for the "truth drug" program. Experiments with scopolamine and morphine proved both unfruitful and very dangerous. The program tested scores of other drugs, including mescaline, barbituates, benzedrine, cannabis indica, to name a few.

The U.S. was highly concerned over the heavy losses of freighters and other ships in the North Atlantic, all victims of German U-boats. Information about German U-boat strategy was desperately needed and it was believed that the information could be obtained through drug-influenced interrogations of German naval P.O.W.s, in violation of the Geneva Accords. Tetrahydrocannabinol acetate, a colorless, odorless marijuana extract, was used to lace a cigarette or food substance without detection. Initially, the experiments were done on volunteer U.S. Army and OSS personnel, and testing was also disguised as a remedy for shell shock. The volunteers became known as "Donovan's Dreamers". The experiments were so hush-hush, that only a few top officials knew about them. President Franklin Roosevelt was aware of the experiments. The "truth drug" achieved mixed success.

The experiments were halted when a memo was written: "The drug defies all but the most expert and search analysis, and for all practical purposes can be considered beyond analysis." The OSS did not, however, halt the program. In 1943 field tests of the extract were being conducted, despite the order to halt them. The most celebrated test was conducted by Captain George Hunter White, an OSS agent and ex-law enforcement official, on August Del Grazio, aka Augie Dallas, aka Dell, aka Little Augie, a New York gangster.
Cigarettes laced with the acetate were offered to Augie without his knowledge of the content. Augie, who had served time in prison for assault and murder, had been one of the world's most notorious drug dealers and smugglers. He operated an opium alkaloid factory in Turkey and he was a leader in the Italian underworld on the Lower East Side of New York. Under the influence of the drug, Augie revealed volumes of information about the underworld operations, including the names of high ranking officials who took bribes from the mob. These experiments led to the encouragement of Donovan. A new memo was issued: "Cigarette experiments indicated that we had a mechanism which offered promise in relaxing prisoners to be interrogated."

When the OSS was disbanded after the war, Captain White continued to administer behavior modifying drugs. In 1947, the CIA replaced the OSS. White's service record indicates that he worked with the OSS, and by 1954 he was a high ranking Federal Narcotics Bureau officer who had been loaned to the CIA on a part-time basis. White rented an apartment in Greenwich Village equipped with one-way mirrors, surveillance gadgets and disguised himself as a seaman. White drugged his acquaintances with LSD and brought them back to his apartment. In 1955, the operation shifted to San Francisco. In San Francisco, "safe houses" were established under the code name Operation Midnight Climax. Midnight Climax hired prostitute addicts who lured men from bars back to the safehouses after their drinks had been spiked with LSD. White filmed the events in the safehouses. The purpose of these "national security brothels" was to enable the CIA to experiment with the act of lovemaking for extracting information from men.

The safehouse experiments continued until 1963 until CIA Inspector General John Earman criticized Richard Helms, the director of the CIA and father of the M.K.-Ultra project. Earman charged the new director John McCone had not been fully briefed on the M.K.-

Ultra Project when he took office and that "the concepts involved in manipulating human behavior are found by many people within and outside the Agency to be distasteful and unethical." He stated that "the rights and interest of U.S. citizens are placed in jeopardy". The Inspector General stated that LSD had been tested on individuals at all social levels, high and low, native American and foreign." Earman's criticisms were rebuffed by Helms, who warned, "Positive operation capacity to use drugs is diminishing owing to a lack of realistic testing. Tests were necessary to keep up with the Soviets." But in 1964, Helms had testified before the Warren Commission investigating the assassination of President John Kennedy, that "Soviet research has consistently lagged five years behind Western research".

Upon leaving government service in 1966, Captain White wrote a startling letter to his superior. In the letter to Dr. Gottlieb, Captain White reminisced about his work in the safehouses with LSD. His comments were frightening. "I was a very minor missionary, actually a heretic, but I toiled wholeheartedly in the vineyards because it was fun, fun, fun," White wrote. "Where else could a red-blooded American boy lie, kill, cheat, steal, rape and pillage with the sanction and blessing of the all-highest?" The CIA and the Mafia (Testimony before the 1951 Sub-Committee on Organized Crime and other public sources.)

Though the CIA continued to maintain drug experiments in the streets of America after the program was officially canceled, the United States reaped tremendous value from it. With George Hunter White's connection to underworld figure Little Augie, connections were made with Mafia king-pin Lucky Luciano, who was in Dannemore Prison. Luciano wanted freedom, the Mafia wanted drugs, and the United States wanted Sicily. The date was 1943. Augie was the go-between between Luciano and the United States War Department. Luciano was transferred to a less harsh prison and began to be visited by representatives of the Office of Naval Intelligence and from underworld figures, such as Meyer Lansky. A strange alliance was formed between the U.S. Intelligence agencies and the Mafia, who controlled the West Side docks in New York. Luciano regained active leadership in organized crime in America.

The U. S. Intelligence community utilized Luciano's underworld connections in Italy. In July of 1943, Allied forces launched their invasion of Sicily, the beginning push into occupied Europe. General George Patton's Seventh Army advanced through hundreds of miles of territory that was fraught with difficulty, booby trapped roads, snipers, confusing mountain topography, all within close range of 60,000 hostile Italian troops. All this was accomplished in four days, a military "miracle" even for Patton. Senate Estes Kefauver's Senate Sub committee on Organized Crime asked, in 1951, how all this was possible. The answer was that the Mafia had helped to protect roads from Italian snipers, served as guides through treacherous mountain terrain, and provided needed intelligence to Patton's army. The part of Sicily which Patton's forces traversed had at one time been completely controlled by the Sicilian Mafia, until Benito Mussolini smashed it through the use of police repression.

Just prior to the invasion, it was hardly even able to continue shaking down farmers and shepherds for protection money. But the invasion changed all this, and the Mafia went on to play a very prominent and well-documented role in the American military occupation of Italy. The expedience of war opened the doors to American drug traffic and Mafia domination. This was the beginning of the Mafia-U.S. Intelligence alliance, an alliance that lasts to this day and helped to support the covert operations of the CIA, such as the Iran-Contra operations. In these covert operations, the CIA would obtain drugs from South America and Southeast Asia, sell them to the Mafia and use the money for the covert purchase of military equipment. These operations accelerated when Congress cut off military funding for the Contras.

One of the Allies' top occupation priorities was to liberate as many of their own soldiers from garrison duties so that they could participate in the military offensive. In order to accomplish this, Don Calogero's Mafia were pressed into service, and in July of 1943, the Civil Affairs Control Office of the U.S. Army appointed him mayor of Villalba and other Mafia officials as mayors of other towns in Sicily. As the northern Italian offensive continued, Allied intelligence became very concerned over the extent to which the Italian Communists' resistance to Mussolini had driven Italian politics to the left. Community Party membership had doubled between 1943 and 1944, huge leftist strikes had shut down factories and the Italian underground fighting Mussolini had risen to almost 150,000 men. By mid-1944, the situation came to a head and the U.S. Army terminated arms drops to the Italian Resistance, and started appointing Mafia officials to occupation administration posts. Mafia groups broke up leftists rallies and reactivated black market operations throughout southern Italy. Lucky Luciano was released from prison in 1946 and deported to Italy, where he rebuilt the heroin trade. The court's decision to release him was made possible by the testimony of intelligence agents at his hearing, and a letter written by a naval officer reciting what Luciano had done for the Navy. Luciano was supposed to have served from 30 to 50 years in prison. Over 100 Mafia members were similarly deported within a couple of years.

Luciano set up a syndicate which transported morphine base from the Middle East to Europe, refined it into heroin, and then shipped it into the United States via Cuba. During the 1950's, Marseilles, in Southern France, became a major city for the heroin labs and the Corsican syndicate began to actively cooperate with the Mafia in the heroin trade. Those became popularly known as the French Connection. In 1948, Captain White visited Luciano and his narcotics associate Nick Gentile in Europe. Gentile was a former American gangster who had worked for the Allied Military Government in Sicily. By this time, the CIA was already subsidizing Corsican and Italian gangsters to oust Communist unions from the Port of Marseilles.

American strategic planners saw Italy and southern France as extremely important for their Naval bases as a counterbalance to the growing naval forces of the Soviet Union. CIO/AFL organizer Irving Brown testified that by the time the CIA subsidies were terminated in 1953, U.S. support was no longer needed because the profits from the heroin traffic was sufficient to sustain operations. When Luciano was originally jailed, the U.S. felt it had eliminated the world's most effective underworld leader and the activities of the Mafia were seriously damaged. Mussolini had been waging a war since 1924 to rid the world of the Sicilian Mafia. Thousands of Mafia members were convicted of crimes and forced to leave the cities and hide out in the mountains. Mussolini's reign of terror had virtually eradicated the international drug syndicates. Combined with the shipping surveillance during the war years, heroin trafficking had become almost nil. Drug use in the United States, before Luciano's release from prison, was on the verge of being entirely wiped out.

Mind Control Experiments Conducted in Our Name The U.S. government has conducted three types of mind-control experiments: Real life experiences, such as those used on Little Augie and the LSD experiments in the safehouses of San Francisco and Greenwich Village; experiments on prisoners, such as in the California Medical Facility at Vacaville; experiments conducted in both mental hospitals and the Veterans Administration hospitals.

Such experimentation requires money, and the United States government has funneled funds for drug experiments through different agencies, both overtly and covertly. The Role of the Law Enforcement Assistance Administration (Reportorial Sources, Including the Washington Post) One of the funding agencies to contribute to the experimentation is the Law Enforcement Assistance Administration (LEAA), a unit of the U.S. Justice Department and one of President Richard Nixon's favorite pet agencies. The Nixon Administration was, at one time, putting together a program for detaining youngsters who showed a tendency toward violence in "concentration" camps. According to the Washington Post, the plan was authored by Dr. Arnold Hutschnecker. Health, Education and Welfare Secretary Robert Finch was told by John Erlichman, Chief of Staff for the Nixon White House, to implement the program. He proposed the screening of children of six years of age for tendencies toward criminality. Those who failed these tests were to be destined to be sent to the camps. The program was never implemented.

LEAA came into existence in 1968 with a huge budget to assist various U.S. law enforcement agencies. Its effectiveness, however, was not considered too great. After spending $6 billion, the F.B.I. reports general crime rose 31 percent and violent crime rose 50 percent. But little accountability was required of LEAA on how it spent its funds. LEAA's role in the behavior modification research began at a meeting held in 1970 in Colorado Springs. Attending that meeting were Richard Nixon, Attorney General John Mitchell, John Erlichman, H.R. Haldemann and other White House staffers. They met with Dr. Bertram Brown, director fo the National Institute of Mental Health, and forged a close collaboration between LEAA and the Institute. LEAA was a product of the Justice Department and the Institute was a product of HEW.

LEAA funded 350 projects involving medical procedures, behavior modification and drugs for delinquency control. Money from the Criminal Justice System was being used to fund mental health projects and vice versa. Eventually, the leadership responsibility and control of the Institute began to deteriorate and their scientists began to answer to LEAA alone. The Role of the National Institute of Mental Health (Source: Court Records and US Senate Subcommittee on Constitutional Rights) The National Institute of Mental Health went on to become one of the greatest supporters of behavior modification research. Throughout the 1960's, court calenders became blighted with lawsuits on the part of "human guinea pigs" who had been experimented upon in prisons and mental institutions. It was these lawsuits which triggered the Senate Subcommittee on Constitutional Rights investigation, headed by Senator Sam Erwin. The subcommittee's harrowing report was virtually ignored by the news media. The Department of Defense (Source: CIA Documents released under FOIA and Subcommittee Testimony) Thirteen behavior modification programs were conducted by the Department of Defense. The Department of Labor had also conducted several experiments, as well as the National Science Foundation.

The Veterans' Administration was also deeply involved in behavior modification and mind control. Each of these agencies, including LEAA, and the Institute, were named in secret CIA documents as those who provided research cover for the MK-ULTRA program. Eventually, LEAA was using much of its budget to fund experiments, including aversive techniques and psychosurgery, which involved, in some cases, irreversible brain surgery on normal brain tissue for the purpose of changing or controlling behavior and/or emotions. Senator Erwin questioned the head of LEAA concerning ethical standards of the behavior modification projects which LEAA had been funding. Erwin was extremely dubious about the idea of the government spending money on this kind of project without strict guidelines and reasonable research supervision in order to protect the human subjects. After Senator Erwin's denunciation of the funding polices, LEAA announced that it would no longer fund medical research into behavior modification and psychosurgery.

Lobotomies Performed on Black Activists (Committee Testimony) Despite the pledge by LEAA's director, Donald E. Santarelli, LEAA ended up funding 537 research projects dealing with behavior modification. There is strong evidence to indicate psychosurgery was still being used in prisons in the 1980's. Immediately after the funding announcement by LEAA, there were 50 psychosurgical operations at Atmore State Prison in Alabama. The inmates became virtual zombies. The operations, according to Dr. Swan of Fisk University, were done on black prisoners who were considered politically active.

Veteran's Administration Practices (Committee Testimony) The Veterans' Administration openly admitted that psychosurgery was a standard procedure for treatment and not used just in experiments. The VA Hospitals in Durham, Long Beach, New York, Syracuse and Minneapolis were known to employ these products on a regular basis. VA clients could typically be subject to these behavior alteration procedures against their will. The Erwin subcommittee concluded that the rights of VA clients had been violated. LEAA also subsidized the research and development of gadgets and techniques useful to behavior modification. Much of the technology, whose perfection LEAA funded, had originally been developed and made operational for use in the Vietnam War. Private Companies Involved Companies like Bangor Punta Corporation and Walter Kidde and Co., through its subsidiary Globe Security System, adapted these devices to domestic use in the U.S. ITT was another company that domesticated the warfare technology for potential use on U.S. citizens. Rand Corporation executive Paul Baran warned that the influx back to the United State of the Vietnam War surveillance gadgets alone, not to mention the behavior modification hardware, could bring about "the most effective, oppressive police state ever created". Some of the Players One of the fascinating aspects of the scandals that plague the U.S. Government is the fact that so often the same names appear from scandal to scandal. From the origins of Ronald Reagan's political career, as Governor of California, Dr. Earl Brian and Edward Meese played key advisory roles. Dr. Brian's name has been linked to the October Surprise and is a central figure in the government's theft of PROMIS soft ware from INSLAW. Brian's role touches from the Cabazon Indian scandals to United Press International. He is one of those low-profile key figures.

And, alas, his name appears again in the nation's behavior modification and mind control experiments. Dr. Brian was Reagan's Secretary of Health when Reagan was Governor. Dr. Brian was an advocate of state subsidies for a research center for the study of violent behavior. The center was to begin operations by mid-1975, and its research was intended to shed light on why people murder or rape, or hijack aircraft. The center was to be operated by the University of California at Los Angeles, and its primary purpose, ac cording to Dr. Brian, was to unify scattered studies on anti-social violence and possibly even touch on socially tolerated violence, such as football or war. Dr. Brian sought $1.3 million for the center.

It certainly was possible that prison inmates might be used as volunteer subjects at the center to discover the unknowns which triggered their violent behavior. Dr. Brian's quest for the center came at the same time Governor Reagan concluded his plans to phase the state of California out of the mental hospital business by 1982. Reagan's plan is echoed by Governor Pete Wilson today, to place the responsibility of rehabilitating young offenders squarely on the shoulders of local communities. But as the proposal became known more publicly, a swell of controversy surrounded it. It ended in a fiasco. The inspiration for the violence center came from three doctors in 1967, five years before Dr. Brian and Governor Reagan unveiled their plans. The "Scientific" Basis for Psychosurgery (Publications of the Participants).

Amidst urban rioting and civil protest, Doctors Sweet, Mark and Ervin of Harvard put forward the thesis that individuals who engage in civil disobedience possess defective or damaged brain cells. If this conclusion were applied to the American Revolution or the Women's Rights Movement, a good portion of American society would be labeled as having brain damage.

In a letter to the Journal of the American Medical Association, they stated: "That poverty, unemployment, slum housing, and inadequate education underlie the nation's urban riots is well known, but the obviousness of these causes may have blinded us to the more subtle role of other possible factors, including brain dysfunction in the rioters who engaged in arson, sniping and physical assault. "There is evidence from several sources that brain dysfunction related to a focal lesion plays a significant role in the violent and assaultive behavior of thoroughly studied patients. Individuals with electroencephalographic abnormalities in the temporal region have been found to have a much greater frequency of behavioral abnormalities (such as poor impulse control, assaultiveness, and psychosis) than is present in people with a normal brain wave pattern." Soon after the publication in the Journal, Dr. Ervin and Dr. Mark published their book Violence and the Brain, which included the claim that there were as many as 10 million individuals in the United States "who suffer from obvious brain disease". They argued that the data of their book provided a strong reason for starting a program of mass screening of Americans.

"Our greatest danger no longer comes from famine or communicable disease. Our greatest danger lies in ourselves and in our fellow humans...we need to develop an 'early warning test' of limbic brain function to detect those humans who have a low threshold for impulsive violence...Violence is a public health problem, and the major thrust of any program dealing with violence must be toward its prevention," they wrote.

The Law Enforcement Assistance Administration funded the doctors $108,000 and the National Institute of Mental Health kicked in another $500,000, under pressure from Congress. They believed that psychosurgery would inevitably be performed in connection with the program, and that, since it irreversibly impaired people's emotional and intellectual capacities, it could be used as an instrument of repression and social control. The doctors wanted screening centers established throughout the nation. In California, the publicity associated with the doctors' report, aided in the development of The Center for the study and Reduction of Violence. Both the state and LEAA provided the funding. The center was to serve as a model for future facilities to be set up throughout the United States.
The Director of the Neurophyschiatric Institute and chairman of the Department of Psychiatry at UCLA, Dr. Louis Jolyon West was selected to run the center. Dr. West is alleged to have been a contract agent for the CIA, who, as part of a network of doctors and scientists, gathered intelligence on hallucinogenic drugs, including LSD, for the super-secret MK-ULTRA program. Like Captain White, West conducted LSD experiments for the CIA on unwitting citizens in the safehouses of San Francisco. He achieved notoriety for his injection of a massive dose of LSD into an elephant at the Oklahoma Zoo, the elephant died when West tried to revive it by administering a combination of drugs.

Dr. West was further known as the psychiatrist who was called upon to examine Jack Ruby, Lee Harvey Oswald's assassin. It was on the basis of West's diagnosis that Ruby was compelled to be treated for mental disorders and put on happy pills. The West examination was ordered after Ruby began to say that he was part of a right-wing conspiracy to kill President John Kennedy. Two years after the commencement of treatment for mental disorder, Ruby died of cancer in prison. (Note: Dr West is now a member of the Board of Directors of the False Memory Syndrome Foundation.) The Violence Control Center (Testimony, FOIA documents, Los Angeles Times, San Francisco Bay Guardian) After January 11, 1973, when Governor Reagan announced plans for the Violence Center, West wrote a letter to the then Director of Health for California, J. M. Stubblebine: "Dear Stub: "I am in possession of confidential in formation that the Army is prepared to turn over Nike missile bases to state and local agencies for non-military purposes. They may look with special favor on health-related applications.

"Such a Nike missile base is located in the Santa Monica Mountains, within a half-hour's drive of the Neuropsychiatric Institute. It is accessible, but relatively remote. The site is securely fenced, and includes various buildings and improvements, making it suitable for prompt occupancy.

"If this site were made available to the Neurophyschiatric Institute as a research facility, perhaps initially as an adjunct to the new Center for the Prevention of Violence, we could put it to very good use. Comparative studies could be carried out there, in an isolated but convenient location, of experimental or model programs for the alteration of undesirable behavior. "Such programs might include control of drug or alcohol abuse, modification of chronic anti-social or impulsive aggressiveness, etc. The site could also accommodate conferences or retreats for instruction of selected groups of mental-health related professionals and of others (e.g., law enforcement personnel, parole officers, special educators) for whom both demonstration and participation would be effective modes of instruction.

"My understanding is that a direct request by the Governor, or other appropriate officers of the State, to the Secretary of Defense (or, of course, the President), could be most likely to produce prompt results." Some of the planned areas of study for the Center included: Studies of violent individuals. Experiments on prisoners from Vacaville and Atascadero, and hyperkinetic children. Experiments with violence-producing and violent inhibiting drugs. Hormonal aspects of passivity and aggressiveness in boys. Studies to discover and compare norms of violence among various ethnic groups. Studies of pre-delinquent children. It would also encourage law enforcement to keep computer files on pre-delinquent children, which would make possible the treatment of children before they became delinquents. The purpose of the Violence Center was not just research. The staff was to include sociologists, lawyers, police officers, clergymen and probation officers. With the backing of Governor Reagan and Dr. Brian, West had secured guarantees of prisoner volunteers from several California correctional institutions, including Vacaville. Vacaville and Atascadero were chosen as the primary sources for the human guinea pigs. These institutions had established a reputation, by that time, of committing some of the worst atrocities in West Coast history. Some of the experimentations differed little from what the Nazis did in the death camps.

Dr. Earl Brian, Governor Ronald Reagan's Secretary of Health, was adamant about his support for mind control centers in California. He felt the behavior modification plan of the Violence Control Centers was important in the prevention of crime. The Violence Control Center was actually the brain child of William Herrmann as part of a pacification plan for California. A counter insurgency expert for Systems Development Corporation and an advisor to Governor Reagan, Herrmann worked with the Stand Research Institute, the RAND Corporation, and the Hoover Center on Violence. Herrman was also a CIA agent who is now serving an eight year prison sentence for his role in a CIA counterfeiting operation. He was also directly linked with the Iran-Contra affair according to government records and Herrmann's own testimony. In 1970, Herrmann worked with Colston Westbrook as his CIA control officer when Westbrook formed and implemented the Black Cultural Association at the Vacaville Medical Facility, a facility which in July experienced the death of three inmates who were forcibly subjected to behavior modification drugs. The Black Cultural Association was ostensibly an education program designed to instill black pride identity in prisons, the Association was really a cover for an experimental behavior modification pilot project designed to test the feasibility of programming unstable prisoners to become more manageable.

Westbrook worked for the CIA in Vietnam as a psychological warfare expert, and as an advisor to the Korean equivalent of the CIA and for the Lon Nol regime in Cambodia. Between 1966 and 1969, he was an advisor to the Vietnamese Police Special Branch under the cover of working as an employee of Pacific Architects and Engineers. His "firm" contracted the building of the interrogation/torture centers in every province of South Vietnam as part of the CIA's Phoenix Program. The program was centered around behavior modification experiments to learn how to extract information from prisoners of war, a direct violation of the Geneva Accords. Westbrook's most prominent client at Vacaville was Donald DeFreeze, who be tween 1967 and 1969, had worked for the Los Angeles Police Department's Public Disorder Intelligence unit and later became the leader of the Symbionese Liberation Army. Many authorities now believe that the Black Cultural Association at Vacaville was the seedling of the SLA. Westbrook even designed the SLA logo, the cobra with seven heads, and gave De Freeze his African name of Cinque. The SLA was responsible for the assassination of Marcus Foster, superintendent of School in Oakland and the kidnapping of Patty Hearst.
As a counterinsurgency consultant for Systems Development Corporation, a security firm, Herrmann told the Los Angeles Times that a good computer intelligence system "would separate out the activist bent on destroying the system" and then develop a master plan "to win the hearts and minds of the people". The San Francisco-based Bay Guardian, recently identified Herrmann as an international arms dealer working with Iran in 1980, and possibly involved in the October Surprise. Herrmann is in an English prison for counterfeiting. He allegedly met with Iranian officials to ascertain whether the Iranians would trade arms for hostages held in Lebanon.

The London Sunday Telegraph confirmed Herrmann's CIA connections, tracing them from 1976 to 1986. He also worked for the FBI. This information was revealed in his London trial. In the 1970's, Dr. Brian and Herrmann worked together under Governor Reagan on the Center for the Study and Reduction of Violence, and then, a decade later, again worked under Reagan. Both men have been identified as working for Reagan with the Iranians.

The Violence Center, however, died an agonizing death. Despite the Ervin Senate Committee investigation and condemnation of mind control, the experiments continued. But when the Watergate scandal broke in the early 1970's, Washington felt it was too politically risky to continue to push for mind control centers.

Top doctors began to withdraw from the proposal because they felt that there were not enough safeguards. Even the Law Enforcement Assistance Agency, which funded the program, backed out, stating, the proposal showed "little evidence of established research ability of the kind of level necessary for a study of this cope".

Eventually it became known that control of the Violence Center was not going to rest with the University of California, but instead with the Department of Corrections and other law enforcement officials. This information was released publicly by the Committee Opposed to Psychiatric Abuse of Prisoners. The disclosure of the letter resulted in the main backers of the program bowing out and the eventual demise of the center. Dr. Brian's final public statement on the matter was that the decision to cut off funding represented "a callous disregard for public safety". Though the Center was not built, the mind control experiments continue to this day.
The Victims of MK-ULTRA (Court Records, Senate Testimony and FOIA Documents) The Central Intelligence Agency held two major interests in use of LSD. to alter normal behavior patterns. The first interest centered around obtaining information from prisoners of war and enemy agents, in contravention of the Geneva Accords. The second was to deter the effectiveness of drugs used against the enemy on the battlefield.

The MK-ULTRA program was originally run by a small number of people within the CIA known as the Technical Services Staff (TSS). Another CIA department, the Office of Security, also began its own testing program. Friction arose and then infighting broke out when the Office of Security commenced to spy on TSS people after it was learned that LSD was being tested on unwitting Americans. Not only did the two branches disagree over the issue of testing the drug on the unwitting, they also disagreed over the issue of how the drug was actually to be used by the CIA. The office of Security envisioned the drug as an interrogation weapon. But the TSS group thought the drug could be used to help destabilize another country, it could be slipped into the food or beverage of a public official in order to make him behave foolishly or oddly in public. One CIA document reveals that L.S.D. could be administered right before an official was to make a public speech.

Realizing that gaining information about the drug in real life situations was crucial to exploiting the drug to its fullest, TSS started conducting experiments on its own people. There was an extensive amount of self-experimentation. The Office of Security felt the TSS group was playing with fire, especially when it was learned that TSS was prepared to spike an annual office Christmas party punch with LSD, the Christmas party of the CIA. L.S.D. could produce serious insanity for periods of eight to 18 hours and possibly longer.

One of the "victims" of the punch was agent Frank Olson. Having never had drugs before, L.S.D. took its toll on Olson. He reported that, every automobile that came by was a terrible monster with fantastic eyes, out to get him personally. Each time a car passed he would huddle down against a parapet, terribly frightened. Olson began to behave erratically. The CIA made preparation to treat Olson at Chestnut Lodge, but before they could, Olson checked into a New York hotel and threw himself out from his tenth story room. The CIA was ordered to cease all drug testing. Mind control drugs and experiments were torturous to the victims. One of three inmates who died in Vacaville Prison in July of 1991 was scheduled to appear in court in an attempt to stop forced administration of a drug, the very drug that may have played a role in his death.

Joseph Cannata believed he was making progress and did not need forced dosages of the drug Haldol. The Solano County Coroner's Office said that Cannata and two other inmates died of hyperthermia, extremely elevated body temperature. Their bodies all had at least 108 degrees temperature when they died. The psychotropic drugs they were being forced to take will elevate body temperature.
Dr. Ewen Cameron, working at McGill University in Montreal, used a variety of experimental techniques, including keeping subjects unconscious for months at a time, administering huge electroshocks and continual doses of L.S.D. Massive lawsuits developed as a result of this testing, and many of the subjects who suffered trauma had never agreed to participate in the experiments. Such CIA experiments infringed upon the much-honored Nuremberg Code concerning medical ethics. Dr. Camron was one of the members of the Nuremberg Tribunal.

L.S.D. research was also conducted at the Addiction Research Center of the U.S. Public Health Service in Lexington, Kentucky. This institution was one of several used by the CIA. The National Institute of Mental Health and the U.S. Navy funded this operation. Vast supplies of L.S.D. and other hallucinogenic drugs were required to keep the experiments going. Dr. Harris Isbell ran the program. He was a member of the Food and Drug Administration's Advisory Committee on the Abuse of Depressant and Stimulants Drugs. Almost all of the inmates were black. In many cases, L.S.D. dosage was increased daily for 75 days. Some 1500 U.S. soldiers were also victims of drug experimentation. Some claimed they had agreed to become guinea pigs only through pressure from their superior officers. Many claimed they suffered from severe depression and other psychological stress. One such soldier was Master Sergeant Jim Stanley. L.S.D. was put in Stanley's drinking water and he freaked out. Stanley's hallucinations continued even after he returned to his regular duties. His service record suffered, his marriage went on the rocks and he ended up beating his wife and children. It wasn't until 17 years later that Stanley was informed by the military that he had been an L.S.D. experiment. He sued the government, but the Supreme Court ruled no soldier could sue the Army for the LSD experiments. Justice William Brennen disagreed with the Court decision.

He wrote, "Experimentation with unknowing human subjects is morally and legally unacceptable." Private James Thornwell was given L.S.D. in a military test in 1961. For the next 23 years he lived in a mental fog, eventually drowning in a Vallejo swimming pool in 1984. Congress had set up a $625,000 trust fund for him. Large scale L.S.D. tests on American soldiers were conducted at Aberdeen Proving Ground in Maryland, Fort Benning, Georgia, Fort Leavenworth, Kansas, Dugway Proving Ground, Utah, and in Europe and the Pacific. The Army conducted a series of L.S.D. tests at Fort Bragg in North Carolina. The purpose of the tests were to ascertain how well soldiers could perform their tasks on the battlefield while under the influence of L.S.D. At Fort McClellan, Alabama, 200 officers in the Chemical Corps were given L.S.D. in order to familiarize them with the drug's effects. At Edgewood Arsenal, soldiers were given L.S.D. and then confined to sensory deprivation chambers and later exposed to a harsh interrogation sessions by intelligence people. In these sessions, it was discovered that soldiers would cooperate if promised they would be allowed to get off the L.S.D.

In Operation Derby Hat, foreign nationals accused of drug trafficking were given L.S.D. by the Special Purpose Team, with one subject begging to be killed in order to end his ordeal. Such experiments were also conducted in Saigon on Viet Cong POWs. One of the most potent drugs in the U.S. arsenal is called BZ or quinuclidinyl benzilate. It is a long-lasting drug and brings on a litany of psychotic experiences and almost completely isolates any person from his environment. The main effects of BZ last up to 80 hours compared to eight hours for L.S.D. Negative after-effects may persist for up to six weeks. Psychological Warfare Drugs (Court Records, FOIA Documents, General Accounting Office investigations).

The BZ experiments were conducted on soldiers at Edgewood Arsenal for 16 years. Many of the "victims" claim that the drug permanently affected their lives in a negative way. It so disorientated one paratrooper that he was found taking a shower in his uniform and smoking a cigar. BZ was eventually put in hand grenades and a 750 pound cluster bomb. Other configurations were made for mortars, artillery and missiles. The bomb was tested in Vietnam and CIA documents indicate it was prepared for use by the U.S. in the event of large-scale civilian uprisings.

In Vacaville, psychosurgery has long been a policy. In one set of cases, experimental psychosurgery was conducted on three inmates, a black, a Chicano and a white person. This involved the procedure of pushing electrodes deep into the brain in order to determine the position of defective brain cells, and then shooting enough voltage into the suspected area to kill the defective cells. One prisoner, who appeared to be improving after surgery, was released on parole, but ended up back in prison. The second inmate became violent and there is no information on the third inmate. Vacaville also administered a "terror drug", Anectine, as a way of "suppressing hazardous behavior". In small doses, Anectine serves as a muscle relaxant; in huge does, it produces prolonged seizure of the respiratory system and a sensation "worse than dying". The drug goes to work within 30 to 40 seconds by paralyzing the small muscles of the fingers, toes, and eyes, and then moves into the the intercostal muscles and the diaphragm. The heart rate subsides to 60 beats per minute, respiratory arrest sets in and the patient remains completely conscious throughout the ordeal, which lasts two to five minutes. The experiments were also used at Atascadero.

Several mind altering drugs were originally developed for non-psychoactive purposes. Some of these drugs are Phenothiazine and Thorzine. The side effects of these drugs can be a living hell. The impact includes the feeling of drowsiness, disorientation, shakiness, dry mouth, blurred vision and an inability to concentrate.

Drugs like Prolixin are described by users as "sheer torture" and "becoming a zombie". The Veterans Administration Hospital has been shown by the General Accounting Office to apply heavy dosages of psychotherapeutic drugs. One patient was taking eight different drugs, three antipsychotic, two antianxiety, one antidepressant, one sedative and one anti-Parkinson. Three of these drugs were being given in dosages equal to the maximum recommended. Another patient was taking seven different drugs. One report tells of a patient who refused to take the drug. "I told them I don't want the drug to start with, they grabbed me and strapped me down and gave me a forced intramuscular shot of Prolixin. They gave me Artane to counteract the Prolixin and they gave me Sinequan, which is a kind of tranquilizer to make me calm down, which over calmed me, so rather than letting up on the medication, they then gave me Ritalin to pep me up."

Prolixin lasts for two weeks. One patient describes how the drug does not calm or sedate nerves, but instead attacks from so deep inside you, you cannot locate the source of the pain. "The drugs turn your nerves in upon yourself. Against your will, your resistance, your resolve, are directed at your own tissues, your own muscles, reflexes, etc.." The patient continues, "The pain grinds into your fiber, your vision is so blurred you cannot read. You ache with restlessness, so that you feel you have to walk, to pace. And then as soon as you start pacing, the opposite occurs to you, you must sit and rest. Back and forth, up and down, you go in pain you cannot locate. In such wretched anxiety you are overwhelmed because you cannot get relief even in breathing." Doctor Jose Delgado: "Man does not have the right to develop his own mind." (Congressional Record, New York Times).

"We need a program of psychosurgery for political control of our society. The purpose is physical control of the mind. Everyone who deviates from the given norm can be surgically mutilated. "The individual may think that the most important reality is his own existence, but this is only his personal point of view. This lacks historical perspective.

"Man does not have the right to develop his own mind. This kind of liberal orientation has great appeal. We must electrically control the brain. Some day armies and generals will be controlled by electric stimulation of the brain." These were the remarks of Dr. Jose Delgado as they appeared in the February 24, 1974 edition of the Congressional Record, No. 262E, Vol. 118.
Despite Dr. Delgado's outlandish statements before Congress, his work was financed by grants from the Office of Naval Research, the Air Force Aero-Medical Research Laboratory, and the Public Health Foundation of Boston. Dr. Delgado was a pioneer of the technology of Electrical Stimulation of the Brain (ESB). The New York Times ran an article on May 17, 1965 entitled Matador With a Radio Stops Wild Bull. The story details Dr. Delgado's experiments at Yale University School of Medicine and work in the field at Cordova, Spain. The New York Times stated:

"Afternoon sunlight poured over the high wooden barriers into the ring, as the brave bull bore down on the unarmed matador, a scientist who had never faced fighting bull. But the charging animal's horn never reached the man behind the heavy red cape. Moments before that could happen, Dr. Delgado pressed a button on a small radio transmitter in his hand and the bull braked to a halt. Then he pressed another button on the transmitter, and the bull obediently turned to the right and trotted away. The bull was obeying commands in his brain that were being called forth by electrical stimulation by the radio signals to certain regions in which fine wires had been painlessly planted the day before." According to Dr. Delgado, experiments of this type have also been performed on humans. While giving a lecture on the Brain in 1965, Dr. Delgado said, "Science has developed a new methodology for the study and control of cerebral function in animals and humans."

Russian Experiments in Hypnotism and Radio Control of the Mind
The late L.L. Vasiliev, professor of physiology at the University of Leningrad wrote in a paper about hypnotism: "As a control of the subject's condition, when she was outside the laboratory in another set of experiments, a radio set was used. The results obtained indicate that the method of using radio signals substantially enhances the experimental possibilities." The professor continued to write, "I.F. Tomaschevsky (a Russian physiologist) carried out the first experiments with this subject at a distance of one or two rooms, and under conditions that the participant would not know or suspect that she would be experimented with. In other cases, the sender was not in the same house, and someone else observed the subject's behavior.
Subsequent experiments at considerable distances were successful. One such experiment was carried out in a park at a distance. Mental suggestions to go to sleep were complied with within a minute." The Russian experiments in the control of a person's mind through hypnosis and radio waves were conducted in the 1930s, some 30 years before Dr. Delgado's bull experiment. Dr. Vasiliev definitely demonstrated that radio transmission can produce stimulation of the brain. It is not a complex process. In fact, it need not be implanted within the skull or be productive of stimulation of the brain, itself. All that is needed to accomplish the radio control of the brain is a twitching muscle. The subject becomes hypnotized and a muscle stimulant is implanted. The subject, while still under hypnosis, is commanded to respond when the muscle stimulant is activated, in this case by radio transmission.
Lincoln Lawrence wrote a book entitled Were We Controlled? Lawrance wrote, "If the subject is placed under hypnosis and mentally programmed to maintain a determination eventually to perform one specific act, perhaps to shoot someone, it is suggested thereafter, each time a particular muscle twitches in a certain manner, which is then demonstrated by using the transmitter, he will increase this determination even more strongly. As the hypnotic spell is renewed again and again, he makes it his life's purpose to carry out this act until it is finally achieved. Thus are the two complementary aspects of Radio-Hypnotic Intracerebral Control (RHIC) joined to reinforce each other, and perpetuate the control, until such time as the controlled behavior is called for. This is done by a second session with the hypnotist giving final instructions. These might be reinforced with radio stimulation in more frequent cycles. They could even carry over the moments after the act to reassure calm behavior during the escape period, or to assure that one conspirator would not indicate that he was aware of the co-conspirator's role, or that he was even acquainted with him."
US Experiments in Radio Control of the Mind (Public Statements of the Principals) RHIC constitutes the joining of two well known tools, the radio part and the hypnotism part. People have found it difficult to accept that an individual can be hypnotized to perform an act which is against his moral principles. Some experiments have been conducted by the U.S. Army which show that this popular perception is untrue.

The chairman of the Department of Psychology at Colgate University, Dr. Estabrooks, has stated, "I can hypnotize a man without his knowledge or consent into committing treason against the United States." Estabrooks was one of the nation's most authoritative sources in the hypnotic field. The psychologist told officials in Washington that a mere 200 well trained hypnotists could develop an army of mind-controlled sixth columnists in wartime United States. He laid out a scenario of an enemy doctor placing thousands of patients under hypnotic mind control, and eventually programming key military officers to follow his assignment. Through such maneuvers, he said, the entire U.S. Army could be taken over. Large numbers of saboteurs could also be created using hypnotism through the work of a doctor practicing in a neighborhood or foreign born nationals with close cultural ties with an enemy power.
Dr. Estabrooks actually conducted experiments on U.S. soldiers to prove his point. Soldiers of low rank and little formal education were placed under hypnotism and their memories tested. Surprisingly, hypnotists were able to control the subjects' ability to retain complicated verbal information. J. G. Watkins followed in Estabrooks steps and induced soldiers of lower rank to commit acts which conflicted not only with their moral code, but also the military code which they had come to accept through their basic training. One of the experiments involved placing a normal, stable army private in a deep trance. Watkins was trying to see if he could get the private to attack a superior officer, a cardinal sin in the military. While the private was in a deep trance, Watkins told him that the officer sitting across from him was an enemy soldier who was going to attempt to kill him. In the private's mind, it was a kill or be killed situation. The private immediately jumped up and grabbed the officer by the throat. The experiment was repeated several times, and in one case the man who was hypnotized and the man who was attacked were very close friends. The results were always the same. In one experiment, the hypnotized subject pulled out a knife and nearly stabbed another person.

Watkins concluded that people could be induced to commit acts contrary to their morality if their reality was distorted by the hypnotism. Similar experiments were conducted by Watkins using WACs exploring the possibility of making military personnel divulge military secrets. A related experiment had to be discontinued because a researcher, who had been one of the subjects, was exposing numerous top-secret projects to his hypnotist, who did not have the proper security clearance for such information. The information was divulged before an audience of 200 military personnel.

Dr. Watson's Experiments on Babies

In man's quest to control the behavior of humans, there was a great breakthrough established by Pavlov, who devised a way to make dogs salivate on cue. He perfected his conditioning response technique by cutting holes in the cheeks of dogs and measured the amount they salivated in response to different stimuli. Pavlov verified that "quality, rate and frequency of the salivation changed depending upon the quality, rate and frequency of the stimuli."
Though Pavlov's work falls far short of human mind control, it did lay the groundwork for future studies in mind and behavior control of humans. John B. Watson conducted experiments in the United States on an 11-month-old infant. After allowing the infant to establish a rapport with a white rat, Watson began to beat on the floor with an iron bar every time the infant came in contact with the rat. After a time, the infant made the association between the appearance of the rat and the frightening sound, and began to cry every time the rat came into view. Eventually, the infant developed a fear of any type of small animal. Watson was the founder of the behaviorist school of psychology.

"Give me the baby, and I'll make it climb and use its hands in constructing buildings or stone or wood. I'll make it a thief, a gunman or a dope fiend. The possibilities of shaping in any direction are almost endless. Even gross differences in anatomical structure limits are far less than you may think. Make him a deaf mute, and I will build you a Helen Keller. Men are built, not born," Watson proclaimed. His psychology did not recognize inner feelings and thoughts as legitimate objects of scientific study, he was only interested in overt behavior.

Though Watson's work was the beginning of man's attempts to control human actions, the real work was done by B.F. Skinner, the high priest of the behaviorists movement. The key to Skinner's work was the concept of operant conditioning, which relied on the notion of reinforcement, all behavior which is learned is rooted in either a positive or negative response to that action. There are two corollaries of operant conditioning" Aversion therapy and desensitization.

Aversion therapy uses unpleasant reinforcement to a response which is undesirable. This can take the form of electric shock, exposing the subject to fear producing situations, and the infliction of pain in general. It has been used as a way of "curing" homosexuality, alcoholism and stuttering. Desensitization involves forcing the subject to view disturbing images over and over again until they no longer produce any anxiety, then moving on to more extreme images, and repeating the process over again until no anxiety is produced. Eventually, the subject becomes immune to even the most extreme images. This technique is typically used to treat people's phobias. Thus, the violence shown on T.V. could be said to have the unsystematic and unintended effect of desensitization.

Skinnerian behaviorism has been accused of attempting to deprive man of his free will, his dignity and his autonomy. It is said to be intolerant of uncertainty in human behavior, and refuses to recognize the private, the ineffable, and the unpredictable. It sees the individual merely as a medical, chemical and mechanistic entity which has no comprehension of its real interests.

Skinner believed that people are going to be manipulated. "I just want them to be manipulated effectively," he said. He measured his success by the absence of resistance and counter control on the part of the person he was manipulating. He thought that his techniques could be perfected to the point that the subject would not even suspect that he was being manipulated. Dr. James V. McConnel, head of the Department of Mental Health Research at the University of Michigan, said, "The day has come when we can combine sensory deprivation with the use of drugs, hypnosis, and the astute manipulation of reward and punishment to gain almost absolute control over an individual's behavior. We want to reshape our society drastically."

The Navy's Murderers (Statements of Lt. Commander Thomas Narut, The London Times) A U.S. Navy psychologist claims that the Office of Naval Intelligence had taken convicted murderers from military prisons, used behavior modification techniques on them, and then relocated them in American embassies throughout the world. Just prior to that time, the U.S. Senate Intelligence Committee had censured the CIA for its global political assassination plots, including plots against Fidel Castro. The Navy psychologist was Lt.

Commander Thomas Narut of the U.S. Regional Medical Center in Naples, Italy. The information was divulged at an Oslo NATO conference of 120 psychologists from the eleven nation alliance. According to Dr. Narut, the U.S. Navy was an excellent place for a researcher to find "captive personnel" whom they could could use as guinea pigs in experiments.

The Navy provided all the funding necessary, according to Narut. Dr. Narut, in a question and answer session with reporters from many nations, revealed how the Navy was secretly programming large numbers of assassins. He said that the men he had worked with for the Navy were being prepared for commando-type operations, as well as covert operations in U.S. embassies worldwide. He described the men who went through his program as "hit men and assassins" who could kill on command. Careful screening of the subjects was accomplished by Navy psychologists through the military records, and those who actually received assignments where their training could be utilized, were drawn mainly from submarine crews, the paratroops, and many were convicted murderers serving military prison sentences. Several men who had been awarded medals for bravery were drafted into the program. The assassins were conditioned through "audio-visual desensitization". The process involved the showing of films of people being injured or killed in a variety of ways, starting with very mild depictions, leading up to the more extreme forms of mayhem. Eventually, the subjects would be able to detach their feelings even when viewing the most horrible of films. The conditioning was most successful when applied to "passive-aggressive" types, and most of these ended up being able to kill without any regrets. The prime indicator of violent tendencies was the Minnesota Multiphasic Personality Inventory. Dr. Narut knew of two Navy programming centers, the neuropsychiatric laboratory in San Diego and the U.S. Regional Medical Center in Italy, where he worked. During the audio-visual desensitization programming, restraints were used to force the subject to view the films. A device was used on the subjects eyelids to prevent him from blinking. Typically, the preliminary film was on an African youth being ritualistically circumcised with a dull knife and without any anesthetic. The second film showed a sawmill scene in which a man accidentally cut off his fingers.

In addition to the desensitization films, the potential assassins underwent programming to create prejudicial attitude in the men, to think of their future enemies, especially the leaders of these countries, as sub-human. Films and lectures were presented demeaning the culture and habits of the people of the countries where it had been decided they would be sent. After his NATO lecture, Dr. Narut disappeared. He could not be located. Within a week of so after the lecture, the Pentagon issued an emphatic denial that the U.S. Navy had "engaged in psychological training or other types of training of personnel as assassins." They disavowed the programming centers in San Diego and Naples and stated they were unable to locate Narut, but did provide confirmation that he was a staff member of the U.S. Regional Medical Center in Naples. Dr. Alfred Zitani, an American delegate to the Oslo conference, did verify Narut's remarks and they were published in the Sunday Times.

Sometime later, Dr. Narut surfaced again in London and recanted his remarks, stating that he was "talking in theoretical and not practical terms." Shortly thereafter, the U.S. Naval headquarters in London issued a statement indicating that Dr. Narut's remarks at the NATO conference should be discounted because he had "personal problems". Dr. Narut never made any further public statements about the program.

During the NATO conference in Oslo, Dr. Narut had remarked that the reason he was divulging the information was because he believed that the information was coming out anyway. The doctor was referring to the disclosure by a Congressional subcommittee which were then appearing in the press concerning various CIA assassination plots. However, what Dr. Narut had failed to realize at the time, was that the Navy's assassination plots were not destined to be revealed to the public at that time. Electromagnetic Control of Human Behavior (Published scientific papers and press reports) There were three scientists who pioneered the work of using an electromagnetic field to control human behavior. Their work began 25 years ago. These three were Dr. Jose Delgado, psychology professor at Yale University; Dr. W. Ross Adey, a physiologist at the Brain Research Institute at UCLA; and Dr. Wilder Penfield, a Canadian.

Dr. Penfield's experiments consisted of the implantation of electrodes deep into the cortexes of epilepsy patients who were to undergo surgery; he was able to drastically improve the memories of these patients through electrical stimulation. Dr. Adey implanted transmitters in the brains of cats and chimpanzees that could send signals to a receiver regarding the electrical activity of the brain; additional radio signals were sent back into the brains of the animals which modified their behavior at the direction of the doctor. Dr. Delgado was able to stop and turn a charging bull through the use of an implanted radio receiver.

Other experiments using platinum, gold and stainless steel electrode implants enabled researchers to induce total madness in cats, put monkeys into a stupor, or to set human beings jerking their arms up and down. Much of Delgado's work was financed by the CIA through phony funding conduits masking themselves as charitable organizations. Following the successes of Delgado's work, the CIA set up their own research program in the field of electromagnetic behavior modification under the code name Sleeping Beauty. With the guidance of Dr. Ivor Browning, a laboratory was set up in New Mexico, specializing in working with the hypothalamus or "sweet spot" of the brain. Here it was found that stimulating this area could produce intense euphoria. Dr. Browning was able to wire a radio receiver-amplifier into the "sweet spot" of a donkey which picked up a five-micro-amp signal, such that he could create intense happiness in the animal. Using the jolts of happiness as an "electronic carrot", Browning was able to send the donkey up a 2000 foot New Mexico mountain and back to its point of origin.

When the donkey was proceeding up the path toward its destination, it was rewarded; when it deviated, the signal stopped. "You've never seen a donkey so eager to keep on course in your whole life," Dr. Browning exclaimed. The CIA utilized the electronic carrot technique in getting trained pigeons to fly miniature microphone-transmitters to the ledge of a KGB safe house where the devices monitored conversations for months. There was a move within the CIA to conduct further experiments on humans, foreigners and prisoners, but officially the White House vetoed the idea as being unethical. In May 1989, it was learned by the CIA that the KGB was subjecting people undergoing interrogation to electromagnetic fields, which produced a panic reaction, thereby bringing them closer to breaking down under questioning.

The subjects were not told that they were being placed under the influence of these beams. A few years earlier, Dr. Ross Adey released photographs and a fact sheet concerning what he called the Russian Lida machine. This consisted of a small transmitter emitting 10-hertz waves which makes the subject susceptible to hypnotic suggestion. The device utilized the outmoded vacuum-tube design. American POWs in Korea have indicated that similar devices had been used for interrogation purposes in POW camps.

The ELF Connection

The general, long term goal of the CIA was to find out whether or not mind control could be achieved through the use of a precise, external, electromagnetic beam. The electrical activity of the brain operates within the range of 100 hertz frequency. This spectrum is called ELF or Extremely Low Frequency range. ELF waves carry very little ionizing radiation and very low heat, and therefore do not manifest gross, observable physical effects on living organisms. Published Soviet experiments with ELFs reveal that there was a marked increase in psychiatric and central nervous system disorders and symptoms of stress for sailors working close to ELF generators. In the mid-1970s, American interest in combining EMR techniques with hypnosis was very prominent. Plans were on file to develop these techniques through experiments on human volunteers. The spoken word of the hypnotist could be conveyed by modulated electromagnetic energy directly into the subconscious parts of the human brain without employing any technical devices for receiving or transacting the messages and without the person exposed to such influence having a chance to control the information input consciously. In California, it was discovered by Dr. Adey that animal brain waves could be altered directly by ELF fields. It was found that monkey brains would fall in phase with ELF waves. These waves could easily pass through the skull, which normally protected the central nervous system from outside influence. In San Leandro, Dr. Elizabeth Rauscher, director of Technic Research Laboratory, has been doing ELF/brain research with human subjects for some time.

One of the frequencies produces nausea for more than an hour. Another frequency, she calls it the marijuana frequency, gets people laughing. "Give me the money and three months," she says, "and I'll be able to affect the behavior of eighty percent of the people in this town without their knowing it."

The Devastating Mental and Physical Effect of Microwaves (Soviet Research, State Department Admissions, Public Record) In the past, the Soviet Union has invested large sums of time and money investigating microwaves. In 1952, while the Cold War was showing no signs of thawing, there was a secret meeting at the Sandia Corporation in New Mexico between U.S. and Soviet scientists involving the exchange of information regarding the biological hazards and safety levels of EMR. The Soviets possessed the greater preponderance of information, and the American scientists were unwilling to take it seriously. In subsequent meetings, the Soviet scientists continued to stress the seriousness of the risks, while American scientists downplayed their importance.

Shortly after the last Sandia meeting, the Soviets began directing a microwave beam at the U.S. embassy in Moscow, using embassy workers as guinea pigs for low-level EMR experiments. Washington, D.C. was oddly quiescent, regarding the Moscow embassy bombardment. Discovered in 1962, the Moscow signal was investigated by the CIA, which hired a consultant, Milton Zaret, and code named the research Project Pandora. According to Zaret, the Moscow signal was composed of several frequencies, and was focused precisely upon the Ambassador's office. The intensity of the bombardment was not made public, but when the State Department finally admitted the existence of the signal, it announced that it was fairly low.

There was consensus among Soviet EMR researchers that a beam such as the Moscow signal was destined to produced blurred vision and loss of mental concentration. The Boston Globe reported that the American ambassador had not only developed a leukemia-like blood disease, but also suffered from bleeding eyes and chronic headaches. Under the CIA's Project Pandora, monkeys were brought into the embassy and exposed to the Moscow signal; they were found to have developed blood composition anomalies and unusual chromosome counts. Embassy personnel were found to have a 40 percent higher than average white blood cell count. While Operation Pandora's data gathering proceeded, embassy personnel continued working in the facility and were not informed of the bombardment until 10 years later. Embassy employees were eventually granted a 20 percent hardship allowance for their service in an unhealthful post. Throughout the period of bombardment, the CIA used the opportunity to gather data on psychological and biological effects of the beam on American personnel.

The U.S. government began to examine the affects of the Moscow signal. The job was turned over to the Defense Advanced Research Projects Agency (DARPA). DARPA is now developing electromagnetic weaponry. The man in charge of the DARPA program, Dr. Jack Verona, is so important and so secretive that he doesn't even return President George Bush's telephone calls. The American public was never informed that the military had planned to develop electromagnetic weapons until 1982, when the revelation appeared in a technical Air Force magazine.

The magazine article stated, "....specifically generated radio-frequency radiation (RFR) fields may pose powerful and revolutionary anti-personnel military trends." The article indicated that that it would be very easy to use electromagnetic fields to disrupt the human brain because the brain, itself, was an electrically mediated organ. It further indicated that a rapidly scanning RFR system would have a stunning or killing capability over a large area. The system was developable. Navy Captain Dr. Paul E. Taylor read a paper at the Air University Center for Aerospace Doctrine, Research and Education, at Maxwell Air Force Base, Alabama. Dr. Taylor was responsible for the Navy's Radiation Laboratory and had been studying radiation effects on humans. In his paper, Dr. Taylor stated, "The ability of individuals to function (as soldiers) could be degraded to such a point that would be combat ineffective." The system was so sophisticated that it employed microwaves and millimeter waves and was transportable by a large truck.

Lawrence Livermore National Laboratory in the South Bay, are working on the development of a "brain bomb". A bomb could be dropped in the middle of a battlefield which would produce microwaves, incapacitating the minds of soldiers within a circumscribed area.

Applications of microwave technology in espionage were available for over 25 years. In a meeting in Berkeley of the American Association for the Advancement of Science as early as 1965, Professor J. Anthony Deutsch of New York University, provided an important segment of research in the field of memory control. In layman terms, Professor Deutsch indicated that the mind is a transmitter and if too much information is received, like too many vehicles on a crowded freeway, the brain ceases to transmit. The Professor indicated that an excess of acetyl choline in the brain can interfere with the memory process and control. He indicated excess amounts of acetyl choline can be artificially produced, through both the administration of drugs or through the use of radio waves. The process is called Electronic Dissolution of Memory (EDOM). The memory transmission can be stopped for as long as the radio signal continues. As a result, the awareness of the person skips over those minutes during which he is subjected to the radio signal. Memory is distorted, and time-orientation is destroyed.

According to Lincoln Lawrence, author of Were We Controlled, EDOM is now operational. "There is already in use a small EDOM generator/transmitter which can be concealed on the body of the person. Contact with this person, a casual handshake or even just a touch, transmits a tiny electronic charge plus an ultra-sonic signal tone which for a short period will disturb the time-orientation of the person affected....it can be a potent weapon for hopelessly confusing evidence in the investigation of a crime "

Microwave Transmission of Voices Direct to the Brain Thirty years ago, Allen Frey discovered that microwaves of 300 to 3000 megahertz could be "heard" by people, even if they were deaf, if pulsed at a certain rate. Appearing to be originating just in back of the head, the sound boomed, clicked, hissed or buzzed, depending upon the frequency. Later research has shown that the perception of the waves take place just in front of the ears. The microwaves causes pressure waves in the brain tissue, and this phenomenon vibrates the sound receptors in the inner ear through the bone structure. Some microwaves are capable of directly stimulating the nerve cells of the auditory pathways. This has been confirmed with experiments with rats, in which the sound registers 120 decibels, which is equal to the volume of a nearby jet during takeoff. Aside from having the capability of causing pain and preventing auditory communication, a more subtle effect was demonstrated at the Walter Reed Army Institute of Research by Dr. Joseph C. Sharp. Dr. Sharp, himself, was the subject of an experiment in which pulsed microwave audiograms, or the microwave analog of the sound vibrations of spoken words, were delivered to his brain in such a way that he was able to understand the words that were spoken. Military and undercover uses of such a device might include driving a subject crazy with inner voices in order to discredit him, or conveying undetectable instructions to a programmed assassin.

But the technology has been carried even a step further. It has been demonstrated by Dr. Ross Adey that microwaves can be used to directly bring about changes in the electrical patterns of different parts of the brain. His experiments showed that he could achieve the same mind control over animals as Dr. Delgado did in the bull incident. Dr. Delgado used brain implants in his animals, Dr. Adey used microwave devices without preconditioning. He made animals act and look like electronic toys. Nazi Mind Control Experiments (Report from the US Naval Technical Mission) At the conclusion of World War Two, American investigators learned that Nazi doctors at the Dachau concentration camp in Germany had been conducting mind control experiments on inmates. They experimented with hypnosis and with the drug mescaline. Mescaline is a quasi-synthetic extract of the peyote cactus, and is very similar to LSD in the hallucinations which it produces. Though they did not achieve the degree of success they had desired, the SS interrogators in conjunction with the Dachau doctors were able to extract the most intimate secrets from the prisoners when the inmates were given very high doses of mescaline.

There were fatal mind control experiments conducted at Auschwitz. The experiments there were described by one informant as "brainwashing with chemicals". The informant said the Gestapo wasn't satisfied with extracting information by torture. "So the next question was, why don't we do it like the Russians, who have been able to get confessions of guilt at their show trials?" They tried various barbiturates and morphine derivatives. After prisoners were fed a coffee-like substance, two of them died in the night and others died later.

The Dachau mescaline experiments were written up in a lengthy report issued by the U.S. Naval Technical Mission, whose job it was at the conclusion of the war to scour all of Europe for every shred of industrial and scientific material that had been produced by the Third Reich. It was as a result of this report that the U.S. Navy became interested in mescaline as an interrogation tool. The Navy initiated Project Chatter in 1947, the same year the Central Intelligence Agency was formed. The Chatter format included developing methods for acquiring information from people against their will, but without inflicting harm or pain. At the conclusion of the war, the OSS was designated as the investigative unit for the International Military Tribunal, which was to become known as the Nuremberg Trials. The purpose of Nuremberg was to try the principal Nazi leaders. Some Nazis were on trial for their experiments, and the U.S. was using its own "truth drugs" on these principal Nazi prisoners, namely Goring, Ribbentrop, Speer and eight others. The Justice in charge of the tribunal had given the OSS permission to use the drugs. The Dachau doctors who performed the mescaline experiments also were involved in aviation medicine. The aviation experiments at Dachau fascinated Heinrich Himmler. Himmler followed the progress of the tests, studied their findings and often suggested improvements. The Germans had a keen interest in several medical problems in the field of flying, they were interested in preventing pilots from slowly becoming unconscious as a result of breathing the thin air of the high altitudes and there was interest in enhancing night vision. The main research in this area was at the Institute of Aviation in Munich, which had excellent laboratories. The experiments in relationship to the Institute were conducted at Dachau. Inmates had been immersed in tubs of ice water with instruments placed in their orifices in order to monitor their painful deaths. Dr. Hubertus Strughold, who ran the German aviation medicine team, confirmed that he had heard humans were used for the Dachau experiments. Hidden in a cave in Hallein were files recording the Dachau experiments.

Nazi Altitude and Cold Endurance Experiments

On May 15, 1941, Dr. Sigmund Rascher wrote a letter to Himmler requesting permission to use the Dachau inmates for experiments on the physiology of high altitudes. Rascher lamented the fact that no such experiments have been done using human subjects. "The experiments are very dangerous and we cannot attract volunteers," he told Himmler. His request was approved. Dachau was filled with Communists and Social Democrats, Jews, Jehovah's Witnesses, Gypsies, clergymen, homosexuals, and people critical of the Nazi government. Upon entering Dachau, prisoners lost all legal status, their hair was shaved off, all their possessions confiscated, they were poorly fed, and they were used as slaves for both the corporations and the government. The SS guards were brutal and sadistic. The idea to test subjects at Dachau was really the brain child of Erich Hippke, chief surgeon of the Luftwaffe. Between March and

August of 1942 extensive experiments were conducted at Dachau regarding the limits of human endurance at high altitudes. These experiments were conducted for the benefit of the German Air Force. The experiments took place in a low-pressure chamber in which altitudes of up to 68,000 feet could be simulated. The subjects were placed in the chamber and the altitude was raised, many inmates died as a result. The survivors often suffered serious injury. One witness at the Nuremberg trails, Anton Pacholegg, who was sent to Dachau in 1942, gave an eyewitness account of the typical pressure test: "The Luftwaffe delivered a cabinet constructed of wood and metal. It was possible in the cabinet to either decrease or increase the air pressure. You could observe through a little window the reaction of the subject inside the chamber. The purpose of these experiments was to test human energy and the subject's capacity...to take large amounts of pure oxygen, and then to test his reaction to a gradual decrease in oxygen. I have personally seen through the observation window of the chamber when a prisoner inside would stand a vacuum until his lungs ruptured. Some experiments gave men such pressure in their heads that they would go mad and pull out their hair in an effort to relieve the pressure. They would tear their heads and face with their fingers and nails in an attempt to maim themselves in their madness. They would beat the walls with their hands and head and scream in an effort to relieve pressure in their eardrums. These cases of extreme vacuums generally ended in the death of the subjects."

The former prisoner also testified, "An extreme experiment was so certain to result in death that in many instances the chamber was used for routine execution purposes rather than an experiment." A minimum 200 prisoners were known to have died in these experiments. The doctors directly involved with the research held very high positions: Karl Brandt was Hitler's personal doctor; Oskar Schroeder was the Chief of the Medical Services of the Luftwaffe; Karl Gebhardt was Chief Surgeon on the Staff of the Reich Physician SS and Police and German Red Cross President; Joachim Mrugowsky was Chief of the Hygienic Institute of the Waffen SS; Helmut Poppendick was a senior colonel in the SS and Chief of the Personal Staff of the Reich Physicians SS and Police; Siegfried Ruff was Director of the Department of Aviation Medicine.

The first human guinea pig was a 37 year old Jew in good health. Himmler invited 40 top Luftwaffe officers to view a movie of an inmate dying in the pressure chamber. After the pressure chamber tests, the cold treatment experiments began. The experiments consisted of immersing inmates in freezing water while their vital signs were monitored. The goal was to discover the cause of death. Heart failure was the answer. An inmate described the procedures: "The basins were filled with water and ice was added until the water measured 37.4 F and the experimental subjects were either dressed in a flying suit or were placed in the water naked. The temperature was measured rectally and through the stomach. The lowering of the body temperature to 32 degrees was terrible for experimental subjects.

At 32 degrees the subject lost consciousness. They were frozen to 25 degrees. The worst experiment was performed on two Russian officer POWs. They were placed in the basin naked. Hour after hour passed, and while usually after a short time, 60 minutes, freezing had set in, these two Russians were still conscious after two hours. After the third hour one Russian told the other, 'Comrade, tell that officer to shoot us.' The other replied, 'Don't expect any mercy from this Fascist dog.' Then they shook hands and said goodbye. The experiment lasted at least five hours until death occurred.

"Dry freezing experiments were also carried out at Dachau. One subject was put outdoors on a stretcher at night when it was extremely cold. While covered with a linen sheet, a bucket of cold water was poured over him every hour. He was kept outdoors under sub-freezing conditions. In subsequent experiments, subjects were simply left outside naked in a court under freezing conditions for hours. Himmler gave permission to move the experiments to Auschwitz, because it was more private and because the subjects of the experiment would howl all night as they froze. The physical pain of freezing was terrible. The subjects died by inches, heartbeat became totally irregular, breathing difficulties and lung endema resulted, hands and feet became frozen white." As the Germans began to lose the war, the aviation doctors began too keep their names from appearing in Himmler's files for fear of future recriminations. The Nazi doctors who experimented on the inmates of prison camps during World War Two were tried for murder at the Nuremberg Tribunal. The accused were educated, trained physicians, they did not kill in anger or in malice, they were creating a science of death. Ironically, in 1933, the Nazi's passed a law for the protection of animals. The law cited the prevention of cruelty and indifference to animals as one of the highest moral values of a people, animal experimentation was unthinkable, but human experimentations were acceptable. The victims of the crime of these doctors numbered into the thousands.

US Contempt for International Human Experimentation Protocols In 1953, while the Central Intelligence Agency was still conducting mind control and behavior modification on unwitting humans in this country, the United States signed the Nuremberg Code, a code born out of the ashes of war and human suffering. The document was a solemn promise never to tolerate such human atrocities again.

The Code maintains three fundamental principles:

1.The subjects of any experimentation must be volunteers who thoroughly understand the purpose and the dangers of the experiments.
2.They must be free to give consent and the consent must be without pressure and they must be free to quit the experiments at any time.
3.The experiments must be likely to yield knowledge which is valuable to everyone. The knowledge must be such that it could not be gained in any other way.
The experiments must be conducted by only the most competent doctors, and they must exercise extreme care. The Nazi aviation experiments met none of these conditions. Most inmates at Dachau knew that the experiments in the pressure chamber were fatal. From the very beginning, control of the experiments was largely in the hands of the SS, which was later judged to be a criminal organization by the Nuremberg Tribunal. Despite our lessons from Nuremberg and the death camps, the CIA, U.S. Navy and the U.S. Army Chemical Corps targeted specific groups of people for experimentation who were not able to resist, prisoners, mental patients, foreigners, ethnic minorities, sex deviants, the terminally ill, children and U.S. military personnel and prisoners of war.
They violated the Nuremberg Code for conducting and subsidizing experiments on unwitting citizens. The CIA began its mind control projects in 1953, the very year that the U.S. signed the Nuremberg Code and pledged with the international community of nations to respect basic human rights and to prohibit experimentation on captive populations without full and free consent.

Dr. Cameron, a CIA operative, was one of the worst offenders against the Code, yet he was a member of the Nuremberg Tribunal, with full knowledge of its testimony. In 1973, a three judge court in Michigan ruled, "experimental psychosurgery, which is irreversible and intrusive, often leads to the blunting of emotions, the deadening of memory, the reduction of affect, and limits the ability to generate new ideas. Its potential for injury to the creativity of the individual is great and can infringe on the right of the individual to be free from interference with his mental process.

"The state's interest in performing psychosurgery and the legal ability of the involuntarily detained mental patient to give consent, must bow to the First Amendment, which protects the generation and free flow of ideas from unwarranted interference with one's mental processes." Citing the Nuremberg Code, the court found that "the very nature of the subject's incarceration diminishes the capacity to consent to psychosurgery." In 1973, the Commonwealth of Massachusetts enacted regulations which would require informed written consent from voluntary patients before electroshock treatment could be performed.

Senator Sam Ervin's Committee lashed out bitterly at the mind control and behavior modification experiments and ordered them discontinued, they were not. The New England Journal of Medicine states, that the consent provisions now in place are "no more than an elaborate ritual." They called it "a device that when the subject is uneducated and uncomprehending, confers no more than a semblance of propriety on human experimentation."

The Nuremberg Tribunal brought to light that some of the most respected figures in the medical profession were involved in the vast crime network of the SS. Only 23 persons were charged with criminal activity in this area, despite the fact that hundreds of medical personnel were involved. The defendants were charged with crimes against humanity. They were found guilty of planning and executing experiments on humans without their consent, in a cruel and brutal manner which involved severe torture, deliberate murder and with the full knowledge of the gravity of their deeds. Only seven of the defendants were sentenced to death and hanged, others received life sentences. Five who were involved in the experiments were not tried. Ernest Grawitz committed suicide, Carl Clauberg was tried in the Soviet Union, Josef Mengele escaped to South America and was later captured by Israeli agents, Horst Schumann disappeared and Siegmund Rascher was executed by Himmler. US Use of Dachau Data and "Friendly" Nazi Doctors.

There were 200 German medical doctors conducting these medical experiments. Most of these doctors were friends of the United States before the war, and despite their inhuman experiments, the U.S. attempted to rebuild a relationship with them after the war. The knowledge the Germans had accumulated at the expense of human life and suffering, was considered a "booty of war", by the Americans and the Russians.The Americans tracked down Dr. Strughold, the aviation doctor who was in charge of the Dachau experiments. With full knowledge that the experiments were conducted on captive humans, the U.S. recruited the doctors to work for them. General Dwight D. Eisenhower gave his personal approval to exploit the work and research of the Nazi's in the death camps.
Within weeks of Eisenhower's order, many of these notorious doctors were working for the U.S. Army at Heidelberg. Army teams scoured Europe for scientific experimental apparatus such as pressure chambers, compressors, G-force machines, giant centrifuges, and electron microscopes. These doctors were wined and dined by the U.S. Army while most of Germany's post-war citizens virtually starved.

The German doctors were brought to the U.S. and went to work for Project Paperclip. All these doctors had been insulated against war crime charges. The Nuremberg prosecutors were shocked that U.S. authorities were using the German doctors despite their criminal past. Under the leadership of Strughold, 34 scientists accepted contracts from Project Paperclip, and were moved to Randolph Air Force Base at San Antonio, Texas. The authorization to hire these Nazi scientists came directly for the Joint Chiefs of Staff. The top military brass stated that they wished to exploit these rare minds. Project Paperclip, ironically, would use Nazi doctors to develop methods of interrogating German prisoners of war. As hostilities began to build after the war between the Americans and the Russians, the U.S. imported as many as 1000 former Nazi scientists.

In 1969, Americans landed on the moon, and two groups of scientist in the control center shared the credit, the rocket team from Peenemunde, Germany, under the leadership of Werner von Braun, these men had perfected the V-2s which were built in the Nordhausen caves where 20,000 slave laborers from prison camp Dora had been worked to death. The second group were the space doctors, lead by 71-year-old Dr. Hubertus Strughold, whose work was pioneered in Experimental Block No. 5 of the Dachau concentration camp and the torture and death of hundreds of inmates. The torture chambers that was used to slowly kill the prisoners of the Nazi's were the test beds for the apparatus that protected Neil Armstrong from harm, from lack of oxygen, and pressure, when he walked on the moon.

# *Office of Policy Coordination*

In 1948 Frank Wisner was appointed director of the Office of Special Projects. Soon afterwards it was renamed the Office of Policy Coordination (OPC). This became the espionage and counter-intelligence branch of the Central Intelligence Agency. Wisner was told to create an organization that concentrated on "propaganda, economic warfare; preventive direct action, including sabotage, anti-sabotage, demolition and evacuation measures; subversion against hostile states, including assistance to underground resistance groups, and support of indigenous anti-Communist elements in threatened countries of the free world."
Later that year Wisner established Mockingbird, a program to influence the domestic American media. Wisner recruited Philip Graham (*Washington Post*) to run the project within the industry. Graham himself recruited others who had worked for military intelligence during the war. This included James Truitt, Russell Wiggins, Phil Geyelin, John Hayes and Alan Barth. Others like Stewart Alsop, Joseph Alsop and James Reston, were recruited from within the Georgetown Set. According to Deborah Davis (*Katharine the Great*): "By the early 1950s, Wisner 'owned' respected members of the New York Times, Newsweek, CBS and other communications vehicles."

In 1951 Allen W. Dulles persuaded Cord Meyer to join the CIA. However, there is evidence that he was recruited several years earlier and had been spying on the liberal organizations he had been a member of in the later 1940s. According to Deborah Davis, Meyer became Mockingbird's "principal operative".

One of the most important journalists under the control of Operation Mockingbird was Joseph Alsop, whose articles appeared in over 300 different newspapers. Other journalists willing to promote the views of the CIA included Stewart Alsop (*New York Herald Tribune*), Ben Bradlee (*Newsweek*), James Reston (*New York Times*), Charles Douglas Jackson (*Time Magazine*), Walter Pincus (*Washington Post*), William C. Baggs (*Miami News*), Herb Gold (*Miami News*) and Charles Bartlett (*Chattanooga Times*). According to Nina Burleigh (*A Very Private Woman*) these journalists sometimes wrote articles that were commissioned by Frank Wisner. The

CIA also provided them with classified information to help them with their work.

After 1953 the network was overseen by Allen W. Dulles, director of the Central Intelligence Agency. By this time Operation Mockingbird had a major influence over 25 newspapers and wire agencies. These organizations were run by people with well-known right-wing views such as William Paley (CBS), Henry Luce (*Time Magazine* and *Life Magazine*), Arthur Hays Sulzberger (*New York Times*), Alfred Friendly (managing editor of the *Washington Post*), Jerry O'Leary (*Washington Star*), Hal Hendrix (*Miami News*), Barry Bingham Sr., (*Louisville Courier-Journal*), James Copley (Copley News Services) and Joseph Harrison (*Christian Science Monitor*).
The Office of Policy Coordination (OPC) was funded by siphoning of funds intended for the Marshall Plan. Some of this money was used to bribe journalists and publishers. Frank Wisner was constantly looked for ways to help convince the public of the dangers of communism. In 1954 Wisner arranged for the funding the Hollywood production of *Animal Farm*, the animated allegory based on the book written by George Orwell.

According to Alex Constantine (*Mockingbird: The Subversion Of The Free Press By The CIA*), in the 1950s, "some 3,000 salaried and contract CIA employees were eventually engaged in propaganda efforts". Wisner was also able to restrict newspapers from reporting about certain events. For example, the CIA plots to overthrow the governments of Iran and Guatemala.

Thomas Braden, head of the of International Organizations Division (IOD), played an important role in Operation Mockingbird. Many years later he revealed his role in these events: "If the director of CIA wanted to extend a present, say, to someone in Europe - a Labour leader - suppose he just thought, This man can use fifty thousand dollars, he's working well and doing a good job - he could hand it to him and never have to account to anybody... There was simply no limit to the money it could spend and no limit to the people it could hire and no limit to the activities it could decide were necessary to conduct the war - the secret war.... It was a multinational. Maybe it was one of the first. Journalists were a target, labor unions a particular target - that was one of the activities in which the communists spent the most money."

In August, 1952, the Office of Policy Coordination and the Office of Special Operations (the espionage division) were merged to form the Directorate of Plans (DPP). Frank Wisner became head of this new organization and Richard Helms became his chief of operations. Mockingbird was now the responsibility of the DPP.

J. Edgar Hoover became jealous of the CIA's growing power. He described the OPC as "Wisner's gang of weirdos" and began carrying out investigations into their past. It did not take him long to discover that some of them had been active in left-wing politics in the 1930s. This information was passed to who started making attacks on members of the OPC. Hoover also gave McCarthy details of an affair that Frank Wisner had with Princess Caradja in Romania during the war. Hoover, claimed that Caradja was a Soviet agent.

Joseph McCarthy also began accusing other senior members of the CIA as being security risks. McCarthy claimed that the CIA was a "sinkhole of communists" and claimed he intended to root out a hundred of them. One of his first targets was Cord Meyer, who was still working for Operation Mockingbird. In August, 1953, Richard Helms, Wisner's deputy at the OPC, told Meyer that Joseph McCarthy had accused him of being a communist. The Federal Bureau of Investigation added to the smear by announcing it was unwilling to give Meyer "security clearance". However, the FBI refused to explain what evidence they had against Meyer. Allen W. Dulles and both came to his defence and refused to permit a FBI interrogation of Meyer.

Joseph McCarthy did not realise what he was taking on. Wisner unleashed Mockingbird on McCarthy. Drew Pearson, Joe Alsop, Jack Anderson, Walter Lippmann and Ed Murrow all went into attack mode and McCarthy was permanently damaged by the press coverage orchestrated by Wisner.

Mockingbird was very active during the overthrow of Jacobo Arbenz in Guatemala. People like Henry Luce was able to censor stories that appeared too sympathetic towards the plight of Arbenz. Allen W. Dulles was even able to keep left-wing journalists from travelling to Guatemala. This including Sydney Gruson of the *New York Times*.

In 1955 President Dwight Eisenhower established the 5412 Committee in order to keep a check on the CIA's covert activities. The committee (also called the Special Group) included the CIA director, the national security adviser, and the deputy secretaries at State and Defence and had the responsibility to decide whether covert actions were "proper" and in the national interest. It was also decided to include Richard B. Russell, chairman of the Senate Armed Services Committee. However, as Allen W. Dulles was later to admit, because of "plausible deniability" planned covert actions were not referred to the 5412 Committee.

Dwight Eisenhower became concerned about CIA covert activities and in 1956 appointed David Bruce as a member of the President's Board of Consultants on Foreign Intelligence Activities (PBCFIA). Eisenhower asked Bruce to write a report on the CIA. It was presented to Eisenhower on 20th December, 1956. Bruce argued that the CIA's covert actions were "responsible in great measure for stirring up the turmoil and raising the doubts about us that exists in many countries in the world today." Bruce was also highly critical of Mockingbird. He argued: "what right have we to go barging around in other countries buying newspapers and handling money to opposition parties or supporting a candidate for this, that, or the other office."

After Richard Bissell lost his post as Director of Plans in 1962, Tracy Barnes took over the running of Mockingbird. According to Evan Thomas (*The Very Best Men*) Barnes planted editorials about political candidates who were regarded as pro-CIA.

In 1963, John McCone, the director of the CIA, discovered that Random House intended to publish *Invisible Government* by David Wise and Thomas Ross. McCone discovered that the book intended to look at his links with the Military Industrial Congress Complex. The authors also claimed that the CIA was having a major influence on American foreign policy. This included the overthrow of Mohammed Mossadegh in Iran (1953) and Jacobo Arbenz in Guatemala (1954). The book also covered the role that the CIA played in the Bay of Pigs operation, the attempts to remove President Sukarno in Indonesia and the covert operations taking place in Laos and Vietnam.

John McCone called in Wise and Ross to demand deletions on the basis of galleys the CIA had secretly obtained from Random House. The authors refused to made these changes and Random House decided to go ahead and publish the book. The CIA considered buying up the entire printing of *Invisible Government* but this idea was rejected when Random House pointed out that if this happened they would have to print a second edition. McCone now formed a special group to deal with the book and tried to arrange for it to get bad reviews.

*Invisible Government* was published in 1964. It was the first full account of America's intelligence and espionage apparatus. In the book Wise and Ross argued that the "Invisible Government is made up of many agencies and people, including the intelligence branches of the State and Defense Departments, of the Army, Navy and Air Force". However, they claimed that the most important organization involved in this process was the CIA.

John McCone also attempted to stop Edward Yates from making a documentary on the CIA for the National Broadcasting Company (NBC). This attempt at censorship failed and NBC went ahead and broadcast this critical documentary.

In June, 1965, Desmond FitzGerald was appointed as head of the Directorate for Plans. He now took charge of Mockingbird. At the end of 1966 FitzGerald discovered that *Ramparts*, a left-wing publication, was planning to publish that the CIA had been secretly funding the National Student Association. FitzGerald ordered Edgar Applewhite to organize a campaign against the magazine. Applewhite later told Evan Thomas for his book, *The Very Best Men*: "I had all sorts of dirty tricks to hurt their circulation and financing. The people running Ramparts were vulnerable to blackmail. We had awful things in mind, some of which we carried off."

This dirty tricks campaign failed to stop *Ramparts* publishing this story in March, 1967. The article, written by Sol Stern, was entitled *NSA and the CIA*. As well as reporting CIA funding of the National Student Association it exposed the whole system of anti-Communist front organizations in Europe, Asia, and South America. It named Cord Meyer as a key figure in this campaign. This included the funding of the literary journal *Encounter*.

In May 1967 Thomas Braden responded to this by publishing an article entitled, *I'm Glad the CIA is Immoral*, in the *Saturday Evening Post*, where he defended the activities of the International Organizations Division unit of the CIA. Braden also confessed that the activities of the CIA had to be kept secret from Congress. As he pointed out in the article: "In the early 1950s, when the cold war was really hot, the idea that Congress would have approved many of our projects was about as likely as the John Birch Society's approving Medicare."

Meyer's role in Operation Mockingbird was further exposed in 1972 when he was accused of interfering with the publication of a book, *The Politics of Heroin in Southeast Asia* by Alfred W. McCoy. The book was highly critical of the CIA's dealings with the drug traffic in Southeast Asia. The publisher, who leaked the story, had been a former colleague of Meyer's when he was a liberal activist after the war.

Further details of Operation Mockingbird was revealed as a result of the Frank Church investigations (Select Committee to Study Governmental Operations with Respect to Intelligence Activities) in 1975. According to the Congress report published in 1976: "The CIA currently maintains a network of several hundred foreign individuals around the world who provide intelligence for the CIA and at times attempt to influence opinion through the use of covert propaganda. These individuals provide the CIA with direct access to a large number of newspapers and periodicals, scores of press services and news agencies, radio and television stations, commercial book publishers, and other foreign media outlets." Church argued that the cost of misinforming the world cost American taxpayers an estimated $265 million a year.

In February, 1976, George Bush, the recently appointed Director of the CIA announced a new policy: “Effective immediately, the CIA will not enter into any paid or contract relationship with any full-time or part-time news correspondent accredited by any U.S. news service, newspaper, periodical, radio or television network or station.” However, he added that the CIA would continue to “welcome” the voluntary, unpaid cooperation of journalists.

Carl Bernstein, who had worked with Bob Woodward in the investigation of Watergate, provided further information about Operation Mockingbird in an article in *Rolling Stone* in October, 1977. Bernstein claimed that over a 25 year period over 400 American journalists secretly carried out assignments for the CIA: "Some of the journalists were Pulitzer Prize winners, distinguished reporters who considered themselves ambassadors-without-portfolio for their country. Most were less exalted: foreign correspondents who found that their association with the Agency helped their work; stringers and freelancers who were as interested it the derring-do of the spy business as in filing articles, and, the smallest category, full-time CIA employees masquerading as journalists abroad."

It is almost certain that Bernstein had encountered Operation Mockingbird while working on his Watergate investigation. For example, Deborah Davis (*Katharine the Great*) has argued that Deep Throat was senior CIA official, Richard Ober, who was running Operation Chaos for Richard Nixon during this period.

According to researchers such as Steve Kangas, Angus Mackenzie and Alex Constantine, Operation Mockingbird was not closed down by the CIA in 1976. For example, in 1998 Kangas argued that CIA asset Richard Mellon Scaife ran "Forum World Features, a foreign news service used as a front to disseminate CIA propaganda around the world."

On 8th February, 1999, Kangas was found dead in the bathroom of the Pittsburgh offices of Richard Mellon Scaife. He had been shot in the head. Officially he had committed suicide but some people believe he was murdered. In an article in *Salon Magazine*, (19th March, 1999) Andrew Leonard asked: "Why did the police report say the gun wound was to the left of his head, while the autopsy reported a wound on the roof of his mouth? Why had the hard drive on his computer been erased shortly after his death? Why had Scaife assigned his No. 1 private detective, Rex Armistead, to look into Kangas' past?"

| **United States Patent** | ***6,506,148*** |
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| **Loos** | **January 14, 2003** |

# Nervous system manipulation by electromagnetic fields from monitors


**Abstract**

Physiological effects have been observed in a human subject in response to stimulation of the skin with weak electromagnetic fields that are pulsed with certain frequencies near 1/2 Hz or 2.4 Hz, such as to excite a sensory resonance. Many computer monitors and TV tubes, when displaying pulsed images, emit pulsed electromagnetic fields of sufficient amplitudes to cause such excitation. It is therefore possible to manipulate the nervous system of a subject by pulsing images displayed on a nearby computer monitor or TV set. For the latter, the image pulsing may be imbedded in the program material, or it may be overlaid by modulating a video stream, either as an RF signal or as a video signal. The image displayed on a computer monitor may be pulsed effectively by a simple computer program. For certain monitors, pulsed electromagnetic fields capable of exciting sensory resonances in nearby subjects may be generated even as the displayed images are pulsed with subliminal intensity.



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| **Field of Search:** | 600/9-27,545 313/419 324/318 378/901 434/236 |



**References Cited [Referenced By]**

**U.S. Patent Documents**

| | | | |
|---|---|---|---|
| 3592965 | Jul., 1971 | Diaz | 313/419. |
| 4800893 | Jan., 1989 | Ross et al. | 600/545. |
| 5169380 | Dec., 1992 | Brennan | 600/26. |
| 5304112 | Apr., 1994 | Mrklas et al. | 434/236. |
| 5400383 | Mar., 1995 | Yassa et al. | 378/901. |
| 5412419 | May., 1995 | Ziarati | 324/318. |
| 5450859 | Sep., 1995 | Litovitz | 600/9. |
| 5782874 | Jul., 1998 | Loos | 607/2. |
| 5800481 | Sep., 1998 | Loos | 607/100. |
| 5899922 | May., 1999 | Loos | 607/2. |
| 5935054 | Aug., 1999 | Loos | 600/9. |
| 6017302 | Jan., 2000 | Loos | 600/28. |
| 6081744 | Jun., 2000 | Loos | 607/2. |
| 6091994 | Jul., 2000 | Loos | 607/100. |
| 6167304 | Dec., 2000 | Loos | 607/2. |
| 6238333 | May., 2001 | Loos | 600/9. |

## Other References

N.Wiener "Nonlinear problems in random theory" p.71-72 John Wiley New York 1958.
M.Hutchison "Megabrain" p.232-3 Ballantine Books New York 1991.
C.A.Terzuolo and T.H.Bullock "Measurement of imposed voltage gradient adequate to modulate neuronal firing" Proc. Nat. Acad. Sci, Physiology 42,687-94, 1956.
O.Kellogg"Foundations of Potential Theory"p. 191 Dover, 1953.
P.M.Morse and H.Feshbach"Methods of Theoretical Physics"p. 1267 McGraw-Hill New York, 1953.

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***Claims***

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I claim:

1. A method for manipulating the nervous system of a subject located near a monitor, the monitor emitting an electromagnetic field when displaying an image by virtue of the physical display process, the subject having a sensory resonance frequency, the method comprising:

creating a video signal for displaying an image on the monitor, the image having an intensity;

modulating the video signal for pulsing the image intensity with a frequency in the range 0.1 Hz to 15 Hz; and

setting the pulse frequency to the resonance frequency.

2. A computer program for manipulating the nervous system of a subject located near a monitor, the monitor emitting an electromagnetic field when displaying an image by virtue of the physical display process, the subject having cutaneous nerves that fire spontaneously and have spiking patterns, the computer program comprising:

a display routine for displaying an image on the monitor, the image having an intensity;

a pulse routine for pulsing the image intensity with a frequency in the range 0.1 Hz to 15 Hz; and

a frequency routine that can be internally controlled by the subject, for setting the frequency;

whereby the emitted electromagnetic field is pulsed, the cutaneous nerves are exposed to the pulsed electromagnetic field, and the spiking patterns of the nerves acquire a frequency modulation.

3. The computer program of claim 2, wherein the pulsing has an amplitude and the program further comprises an amplitude routine for control of the amplitude by the subject.

4. The computer program of claim 2, wherein the pulse routine comprises:

a timing procedure for timing the pulsing; and

an extrapolation procedure for improving the accuracy of the timing procedure.

5. The computer program of claim 2, further comprising a variability routine for introducing variability in the pulsing.

6. Hardware means for manipulating the nervous system of a subject located near a monitor, the monitor being responsive to a video stream and emitting an electromagnetic field when displaying an image by virtue of the physical display process, the image having an intensity, the subject having cutaneous nerves that fire spontaneously and have spiking patterns, the hardware means comprising:

pulse generator for generating voltage pulses;

means, responsive to the voltage pulses, for modulating the video stream to pulse the image intensity;

whereby the emitted electromagnetic field is pulsed, the cutaneous nerves are exposed to the pulsed electromagnetic field, and the spiking patterns of the nerves acquire a frequency modulation.

7. The hardware means of claim 6, wherein the video stream is a composite video signal that has a pseudo-dc level, and the means for modulating the video stream comprise means for pulsing the pseudo-dc level.

8. The hardware means of claim 6, wherein the video stream is a television broadcast signal, and the means for modulating the video stream comprise means for frequency wobbling of the television broadcast signal.

9. The hardware means of claim 6, wherein the monitor has a brightness adjustment terminal, and the means for modulating the video stream comprise a connection from the pulse generator to the brightness adjustment terminal.

10. A source of video stream for manipulating the nervous system of a subject located near a monitor, the monitor emitting an electromagnetic field when displaying an image by virtue of the physical display process, the subject having cutaneous nerves that fire spontaneously and have spiking patterns, the source of video stream comprising:

means for defining an image on the monitor, the image having an intensity; and

means for subliminally pulsing the image intensity with a frequency in the range 0.1 Hz to 15 Hz;

whereby the emitted electromagnetic field is pulsed, the cutaneous nerves are exposed to the pulsed electromagnetic field, and the spiking patterns of the nerves acquire a frequency modulation.

11. The source of video stream of claim 10 wherein the source is a recording medium that has recorded data, and the means for subliminally pulsing the image intensity comprise an attribute of the recorded data.

12. The source of video stream of claim 10 wherein the source is a computer program, and the means for subliminally pulsing the image intensity comprise a pulse routine.

13. The source of video stream of claim 10 wherein the source is a recording of a physical scene, and the means for subliminally pulsing the image intensity comprise:

pulse generator for generating voltage pulses;

light source for illuminating the scene, the light source having a power level; and

modulation means, responsive to the voltage pulses, for pulsing the power level.

14. The source of video stream of claim 10, wherein the source is a DVD, the video stream comprises a luminance signal and a chrominance signal, and the means for subliminal pulsing of the image intensity comprise means for pulsing the luminance signal.

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***Description***

BACKGROUND OF THE INVENTION

The invention relates to the stimulation of the human nervous system by an electromagnetic field applied externally to the body. A neurological effect of external electric fields has been mentioned by Wiener (1958), in a discussion of the bunching of brain waves through nonlinear interactions. The electric field was arranged to provide "a direct electrical driving of the brain". Wiener describes the field as set up by a 10 Hz alternating voltage of 400 V applied in a room between ceiling and ground. Brennan (1992) describes in U.S. Pat. No. 5,169,380 an apparatus for alleviating disruptions in circadian rythms of a mammal, in which an alternating electric field is applied across the head of the subject by two electrodes placed a short distance from the skin.

A device involving a field electrode as well as a contact electrode is the "Graham Potentializer" mentioned by Hutchison (1991). This relaxation device uses motion, light and sound as well as an alternating electric field applied mainly to the head. The contact electrode is a metal bar in Ohmic contact with the bare feet of the subject, and the field electrode is a hemispherical metal headpiece placed several inches from the subject's head.

In these three electric stimulation methods the external electric field is applied predominantly to the head, so that electric currents are induced in the brain in the physical manner governed by electrodynamics. Such currents can be largely avoided by applying the field not to the head, but rather to skin areas away from the head. Certain cutaneous receptors may then be stimulated and they would provide a signal input into the brain along the natural pathways of afferent nerves. It has been found that, indeed, physiological effects can be induced in this manner by very weak electric fields, if they are pulsed with a frequency near 1/2 Hz. The observed effects include ptosis of the eyelids, relaxation, drowziness, the feeling of pressure at a centered spot on the lower edge of the brow, seeing moving patterns of dark purple and greenish yellow with the eyes closed, a tonic smile, a tense feeling in the stomach, sudden loose stool, and sexual excitement, depending on the precise frequency used, and the skin area to which the field is applied. The sharp frequency dependence suggests involvement of a resonance mechanism.

It has been found that the resonance can be excited not only by externally applied pulsed electric fields, as discussed in U.S. Pat. Nos. 5,782,874, 5,899,922, 6,081,744, and 6,167,304, but also by pulsed magnetic fields, as described in U.S. Pat. Nos. 5,935,054 and 6,238,333, by weak heat pulses applied to the skin, as discussed in U.S. Pat. Nos. 5,800,481 and 6,091,994, and by subliminal acoustic pulses, as described in U.S. Pat. No. 6,017,302. Since the resonance is excited through sensory pathways, it is called a sensory resonance. In addition to the resonance near 1/2 Hz, a sensory resonance has been found near 2.4 Hz. The latter is characterized by the slowing of certain cortical processes, as discussed in the '481, '922, '302, '744, '944, and '304 patents.

The excitation of sensory resonances through weak heat pulses applied to the skin provides a clue about what is going on neurologically. Cutaneous temperature-sensing receptors are known to fire spontaneously. These nerves spike somewhat randomly around an average rate that depends on skin temperature. Weak heat pulses delivered to the skin in periodic fashion will therefore cause a slight frequency modulation (fm) in the spike patterns generated by the nerves. Since stimulation through other sensory modalities results in similar physiological effects, it is believed that frequency modulation of spontaneous afferent neural spiking patterns occurs there as well.

It is instructive to apply this notion to the stimulation by weak electric field pulses administered to the skin. The externally generated fields induce electric current pulses in the underlying tissue, but the current density is much too small for firing an otherwise quiescent nerve. However, in experiments with adapting stretch receptors of the crayfish, Terzuolo and Bullock (1956) have observed that very small electric fields can suffice for modulating the firing of already active nerves. Such a modulation may occur in the electric field stimulation under discussion.

Further understanding may be gained by considering the electric charges that accumulate on the skin as a result of the induced tissue currents. Ignoring thermodynamics, one would expect the accumulated polarization charges to be confined strictly to the outer surface of the skin. But charge density is caused by a slight excess in positive or negative ions, and thermal motion distributes the ions through a thin layer. This implies that the externally applied electric field actually penetrates a short distance into the tissue, instead of stopping abruptly at the outer skin surface. In this manner a considerable fraction of the applied field may be brought to bear on some cutaneous nerve endings, so that a slight modulation of the type noted by Terzuolo and Bullock may indeed occur.

The mentioned physiological effects are observed only when the strength of the electric field on the skin lies in a certain range, called the effective intensity window. There also is a bulk effect, in that weaker fields suffice when the field is applied to a larger skin area. These effects are discussed in detail in the '922 patent.

Since the spontaneous spiking of the nerves is rather random and the frequency modulation induced by the pulsed field is very shallow, the signal to noise ratio (S/N) for the fm signal contained in the spike trains along the afferent nerves is so small as to make recovery of the fm signal from a single nerve fiber impossibile. But application of the field over a large skin area causes simultaneous stimulation of many cutaneous nerves, and the fm modulation is then coherent from nerve to nerve. Therefore, if the afferent signals are somehow summed in the brain, the fm modulations add while the spikes from different nerves mix and interlace. In this manner the S/N can be increased by appropriate neural processing. The matter is discussed in detail in the '874 patent. Another increase in sensitivity is due to involving a resonance mechanism, wherein considerable neural circuit oscillations can result from weak excitations.

An easily detectable physiological effect of an excited 1/2 Hz sensory resonance is ptosis of the eyelids. As discussed in the '922 patent, the ptosis test involves first closing the eyes about half way. Holding this eyelid position, the eyes are rolled upward, while giving up voluntary control of the eyelids. The eyelid position is then determined by the state of the autonomic nervous system. Furthermore, the pressure excerted on the eyeballs by the partially closed eyelids increases parasympathetic activity. The eyelid position thereby becomes somewhat labile, as manifested by a slight flutter. The labile state is sensitive to very small shifts in autonomic state. The ptosis influences the extent to which the pupil is hooded by the eyelid, and thus how much light is admitted to the eye. Hence, the depth of the ptosis is seen by the subject, and can be graded on a scale from 0 to 10.

In the initial stages of the excitation of the 1/2 Hz sensory resonance, a downward drift is detected in the ptosis frequency, defined as the stimulation frequency for which maximum ptosis is obtained. This drift is believed to be caused by changes in the chemical milieu of the resonating neural circuits. It is thought that the resonance causes perturbations of chemical concentrations somewhere in the brain, and that these perturbations spread by diffusion to nearby resonating circuits. This effect, called "chemical detuning", can be so strong that ptosis is lost altogether when the stimulation frequency is kept constant in the initial stages of the excitation. Since the stimulation then falls somewhat out of tune, the resonance decreases in amplitude and chemical detuning eventually diminishes. This causes the ptosis frequency to shift back up, so that the stimulation is more in tune and the ptosis can develop again. As a result, for fixed stimulation frequencies in a certain range, the ptosis slowly cycles with a frequency of several minutes. The matter is discussed in the '302 patent.

The stimulation frequencies at which specific physiological effects occur depend somewhat on the autonomic nervous system state, and probably on the endocrine state as well.

Weak magnetic fields that are pulsed with a sensory resonance frequency can induce the same physiological effects as pulsed electric fields. Unlike the latter however, the magnetic fields penetrate biological tissue with nearly undiminished strength. Eddy currents in the tissue drive electric charges to the skin, where the charge distributions are subject to thermal smearing in much the same way as in electric field stimulation, so that the same physiological effects develop. Details are discussed in the '054 patent.

SUMMARY

Computer monotors and TV monitors can be made to emit weak low-frequency electromagnetic fields merely by pulsing the intensity of displayed images. Experiments have shown that the 1/2 Hz sensory resonance can be excited in this manner in a subject near the monitor. The 2.4 Hz sensory resonance can also be excited in this fashion. Hence, a TV monitor or computer monitor can be used to manipulate the nervous system of nearby people.

The implementations of the invention are adapted to the source of video stream that drives the monitor, be it a computer program, a TV broadcast, a video tape or a digital video disc (DVD).

For a computer monitor, the image pulses can be produced by a suitable computer program. The pulse frequency may be controlled through keyboard input, so that the subject can tune to an individual sensory resonance frequency. The pulse amplitude can be controlled as well in this manner. A program written in Visual Basic(R) is particularly suitable for use on computers that run the Windows 95(R) or Windows 98(R) operating system. The structure of such a program is described. Production of periodic pulses requires an accurate timing procedure. Such a procedure is constructed from the GetTimeCount function available in the Application Program Interface (API) of the Windows operating system, together with an extrapolation procedure that improves the timing accuracy.

Pulse variability can be introduced through software, for the purpose of thwarting habituation of the nervous system to the field stimulation, or when the precise resonance frequency is not known. The variability may be a pseudo-random variation within a narrow interval, or it can take the form of a frequency or amplitude sweep in time. The pulse variability may be under control of the subject.

The program that causes a monitor to display a pulsing image may be run on a remote computer that is connected to the user computer by a link; the latter may partly belong to a network, which may be the Internet.

For a TV monitor, the image pulsing may be inherent in the video stream as it flows from the video source, or else the stream may be modulated such as to overlay the pulsing. In the first case, a live TV broadcast can be arranged to have the feature imbedded simply by slightly pulsing the illumination of the scene that is being broadcast. This method can of course also be used in making movies and recording video tapes and DVDs.

Video tapes can be edited such as to overlay the pulsing by means of modulating hardware. A simple modulator is discussed wherein the luminance signal of composite video is pulsed without affecting the chroma signal. The same effect may be introduced at the consumer end, by modulating the video stream that is produced by the video source. A DVD can be edited through software, by introducing pulse-like variations in the digital RGB signals. Image intensity pulses can be overlaid onto the analog component video output of a DVD player by modulating the luminance signal component. Before entering the TV set, a television signal can be modulated such as to cause pulsing of the image intensity by means of a variable delay line that is connected to a pulse generator.

Certain monitors can emit electromagnetic field pulses that excite a sensory resonance in a nearby subject, through image pulses that are so weak as to be subliminal. This is unfortunate since it opens a way for mischievous application of the invention, whereby people are exposed

unknowingly to manipulation of their nervous systems for someone else's purposes. Such application would be unethical and is of course not advocated. It is mentioned here in order to alert the public to the possibility of covert abuse that may occur while being online, or while watching TV, a video, or a DVD.

DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates the electromagnetic field that emanates from a monitor when the video signal is modulated such as to cause pulses in image intensity, and a nearby subject who is exposed to the field.

FIG. 2 shows a circuit for modulation of a composite video signal for the purpose of pulsing the image intensity.

FIG. 3 shows the circuit for a simple pulse generator.

FIG. 4 illustrates how a pulsed electromagnetic field can be generated with a computer monitor.

FIG. 5 shows a pulsed electromagnetic field that is generated by a television set through modulation of the RF signal input to the TV.

FIG. 6 outlines the structure of a computer program for producing a pulsed image.

FIG. 7 shows an extrapolation procedure introduced for improving timing accuracy of the program of FIG. 6.

FIG. 8 illustrates the action of the extrapolation procedure of FIG. 7.

FIG. 9 shows a subject exposed to a pulsed electromagnetic field emanating from a monitor which is responsive to a program running on a remote computer via a link that involves the Internet.

FIG. 10 shows the block diagram of a circuit for frequency wobbling of a TV signal for the purpose of pulsing the intensity of the image displayed on a TV monitor.

FIG. 11 depicts schematically a recording medium in the form of a video tape with recorded data, and the attribute of the signal that causes the intensity of the displayed image to be pulsed.

FIG. 12 illustrates how image pulsing can be embedded in a video signal by pulsing the illumination of the scene that is being recorded.

FIG. 13 shows a routine that introduces pulse variability into the computer program of FIG. 6.

FIG. 14 shows schematically how a CRT emits an electromagnetic field when the displayed image is pulsed.

FIG. 15 shows how the intensity of the image displayed on a monitor can be pulsed through the brightness control terminal of the monitor.

FIG. 16 illustrates the action of the polarization disc that serves as a model for grounded conductors in the back of a CRT screen.

FIG. 17 shows the circuit for overlaying image intensity pulses on a DVD output.

FIG. 18 shows measured data for pulsed electric fields emitted by two different CRT type monitors, and a comparison with theory.

## DETAILED DESCRIPTION

Computer monitors and TV monitors emit electromagnetic fields. Part of the emission occurs at the low frequencies at which displayed images are changing. For instance, a rythmic pulsing of the intensity of an image causes electromagnetic field emission at the pulse frequency, with a strength proportional to the pulse amplitude. The field is briefly referred to as "screen emission". In discussing this effect, any part or all what is displayed on the monitor screen is called an image. A monitor of the cathode ray tube (CRT) type has three electron beams, one for each of the basic colors red, green, and blue. The intensity of an image is here defined as

I=.intg.j dA, (1)

where the integral extends over the image, and

j=jr+jg+jb, (2)

jr, jg, and jb being the electric current densities in the red, green, and blue electron beams at the surface area dA of the image on the screen. The current densities are to be taken in the distributed electron beam model, where the discreteness of pixels and the raster motion of the beams are ignored, and the back of the monitor screen is thought to be irradiated by diffuse electron beams. The beam current densities are then functions of the coordinates x and y over the screen. The model is appropriate since we are interested in the electromagnetic field emision caused by image pulsing with the very low frequencies of sensory resonances, whereas the emissions with the much higher horizontal and vertical sweep frequencies are of no concern. For a CRT the intensity of an image is expressed in millamperes.

For a liquid crystal display (LCD), the current densities in the definition of image intensity are to be replaced by driving voltages, multiplied by the aperture ratio of the device. For an LCD, image intensities are thus expressed in volts.

It will be shown that for a CRT or LCD screen emissions are caused by fluctuations in image intensity. In composite video however, intensity as defined above is not a primary signal feature, but luminance Y is. For any pixel one has

Y=0.299R+0.587G+0.114B, (3)

where R, G, and B are the intensities of the pixel respectively in red, green and blue, normalized such as to range from 0 to 1. The definition (3) was provided by the Commission Internationale de l'Eclairage (CIE), in order to account for brightness differences at different colors, as perceived by the human visual system. In composite video the hue of the pixel is determined by the chroma signal or chrominance, which has the components R-Y and B-Y It follows that pulsing pixel luminance while keeping the hue fixed is equivalent to pulsing the pixel intensity, up to an amplitude factor. This fact will be relied upon when modulating a video stream such as to overlay image intensity pulses.

It turns out that the screen emission has a multipole expansion wherein both monopole and dipole contributions are proportional to the rate of change of the intensity I of (1). The higher order multipole contributions are proportional to the rate of change of moments of the current density j over the image, but since these contributions fall off rapidly with distance, they are not of practical importance in the present context. Pulsing the intensity of an image may involve different pulse amplitudes, frequencies, or phases for different parts of the image. Any or all of these features may be under subject control.

The question arises whether the screen emission can be strong enough to excite sensory resonances in people located at normal viewing distances from the monitor. This turns out to be the case, as shown by sensory resonance experiments and independently by measuring the strength of the emitted electric field pulses and comparing the results with the effective intensity window as explored in earlier work.

One-half Hertz sensory resonance experiments have been conducted with the subject positioned at least at normal viewing distance from a 15" computer monitor that was driven by a computer program written in Visual Basic(R), version 6.0 (VB6). The program produces a pulsed image with uniform luminance and hue over the full screen, except for a few small control buttons and text boxes. In VB6, screen pixel colors are determined by integers R, G, and B, that range from 0 to 255, and set the contributions to the pixel color made by the basic colors red, green, and blue. For a CRT-type monitor, the pixel intensities for the primary colors may depend on the RGB values in a nonlinear manner that will be discussed. In the VB6 program the RGB values are modulated by small pulses .DELTA.R, .DELTA.G, .DELTA.B, with a frequency that can be chosen by the subject or is swept in a predetermined manner. In the sensory resonance experiments mentioned above, the ratios .DELTA.R/R, .DELTA.G/G, and .DELTA.B/B were always smaller than 0.02, so that the image pulses are quite weak. For certain frequencies near 1/2 Hz, the subject experienced physiological effects that are known to accompany the excitation of the 1/2 Hz sensory resonance as mentioned in the Background Section. Moreover, the measured field pulse amplitudes fall within the effective intensity window for the 1/2 Hz resonance, as explored in earlier experiments and discussed in the '874, '744, '922, and '304 patents. Other experiments have shown that the 2.4 Hz sensory resonance can be exited as well by screen emissions from monitors that display pulsed images.

These results confirm that, indeed, the nervous system of a subject can be manipulated through electromagnetic field pulses emitted by a nearby CRT or LCD monitor which displays images with pulsed intensity.

The various implementations of the invention are adapted to the different sources of video stream, such as video tape, DVD, a computer program, or a TV broadcast through free space or cable. In all of these implementations, the subject is exposed to the pulsed electromagnetic field that is generated by the monitor as the result of image intensity pulsing. Certain cutaneous nerves of the subject exhibit spontaneous spiking in patterns which, although rather random, contain sensory information at least in the form of average frequency. Some of these nerves have receptors that respond to the field stimulation by changing their average spiking frequency, so that the spiking patterns of these nerves acquire a frequency modulation, which is conveyed to the brain. The modulation can be particularly effective if it has a frequency at or near a sensory resonance frequency. Such frequencies are expected to lie in the range from 0.1 to 15 Hz.

An embodiment of the invention adapted to a VCR is shown in FIG. 1, where a subject 4 is exposed to a pulsed electric field 3 and a pulsed magnetic field 39 that are emitted by a monitor 2, labeled "MON", as the result of pulsing the intensity of the displayed image. The image is here generated by a video casette recorder 1, labeled "VCR", and the pulsing of the image intensity is obtained by modulating the composite video signal from the VCR output. This is done by a video modulator 5, labeled "VM", which responds to the signal from the pulse generator 6, labeled "GEN". The frequency and amplitude of the image pulses can be adjusted with the frequency control 7 and amplitude control 8. Frequency and amplitude adjustments can be made by the subject.

The circuit of the video modulator 5 of FIG. 1 is shown in FIG. 2, where the video amplifiers 11 and 12 process the composite video signal that enters at the input terminal 13. The level of the video signal is modulated slowly by injecting a small bias current at the inverting input 17 of the first amplifier 11. This current is caused by voltage pulses supplied at the modulation input 16, and can be adjusted through the potentiometer 15. Since the noninverting input of the amplifier is grounded, the inverting input 17 is kept essentially at ground potential, so that the bias current is is not influenced by the video signal. The inversion of the signal by the first amplifier 11 is undone by the second amplifier 12. The gains of the amplifiers are chosen such as to give a unity overall gain. A slowly varying current injected at the inverting input 17 causes a slow shift in the "pseudo-dc" level of the composite video signal, here defined as the short-term average of the signal. Since the pseudo-dc level of the chroma signal section determines the luminance, the latter is modulated by the injected current pulses. The chroma signal is not affected by the slow modulation of the pseudodc level, since that signal is determined by the amplitude and phase with respect to the color carrier which is locked to the color burst. The effect on the sync pulses and color bursts is of no consequence either if the injected current pulses are very small, as they are in practice. The modulated composite video signal, available at the output 14 in FIG. 2, will thus exhibit a modulated luminance, whereas the chroma signal is unchanged. In the light of the foregoing discussion about luminance and intensity, it follows that the modulator of FIG. 2 causes a pulsing of the image intensity I. It remains to give an example how the pulse signal at the modulation input 16 may be obtained. FIG. 3 shows a pulse generator that is suitable for this purpose, wherein the RC timer 21 (Intersil ICM7555) is hooked up for astable operation and produces a square wave voltage with a frequency that is determined by capacitor 22 and potentiometer 23. The timer 21 is powered by a battery 26, controlled by the switch 27. The square wave voltage at output 25 drives the LED 24, which may be used for monitoring of the pulse frequency, and also serves as power indicator. The pulse output may be rounded in ways that are well known in the art. In the setup of FIG. 1, the output of VCR 1 is connected to the video input 13 of FIG. 2, and the video output 14 is connected to the monitor 2 of FIG. 1.

In the preferred embodiment of the invention, the image intensity pulsing is caused by a computer program. As shown in FIG. 4, monitor 2, labeled "MON", is connected to computer 31 labeled "COMPUTER", which runs a program that produces an image on the monitor and causes the image intensity to be pulsed. The subject 4 can provide input to the computer through the keyboard 32 that is connected to the computer by the connection 33. This input may involve adjustments of the frequency or the amplitude or the variability of the image intensity pulses. In particular, the pulse frequency can be set to a sensory resonance frequency of the subject for the purpose of exciting the resonance.

The structure of a computer program for pulsing image intensity is shown in FIG. 6. The program may be written in Visual Basic(R) version 6.0 (VB6), which involves the graphics interface familiar from the Windows(R) operating system. The images appear as forms equipped with user controls such as command buttons and scroll bars, together with data displays such as text boxes. A compiled VB6 program is an executable file. When activated, the program declares variables and functions to be called from a dynamic link library (DLL) that is attached to the operating system; an initial form load is performed as well. The latter comprises setting the screen color as specified by integers R, G, and B in the range 0 to 255, as mentioned above. In FIG. 6, the initial setting of the screen color is labeled as 50. Another action of the form load routine is the computation 51 of the sine function at eight equally spaced points, I=0 to 7, around the unit circle. These values are needed when modulating the RGB numbers. Unfortunately, the sine function is distorted by the rounding to integer RGB values that occurs in the VB6 program. The image is chosen to fill as much of the screen area as possible, and it has spatially uniform luminance and hue.

The form appearing on the monitor displays a command button for starting and stopping the image pulsing, together with scroll bars 52 and 53 respectively for adjustment of the pulse frequency F and the pulse amplitude A. These pulses could be initiated by a system timer which is activated upon the elapse of a preset time interval. However, timers in VB6 are too inaccurate for the purpose of providing the eight RGB adjustment points in each pulse cycle. An improvement can be obtained by using the GetTickCount function that is available in the Application Program Interface (API) of Windows 95(R) and Windows 98(R). The GetTickCount function returns the system time that has elapsed since starting Windows, expressed in milliseconds. User activation of the start button 54 provides a tick count TN through request 55 and sets the timer interval to TT miliseconds, in step 56. TT was previously calculated in the frequency routine that is activated by changing the frequency, denoted as step 52.

Since VB6 is an event-driven program, the flow chart for the program falls into disjoint pieces. Upon setting the timer interval to TT in step 56, the timer runs in the background while the program may execute subroutines such as adjustment of pulse frequency or amplitude. Upon elapse of the timer interval TT, the timer subroutine 57 starts execution with request 58 for a tick count, and in 59 an upgrade is computed of the time TN for the next point at which the RGB values are to be adjusted. In step 59 the timer is turned off, to be reactivated later in step 67. Step 59 also resets the parameter CR which plays a role in the extrapolation procedure 61 and the condition 60. For ease of understanding at this point, it is best to pretend that the action of 61 is simply to get a tick count, and to consider the loop controled by condition 60 while keeping CR equal to zero. The loop would terminate when the tick count M reaches or exceeds the time TN for the next phase point, at which time the program should adjust the image intensity through steps 63-65. For now step 62 is to be ignored also, since it has to do with the actual extrapolation procedure 61. The increments to the screen colors R1, G1, and B1 at the new phase point are computed according to the sine function, applied with the amplitude A that was set by the user in step 53. The number I that labels the phase point is incremented by unity in step 65, but if this results in I=8 the value is reset to zero in 66. Finally, the timer is reactivated in step 67, initiating a new 1/8-cycle step in the periodic progression of RGB adjustments.

A program written in this way would exhibit a large jitter in the times at which the RGB values are changed. This is due to the lumpiness in the tick counts returned by the GetTickCount function. The lumpiness may be studied separately by running a simple loop with C=GetTickCount, followed by writing the result C to a file. Inspection shows that C has jumped every 14 or 15 milliseconds, between long stretches of constant values. Since for a 1/2 Hz image intensity modulation the 1/8-cycle phase points are 250 ms apart, the lumpiness of 14 or 15 ms in the tick count would cause considerable inaccuracy. The full extrapolation procedure 61 is introduced in order to diminish the jitter to acceptable levels. The procedure works by refining the heavy-line staircase function shown in FIG. 8, using the slope RR of a recent staircase step to accurately determine the loop count 89 at which the loop controled by 60 needs to be exited. Details of the extrapolation procedure are shown in FIG. 7 and illustrated in FIG. 8. The procedure starts at 70 with both flags off, and CR=0, because of the assignment in 59 or 62 in

FIG. 6. A tick count M is obtained at 71, and the remaining time MR to the next phase point is computed in 72. Conditions 77 and 73 are not satisfied and therefore passed vertically in the flow chart, so that only the delay block 74 and the assignments 75 are executed. Condition 60 of FIG. 6 is checked and found to be satisfied, so that the extrapolation procedure is reentered. The process is repeated until the condition 73 is met when the remaining time MR jumps down through the 15 ms level, shown in FIG. 8 as the transition 83. The condition 73 then directs the logic flow to the assignments 76, in which the number DM labeled by 83 is computed, and FLG1 is set. The computation of DM is required for finding the slope RR of the straight-line element 85. One also needs the "Final LM" 86, which is the number of loops traversed from step 83 to the next downward step 84, here shown to cross the MR=0 axis. The final LM is determined after repeatedly incrementing LM through the side loop entered from the FLG1=1 condition 77, which is now satisfied since FLG1 was set in step 76. At the transition 84 the condition 78 is met, so that the assignments 79 are executed. This includes computation of the slope RR of the line element 85, setting FLG2, and resetting FLG1. From here on, the extrapolation procedure increments CR in steps of RR while skipping tick counts until condition 60 of FIG. 6 is violated, the loop is exited, and the RGB values are adjusted.

A delay block 74 is used in order to stretch the time required for traversing the extrapolation procedure. The block can be any computation intensive subroutine such as repeated calculations of tangent and arc tangent functions.

As shown in step 56 of FIG. 6, the timer interval TT is set to 4/10 of the time TA from one RGB adjustment point to the next. Since the timer runs in the background, this arrangement provides an opportunity for execution of other processes such as user adjustment of frequency or amplitude of the pulses.

The adjustment of the frequency and other pulse parameters of the image intensity modulation can be made internally, i.e., within the running program. Such internal control is to be distinguished from the external control provided, for instance, in screen savers. In the latter, the frequency of animation can be modified by the user, but only after having exited the screen saver program. Specifically, in Windows 95(R) or Windows 98(R), to change the animation frequency requires stopping the screen saver execution by moving the mouse, whereafter the frequency may be adjusted through the control panel. The requirement that the control be internal sets the present program apart from so-called banners as well.

The program may be run on a remote computer that is linked to the user computer, as illustrated in FIG. 9. Although the monitor 2, labeled "MON", is connected to the computer 31', labeled "COMPUTER", the program that pulses the images on the monitor 2 runs on the remoter computer 90, labeled "REMOTE COMPUTER", which is connected to computer 31' through a link 91 which may in part belong to a network. The network may comprise the Internet 92.

The monitor of a television set emits an electromagnetic field in much the same way as a computer monitor. Hence, a TV may be used to produce screen emissions for the purpose of nervous system manipulation. FIG. 5 shows such an arrangement, where the pulsing of the image intensity is achieved by inducing a small slowly pulsing shift in the frequency of the RF signal that enters from the antenna. This process is here called "frequency wobbling" of the RF signal. In FM TV, a slight slow frequency wobble of the RF signal produces a pseudo-dc signal level fluctuation in the composite video signal, which in turn causes a slight intensity fluctuation of the image displayed on the monitor in the same manner as discussed above for the modulator of FIG. 2. The frequency wobbling is induced by the wobbler 44 of FIG. 5 labeled "RFM", which is placed in the antenna line 43. The wobbler is driven by the pulse generator 6, labeled "GEN". The subject can adjust the frequency and the amplitude of the wobble through the tuning control 7 and the amplitude control 41. FIG. 10 shows a block diagram of the frequency wobbler circuit that employs a variable delay line 94, labelled "VDL". The delay is determined by the signal from pulse generator 6, labelled "GEN". The frequency of the pulses can be adjusted with the tuning control 7. The amplitude of the pulses is determined by the unit 98, labelled "MD", and can be adjusted with the amplitude control 41. Optionally, the input to the delay line may be routed through a preprocessor 93, labelled "PRP", which may comprise a selective RF amplifier and down converter; a complimentary up conversion should then be performed on the delay line output by a postprocessor 95, labelled "POP". The output 97 is to be connected to the antenna terminal of the TV set.

The action of the variable delay line 94 may be understood as follows. Let periodic pulses with period L be presented at the input. For a fixed delay the pulses would emerge at the output with the same period L. Actually, the time delay T is varied slowly, so that it increases approximately by LdT/dt between the emergence of consecutive pulses at the device output. The pulse period is thus increased approximately by

.DELTA.L=LdT/dt. (4)

In terms of the frequency .intg., Eq. (4) implies approximately

.DELTA..intg./.intg.=-dT/dt. (5)

For sinusoidal delay T(t) with amplitude b and frequency g, one has

.DELTA..intg./.intg.=-2.pi.gb cos (2.pi.gt), (6)

which shows the frequency wobbling. The approximation is good for gb<<1, which is satisfied in practice. The relative frequency shift amplitude 2.pi.gb that is required for effective image intensity pulses is very small compared to unity. For a pulse frequency g of the order of 1 Hz, the delay may have to be of the order of a millisecond. To accomodate such long delay values, the delay line may have to be implemented as a digital device. To do so is well within the present art. In that case it is natural to also choose digital implementations for the pulse generator 6 and the pulse amplitude controller 98, either as hardware or as software.

Pulse variability may be introduced for alleviating the need for precise tuning to a resonance frequency. This may be important when sensory resonance frequencies are not precisely known, because of the variation among individuals, or in order to cope with the frequency drift that results from chemical detuning that is discussed in the '874 patent. A field with suitably chosen pulse variability can then be more effective than a fixed frequency field that is out of tune. One may also control tremors and seizures, by interfering with the pathological oscillatory activity of neural circuits that occurs in these disorders. Electromagnetic fields with a pulse variability that results in a narrow spectrum of frequencies around the frequency of the pathological oscillatory activity may then evoke nerve signals that cause phase shifts which diminish or quench the oscillatory activity.

Pulse variability can be introduced as hardware in the manner described in the '304 patent. The variability may also be introduced in the computer program of FIG. 6, by setting FLG3 in step 68, and choosing the amplitude B of the frequency fluctuation. In the variability routine 46, shown in some detail in FIG. 13, FLG3 is detected in step 47, whereupon in steps 48 and 49 the pulse frequency F is modified pseudo randomly by a term proportional to B, every 4th cycle.

Optionally, the amplitude of the image intensity pulsing may be modified as well, in similar fashion. Alternatively, the frequency and amplitude may be swept through an adjustable ramp, or according to any suitable schedule, in a manner known to those skilled in the art. The pulse variability may be applied to subliminal image intensity pulses.

When an image is displayed by a TV monitor in response to a TV broadcast, intensity pulses of the image may simply be imbedded in the program material. If the source of video signal is a recording medium, the means for pulsing the image intensity may comprise an attribute of recorded data. The pulsing may be subliminal. For the case of a video signal from a VCR, the pertinent data attribute is illustrated in FIG. 11, which shows a video signal record on part of a video tape 28. Depicted schematically are segments of the video signal in intervals belonging to lines in three image frames at different places along the tape. In each segment, the chroma signal 9 is shown, with its short-term average level 29 represented as a dashed line. The short-term average signal level, also called the pseudo-dc level, represents the luminance of the image pixels. Over each segment, the level is here constant because the image is for simplicity chosen as having a uniform luminance over the screen. However, the level is seen to vary from frame to frame, illustrating a luminance that pulses slowly over time. This is shown in the lower portion of the drawing, wherein the IRE level of the short-term chroma signal average is plotted versus time. The graph further shows a gradual decrease of pulse amplitude in time, illustrating that luminance pulse amplitude variations may also be an attribute of the recorded data on the video tape. As discussed, pulsing the luminance for fixed chrominance results in pulsing of the image intensity.

Data stream attributes that represent image intensity pulses on video tape or in TV signals may be created when producing a video rendition or making a moving picture of a scene, simply by pulsing the illumination of the scene. This is illustrated in FIG. 12, which shows a scene 19 that is recorded with a video camera 18, labelled "VR". The scene is illuminated with a lamp 20, labelled "LAMP", energized by an electric current through a cable 36. The current is modulated in pulsing fashion by a modulator 30, labeled "MOD", which is driven by a pulse generator 6, labelled "GENERATOR", that produces voltage pulses 35. Again, pulsing the luminance but not the chrominance amounts to pulsing the image intensity.

The brightness of monitors can usually be adjusted by a control, which may be addressable through a brightness adjustment terminal. If the control is of the analog type, the displayed image intensity may be pulsed as shown in FIG. 15, simply by a pulse generator 6, labeled "GEN", that is connected to the brigthness adjustment terminal 88 of the monitor 2, labeled "MON". Equivalent action can be provided for digital brightness controls, in ways that are well known in the art.

The analog component video signal from a DVD player may be modulated such as to overlay image intensity pulses in the manner illustrated in FIG. 17. Shown are a DVD player 102, labeled "DVD", with analog component video output comprised of the luminance Y and chrominance C. The overlay is accomplished simply by shifting the luminance with a voltage pulse from generator 6, labeled "GENERATOR". The generator output is applied to modulator 106, labeled "SHIFTER". Since the luminance Y is pulsed without changing the chrominance C, the image intensity is pulsed. The frequency and amplitude of the image intensity pulses can be adjusted respectively with the tuner 7 and amplitude control 107. The modulator 105 has the same structure as the modulator of FIG. 2, and the pulse amplitude control 107 operates the potentiometer 15 of FIG. 2. The same procedure can be followed for editing a DVD such as to overlay image intensity pulses, by processing the modulated luminance signal through an analog-to-digital converter, and recording the resulting digital stream onto a DVD, after appropriate compression. Alternatively, the digital luminance data can be edited by electronic reading of the signal, decompression, altering the digital data by software, and recording the resulting digital signal after proper compression, all in a manner that is well known in the art.

The mechanism whereby a CRT-type monitor emits a pulsed electromagnetic field when pulsing the intensity of an image is illustrated in FIG. 14. The image is produced by an electron beam 10 which impinges upon the backside 88 of the screen, where the collisions excite phosphors that subsequently emit light. In the process, the electron beam deposits electrons 18 on the screen, and these electrons contribute to an electric field 3 labelled "E". The electrons flow along the conductive backside 88 of the screen to the terminal 99 which is hooked up to the high-voltage supply 40, labelled "HV". The circuit is completed by the ground connection of the supply, the video amplifier 87, labeled "VA", and its connection to the cathodes of the CRT. The electron beams of the three electron guns are collectively shown as 10, and together the beams carry a current J. The electric current J flowing through the described circuit induces a magnetic field 39, labeled "B". Actually, there are a multitude of circuits along which the electron beam current is returned to the CRT cathodes, since on a macroscopic scale the conductive back surface 88 of the screen provides a continuum of paths from the beam impact point to the high-voltage terminal 99. The magnetic fields induced by the currents along these paths partially cancel each other, and the resulting field depends on the location of the pixel that is addressed. Since the beams sweep over the screen through a raster of horizontal lines, the spectrum of the induced magnetic field contains strong peaks at the horizontal and vertical frequencies. However, the interest here is not in fields at those frequencies, but rather in emissions that result from an image pulsing with the very low frequencies appropriate to sensory resonances. For this purpose a diffuse electron current model suffices, in which the pixel discreteness and the raster motion of the electron beams are ignored, so that the beam current becomes diffuse and fills the cone subtended by the displayed image. The resulting low-frequency magnetic field depends on the temporal changes in the intensity distribution over the displayed image. Order-of-magnitude estimates show that the low-frequency magnetic field, although quite small, may be sufficient for the excitation of sensory resonances in subjects located at a normal viewing distance from the monitor.

The monitor also emits a low-frequency electric field at the image pulsing frequency. This field is due in part to the electrons 18 that are deposited on the screen by the electron beams 10. In the diffuse electron beam model, screen conditions are considered functions of the time t and of the Cartesian coordinates x and y over a flat CRT screen.

The screen electrons 18 that are dumped onto the back of the screen by the sum j(x,y,t) of the diffuse current distributions in the red, green, and blue electron beams cause a potential distribution V(x,y,t) which is influenced by the surface conductivity .sigma. on the back of the screen and by capacitances. In the simple model where the screen has a capacitance distribution c(x,y) to ground and mutual capacitances between parts of the screen at different potentials are neglected, a potential distribution V(x,y,t) over the screen implies a surface charge density distribution

q=Vc(x,y), (7)

and gives rise to a current density vector along the screen,

j.sub.s =-.sigma.grad.sub.s V, (8)

where grad.sub.s is the gradient along the screen surface. Conservation of electric charge implies

j=cV-div.sub.s (.sigma.grad.sub.s V), (9) where the dot over the voltage denotes the time derivative, and div.sub.s is the divergence in the screen surface. The partial differential equation (9) requires a boundary condition for the solution V(x,y,t) to be unique. Such a condition is provided by setting the potential at the rim of the screen equal to the fixed anode voltage. This is a good approximation, since the resistance R.sub.r between the screen rim and the anode terminal is chosen small in CRT design, in order to keep the voltage loss JR.sub.r to a minimum, and also to limit low-frequency emissions.

Something useful can be learned from special cases with simple solutions. As such, consider a circular CRT screen of radius R with uniform conductivity, showered in the back by a diffuse electron beam with a spatially uniform beam current density that is a constant plus a sinusoidal part with frequency .intg.. Since the problem is linear, the voltage V due to the sinusoidal part of the beam current can be considered separately, with the boundary condition that V vanish at the rim of the circular screen. Eq. (9) then simplifies to

V"+V"/r-i2.pi..intg.cn V=-J.eta./A, r.ltoreq.R, (10)

where r is a radial coordinate along the screen with its derivative denoted by a prime, .eta.=1/.sigma. is the screen resistivity, A the screen area, J the sinusoidal part of the total beam current, and i=(-1), the imaginary unit. Our interest is in very low pulse frequencies .intg. that are suitable for excitation of sensory resonances. For those frequencies and for practical ranges for c and .eta., the dimensionless number 2.pi..intg.cA.eta. is very much smaller than unity, so that it can be neglected in Eq. (10). The boundary value problem then has the simple solution ##EQU1##

In deriving (11) we neglected the mutual capacitance between parts of the screen that are at different potentials. The resulting error in (10) is negligible for the same reason that the i2.pi..intg.cA.eta. term in (10) can be neglected.

The potential distribution V(r) of (11) along the screen is of course accompanied by electric charges. The field lines emanating from these charges run mainly to conductors behind the screen that belong to the CRT structure and that are either grounded or connected to circuitry with a low impedance path to ground. In either case the mentioned conductors must be considered grounded in the analysis of charges and fields that result from the pulsed component J of the total electron beam current. The described electric field lines end up in electric charges that may be called polarization charges since they are the result of the polarization of the conductors and circuitry by the screen emission. To estimate the pulsed electric field, a model is chosen where the mentioned conductors are represented together as a grounded perfectly conductive disc of radius R, positioned a short distance .delta. behind the screen, as depicted in FIG. 16. Since the grounded conductive disc carries polarization charges, it is called the polarization disc. FIG. 16 shows the circular CRT screen 88 and the polarization disc 101, briefly called "plates". For small distances .delta., the capacitance density between the plates of opposite polarity is nearly equal to .epsilon./.delta., where .epsilon. is the permittivity of free space. The charge distributions on the screen and polarization disc are respectively .epsilon.V(r)/.delta.+q.sub.0 and -.epsilon.V(r)/.delta.+q.sub.0, where the .epsilon.V(r)/.delta. terms denote opposing charge densities at the end of the dense field lines that run between the two plates. That the part q.sub.0 is needed as well will become clear in the sequel.

The charge distributions .epsilon.V(r)/.delta.+q.sub.0 and -.epsilon.V(r)/.delta.+q.sub.0 on the two plates have a dipole moment with the density ##EQU2##

directed perpendicular to the screen. Note that the plate separation .delta. has dropped out. This means that the precise location of the polarization charges is not critical in the present model, and further that .delta. may be taken as small as desired. Taking .delta. to zero, one thus arrives at the mathematical model of pulsed dipoles distributed over the circular CRT screen. The field due to the charge distribution q.sub.0 will be calculated later.

The electric field induced by the distributed dipoles (12) can be calculated easily for points on the centerline of the screen, with the result ##EQU3##

where V(0) is the pulse voltage (11) at the screen center, .rho. the distance to the rim of the screen, and z the distance to the center of the screen. Note that V(0) pulses harmonically with frequency .intg., because in (11) the sinusoidal part J of the beam current varies in this manner.

The electric field (13) due to the dipole distribution causes a potential distribution V(r)/2 over the screen and a potential distribution of -V(r)/2 over the polarization disc, where V(r) is nonuniform as given by (11). But since the polarization disc is a perfect conductor it cannot support voltage gradients, and therefore cannot have the potential distribution -V(r)/2. Instead, the polarization disc is at ground potential. This is where the charge distribution q.sub.0 (r) comes in; it must be such as to induce a potential distribution V(r)/2 over the polarization disc. Since the distance between polarization disc and screen vanishes in the mathematical model, the potential distribution V(r)/2 is induced over the screen as well. The total potential over the monitor screen thus becomes V(r) of (11), while the total potential distribution over the polarization disc becomes uniformly zero. Both these potential distributions are as physically required. The electric charges q.sub.0 are moved into position by polarization and are partly drawn from the earth through the ground connection of the CRT.

In our model the charge distribution q.sub.0 is located at the same place as the dipole distribution, viz., on the plane z=0 within the circle with radius R. At points on the center line of the screen, the electric field due to the monopole distribution q.sub.0 is calculated in the following manner. As discussed, the monopoles must be such that they cause a potential .phi..sub.0 that is equal to V(r)/2 over the disc with radius R centered in the plane z=0. Although the charge distribution q.sub.0 (r) is uniquely defined by this condition, it cannot be calculated easily in a straightforward manner. The difficulty is circumvented by using an intermediate result derived from Excercise 2 on page 191 of Kellogg (1953), where the charge distribution over a thin disc with uniform potential is given. By using this result one readily finds the potential .phi.*(z) on the axis of this disc as ##EQU4##

where .beta.(R.sub.1) is the angle subtended by the disc radius R.sub.1, as viewed from the point z on the disc axis, and V* is the disc potential. The result is used here in an attempt to construct the potential .phi..sub.0 (z) for a disc with the nonuniform potential V(r)/2, by the ansatz of writing the field as due to a linear combination of abstract discs with various radii R.sub.1 and potentials, all centered in the plane z=0. In the ansatz the potential on the symmetry axis is written ##EQU5##

where W is chosen as the function 1-R.sub.1.sup.2 /R.sup.2, and the constants a and b are to be determined such that the potential over the plane z=0 is V(r)/2 for radii r ranging from 0 to R, with V(r) given by (11). Carrying out the integration in (15) gives

.phi..sub.0 (z)=.alpha..beta.(R)-b{(1+z.sup.2 /R.sup.2).beta.(R)-.vertline.z.vertline./R}. (16)

In order to find the potential over the disc r<R in the plane z=0, the function .phi..sub.0 (z) is

expanded in powers of z/R for $0<z<R$, whereafter the powers z.sup.n are replaced by r.sup.n P.sub.n (cos.theta.), where the P.sub.n are Legendre polynomials, and (r,.theta.) are symmetric spherical coordinates centered at the screen center. This procedure amounts to a continuation of the potential from the z-axis into the half ball $r<R$, $z>0$, in such a manner that the Laplace equation is satisfied. The method is discussed by Morse and Feshbach (1953). The "Laplace continuation" allows calculation of the potential .phi..sub.0 along the surface of the disc $r<R$ centered in the plane z=0. The requirement that this potential be V(r)/2 with the function V(r) given by (11) allows solving for the constants a and b, with the result

a=-V(0)/.pi., b=-2V(0)/.pi.. (17)

Using (17) in (16) gives ##EQU6##

and by differentiation with respect to z one finally finds ##EQU7##

for the electric field on the center line of the screen brought about by the charge distribution q.sub.0 (z).

The center-line electric field is the sum of the part (13) due to distributed pulsed dipoles and part (19) due to distributed pulsed monopoles. Although derived for circular screens, the results may serve as an approximation for other shapes, such as the familiar rounded rectangle, by taking R as the radius of a circle that has the same area as the screen.

For two CRT-type monitors the pulsed electric field due to image intensity pulsing has been measured at several points on the screen center line for pulse frequencies of 1/2 Hz. The monitors were the 15" computer monitor used in the sensory resonance experiments mentioned above, and a 30" TV tube. The experimental results need to be compared with the theory derived above. Since R is determined by the screen area, the electric fields given by (13) and (19) have as only free parameter the pulse voltage V(0) at the screen center. The amplitude of this voltage can therefore be determined for the tested monitors by fitting the experimental data to the theoretical results. Prior to fitting, the data were normalized to an image that occupies the entire screen and is pulsed uniformly with a 100% intensity amplitude. The results of the one-parameter fit are displayed in FIG. 18, which shows the theoretical graph 100, together with the normalized experimental data points 103 for the 15- computer monitor and for the 30" TV tube. FIG. 18 shows that the developed theory agrees fairly well with the experimental results. From the best fit one can find the center-screen voltage pulse amplitudes. The results, normalized as discussed above, are .vertline.V(0).vertline.=266.2 volt for the 15" computer monitor and .vertline.V(0).vertline.=310.1 volt for the 30" TV tube. With these amplitudes in hand, the emitted pulsed electric field along the center line of the monitors can be calculated from the sum of the fields (13) and (19). For instance, for the 15" computer monitor with 1.8% RGB pulse modulation used in the 1/2 Hz sensory resonance experiments mentioned above, the pulsed electric field at the center of the subject, located at z=70 cm on the screen center line, is calculated as having an amplitude of 0.21 V/m. That such a pulsed electric field, applied to a large portion of the skin, is sufficient for exciting the 1/2 Hz sensory resonance is consistent with experimental results discussed in the '874 patent.

In deriving (11), the dimensionless number 2.pi..intg.cA.eta. was said to be much smaller than unity. Now that the values for .vertline.V(0).vertline. are known, the validity of this statement can be checked. Eq. (11) implies that .vertline.V(0).vertline. is equal to .eta..vertline.J.vertline./4.pi.. The sum of the beam currents in the red, green, and blue electron guns for 100% intensity modulation is estimated to have pulse amplitudes .vertline.J.vertline. of 0.5 mA and 2.0 mA respectively for the 15" computer monitor and the 30" TV tube. Using the derived values for .vertline.V(0).vertline., one arrives at estimates for the screen resistivity .eta. as 6.7 M.OMEGA./square and 1.9 M.OMEGA./square respectively for the 15" computer monitor and the 30" TV tube. Estimating the screen capacity cA as 7 pf and 13 pf, 2.pi..intg.cA.eta. is found to be 148.times.10.sup.-6 and 78.times.10.sup.-6, respectively for the 15" computer monitor and the 30" TV tube. These numbers are very small compared to unity, so that the step from (10) to (11) is valid.

The following procedures were followed in preparing pulsed images for the field measurements. For the 15" computer monitor the images were produced by running the VB6 program discussed above. The pulsed image comprised the full screen with basic RGB values chosen uniformly as R=G=B=127, with the exception of an on/off button and a few data boxes which together take up 17% of the screen area. The image intensity was pulsed by modifying the R, G, and B values by integer-rounded sine functions .DELTA.R(t), .DELTA.G(t), and .DELTA.B(t), uniformly over the image, except at the button and the data boxes. The measured electric field pulse amplitudes were normalized to a pulsed image that occupies all of the screen area and has 100% intensity modulation for which the image pulses between black and the maximum intensity, for the fixed RGB ratios used. The image intensity depends on the RGB values in a nonlinear manner that will be be discussed. For the measurements of the pulsed electric field emitted by 30" TV tube, a similar image was used as for the 15" computer monitor. This was done by playing back a camcorder recording of the computer monitor display when running the VB6 program, with 40% pulse modulation of R, G, and B.

In front of the monitor, i.e., for z>0, the parts (13) and (19) contribute about equally to the electric field over a practical range of distances z. When going behind the monitor where z is negative the monopole field flips sign so that the two parts nearly cancel each other, and the resulting field is very small. Therefore, in the back of the CRT, errors due to imperfections in the theory are relatively large. Moreover our model, which pretends that the polarization charges are all located on the polarization disc, fails to account for the electric field flux that escapes from the outer regions of the back of the screen to the earth or whatever conductors happen to be present in the vincinity of the CRT. This flaw has relatively more serious consequences in the back than in front of the monitor.

Screen emissions in front of a CRT can be cut dramatically by using a grounded conductive transparent shield that is placed over the screen or applied as a coating. Along the lines of our model, the shield amounts to a polarization disc in front of the screen, so that the latter is now sandwiched between to grounded discs. The screen has the pulsed potential distribution V(r) of (11), but no electric flux can escape. The model may be modified by choosing the polarization disc in the back somewhat smaller than the screen disc, by a fraction that serves as a free parameter. The fraction may then be determined from a fit to measured fields, by minimizing the relative standard deviation between experiment and theory.

In each of the electron beams of a CRT, the beam current is a nonlinear function of the driving voltage, i.e., the voltage between cathode and control grid. Since this function is needed in the normalization procedure, it was measured for the 15" computer monitor that has been used in the 1/2 Hz sensory resonance experiments and the electric field measurements. Although the beam current density j can be determined, it is easier to measure the luminance, by reading a light meter that is brought right up to the monitor screen. With the RGB values in the VB6 program taken as the same integer K, the luminance of a uniform image is proportional to the image intensity I. The luminance of a uniform image was measured for various values of K. The results were fitted with

$$I=c_1 K^{\gamma}, \quad (20)$$

where $c_1$ is a constant. The best fit, with 6.18% relative standard deviation, was obtained for $\gamma=2.32$.

Screen emissions also occur for liquid crystal displays (LCD). The pulsed electric fields may have considerable amplitude for LCDs that have their driving electrodes on opposite sides of the liquid crystal cell, for passive matrix as well as for active matrix design, such as thin film technology (TFT). For arrangements with in-plane switching (IPS) however, the driving electrodes are positioned in a single plane, so that the screen emission is very small. For arrangements other than IPS, the electric field is closely approximated by the fringe field of a two-plate condenser, for the simple case that the image is uniform and extends over the full screen. For a circular LCD screen with radius R, the field on the center line can be readily calculated as due to pulsed dipoles that are uniformly distributed over the screen, with the result

$$E_d(z)=(1/2)VR^2/(z^2+R^2)^{3/2}, \quad (21)$$

where $E_d(z)$ is the amplitude of the pulsed electric field at a distance z from the screen and V is a voltage pulse amplitude, in which the aperture ratio of the LCD has been taken into account. Eq. (21) can be used as an approximation for screens of any shape, by taking R as the radius of a circle with the same area as the screen. The result applies to the case that the LCD does not have a ground connection, so that the top and bottom electrodes are at opposite potential, i.e., V/2 and -V/2.

If one set of LCD electrodes is grounded, monopoles are needed to keep these electrodes at zero potential, much as in the case of a CRT discussed above. The LCD situation is simpler however, as there is no charge injection by electron beams, so that the potentials on the top and bottom plates of the condenser in the model are spatially uniform. From (14) it is seen that monopoles, distributed over the disc of radius R in the plane z=0 such as to provide on the disc a potential V/2, induce on the symmetry axis a potential ##EQU8##

Differentiating with respect to z gives the electric field on the symmetry axis ##EQU9##

induced by the pulsed monopoles. For an LCD with one set of electrodes grounded, the pulsed electric field for screen voltage pulse amplitude V at a distance z from the screen on the center line has an amplitude that is the sum of the parts (21) and (23). The resultant electric field in the back is relatively small, due to the change in sign in the monopole field that is caused by the factor $z/|z|$. Therefore, screen emissions in front of an LCD can be kept small simply by having the grounded electrodes in front.

As a check on the theory, the pulsed electric field emitted by the 3" LCD-TFT color screen of the camcorder mentioned above has been measured at eleven points on the center line of the screen, ranging from 4.0 cm to 7.5 cm. The pulsed image was produced by playing back the video recording of the 15" computer monitor that was made while running the VB6 program discussed above, for a image intensity pulse frequency of 1/2 Hz, R=G=B=K, modulated around K=127 with an amplitude $\Delta K=51$. After normalization to a uniform full screen image with 100% intensity modulation by using the nonlinear relation (20), the experimental data were fitted to the theoretical curve that expresses the sum of the fields (21) and (23). The effective screen pulse voltage amplitude V was found to be 2.1 volt. The relative standard deviation in V for the fit is 5.1%, which shows that theory and experiment are in fairly good agreement.

Certain monitors can cause excitation of sensory resonances even when the pulsing of displayed images is subliminal, i.e., unnoticed by the average person. When checking this condition on a computer monitor, a problem arises because of the rounding of RGB values to integers, as occurs in the VB6 program. For small pulse amplitude the sine wave is thereby distorted into a square wave, which is easier to spot. This problem is alleviated somewhat by choosing .DELTA.R=0, .DELTA.G=0, and .DELTA.B=2, since then the 8 rounded sine functions around the unit circle, multiplied with the pulse amplitude .DELTA.B=2 become the sequence 1, 2 11 2, 1, -1 -2, -2, -1, etc, which is smoother to the eye than a square wave. Using the VB6 program and the 15" computer monitor mentioned above with R=71, G=71, and B=233, a 1/2 Hz pulse modulation with amplitudes .DELTA.R=.DELTA.G=0 and .DELTA.B=2 could not be noticed by the subject, and is therefore considered subliminal. It is of interest to calculate the screen emission for this case, and conduct a sensory resonance experiment as well. A distance z=60 cm was chosen for the calculation and the experiment. Using Eq. (20), the image intensity pulse modulation for the case is found to be 1.0% of the maximum intensity modulation. Using R=13.83 cm together with .vertline.V(0).vertline.=266.2 V for the 15" computer monitor, and the theoretical graph 100 of FIG. 18, the pulsed electric field at z=60 cm was found to have an amplitude of 138 mV/m. In view of the experimental results discussed in the '874 and '922 patents, such a field, used at a pulse frequency chosen appropriately for the 1/2 Hz sensory resonance and applied predominantly to the face, is expected to be sufficient for exciting the 1/2 Hz sensory resonance. A confirmation experiment was done by running the VB6 program with the discussed settings and the 15" monitor. The center of the subject's face was positioned on the screen center line, at a distance of 60 cm from the screen. A frequency sweep of -0.1% per ten cycles was chosen, with an initial pulse frequency of 34 ppm. Full ptosis was experienced by the subject at 20 minutes into the run, when the pulse frequency was f=31.76 ppm. At 27 minutes into the run, the frequency sweep was reversed to +0.1% per ten cycles. Full ptosis was experienced at f=31.66 ppm. At 40 minutes into the run, the frequency sweep was set to -0.1% per ten cycles. Full ptosis occurred at f=31.44 ppm. The small differences in ptosis frequency are attributed to chemical detuning, discussed in the Background Section. It is concluded that the 1/2 Hz sensory resonance was excited in this experiment by screen emissions from subliminal image pulsing on the 15" computer monitor at a distance of 60 cm. For each implementation and embodiment discussed, the image pulsing may be subliminal.

The human eye is less sensitive to changes in hue than to changes in brightness. In composite video this fact allows using a chrominance bandwidth that is smaller than the luminance bandwidth. But it also has the consequence that pulsing of the chrominance for fixed luminance allows larger pulse amplitudes while staying within the subliminal pulse regime. Eq. (3) shows how to pulse the chrominance components R-Y and B-Y while keeping Y fixed; for the change in pixel intensity one then has

.DELTA.I.sub.h =0.491.DELTA.(R-Y)+0.806.DELTA.(B-Y). (24)

Luminance pulses with fixed chrominance give a change in pixel intensity

.DELTA.I.sub.1 =3.DELTA.Y. (25)

Of course, pure chrominance pulses may be combined with pure luminance pulses; an instance of such combination has been mentioned above.

The subliminal region in color space needs to be explored to determine how marginally subliminal pulses .DELTA.R, .DELTA.G, and .DELTA.B depend on RGB values. Prior to this, the condition for image pulses to be subliminal should not be phrased solely in terms of the percentage of intensity pulse amplitude. The subliminal image pulsing case considered above, where the monitor is driven by a VB6 computer program with R=G=71, B=233, and .DELTA.R=.DELTA.G=0, .DELTA.B=2 for full-screen images will be referred to as "the standard subliminal image pulsing".

In the interest of the public we need to know the viewing distances at which a TV with subliminally pulsed images can cause excitation of sensory resonances. A rough exploration is reported here which may serve as starting point for further work. The exploration is limited to estimating the largest distance z=z.sub.max along the center line of the 30" TV at which screen emissions can excite the 1/2 Hz resonance, as determined by the ptosis test. The TV is to display an image which undergoes the standard subliminal pulsing as defined above. It would be best to perform this test with the 30" TV on which the subliminally pulsed images are produced by means of a video. Since such a video was not available, the ptosis test was conducted instead with a pulsed electric field source consisting of a small grounded doublet electrode of the type discussed in the '874 patent. The doublet was driven with a sinusoidal voltage of 10 V amplitude, and the center of mass of the subject was located on the center line of the doublet at a distance z=z.sub.d =323 cm. The doublet electrodes are rectangles of 4.4 cm by 4.7 cm. At the large distance z.sub.d there is whole-body exposure to the field, so that the bulk effect discussed in the '874 patent comes into play, as is expected to happen also at the distance z.sub.max from the 30" TV monitor. The subject was facing the "hot" electrode of the doublet, so that at the subject center the electric field was the sum of the parts (21) and (23), for positive values of z. It was thought important to use a sine wave, since that would be the "commercially" preferred pulse shape which allows larger pulse amplitudes without being noticed. The only readily available sine wave generator with the required voltage was an oscillator with a rather coarse frequency control that cannot be set accurately, although the frequency is quite stable and can be measured accurately. For the experiment a pulse frequency of 0.506 Hz was accepted, although it differs considerably from the steady ptosis frequency for this case. The subject experienced several ptosis cycles of moderate intensity, starting 8 minutes into the experiment run. It is concluded that the 1/2 Hz sensory resonance was excited, and that the stimulating field was close to the weakest field capable of excitation. From Eqs. (21) and (23), the electric field pulse amplitude at the center of mass of the subject was found to be 7.9 mV/m. That an electric field with such a small pulse amplitude, applied to the whole body, is capable of exciting the 1/2 Hz sensory resonance is consistent with experimental results reported in the '874 patent, although these were obtained for the 2.4 Hz resonance. Next, the distance z.sub.max was determined at which the 30" TV tube with 1% image intensity pulse amplitude produces an electric field with a pulse amplitude of 7.9 mV/m, along the center line of the screen. From Eqs. (13) and (19) one finds z.sub.max =362.9 cm. At more than 11 feet, this is a rather large distance for viewing a 30" TV. Yet, the experiment and theory discussed show that the 1/2 Hz sensory resonance can be excited at this large distance, by pulsing the image intensity subliminally. Of course, the excitation occurs as well for a range of smaller viewing distances. It is thus apparent that the human nervous system can be manipulated by screen emissions from subliminal TV image pulses.

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The invention is not limited by the embodiments shown in the drawings and described in the specification, which are given by way of example and not of limitation, but only in accordance with the scope of the appended claims.

# MIND CONTROL TECHNIQUES AND TACTICS

By Glenn Krawczyk

From an article in Nexus Magazine Dec/Jan 1993
The Long and Winding Road

Recently Nexus reported on the Central Intelligence Agency's secret 25 year multi-million dollar mind control program, MKULTRA, and its numerous sub-projects, which included research into every conceivable technique to control the human mind. Tests were conducted on unwitting and poorly informed citizens, prison inmates, and servicemen, using psycho-active drugs, hypnosis, sensory deprivation, electroconvulsive therapy (ECT), psychosurgery, deep sleep therapy, biological agents (i.e. chemical weapons), "harassment substances", brain concussion, stress, electronic brain stimulation (ESB), electronic brain implants, electromagnetic radio frequency energy, and many other techniques. They were applied to subjects in any combination that showed promise for influencing or controlling human behaviour. No stone was left unturned.

It cannot be over-emphasised, the results of mind control experimentation, which has been conducted by a number of so-called "civilised" nations, have led to a new breed of weapons, and those weapons are in use today. They are the weapons of the New world Order and are specifically designed to rob individuals, and even entire nations, of their capacity for freedom of thought.

**Basic Techniques for Control**

The human brain has often been compared to a computer. Information is fed in, processed, integrated, and a response is then formulated and acted upon. Mind controllers manipulate information in the same manner as a computer programmer manipulates information.

First you control the source, quality and quantity of information fed into the processor, in our case, the brain. Then you control the manner in which the information is processed, in this case, by manipulating states of human consciousness. Induction of states of heightened suggestibility is the most common form of manipulation. Television is an effective and broad reaching device used for this purpose. (The CIA set up its own 'television channel' which broadcasts from airborne transmitters with sufficient power to interrupt any country's regular broadcasts, and which will no doubt be used for Psychological Warfare). You then monitor your target's response to the "program" and reinforce messages necessary to obtain the desired result. This takes the form of positive or negative feedback. In any other language, this would be known as conditioning.

The mind control weapons of tomorrow are here today. There are devices designed to introduce thoughts into the human mind, devices designed to directly manipulate states of consciousness, (i.e. the mind's processing capability), and devices designed to read the brain wave patterns, or thought, from a distance.

**The Secrets of Life**

In January 1991 the University of Arizona hosted a conference entitled the 'NATO Advance Research Workshop on Coherent and Emergent Phenomena in Biomolecular Systems'. The conference revealed some fascinating, but frightening, developments in the world of biomolecular systems, a field which encompasses a wide range of disciplines ranging from biomolecular chemistry, nanotechnology, psychoneuroimmunology, to bio-molecular engineering, and a number of other areas related to the study of human consciousness. The organiser and host of the conference, Dr Stuart Hameroff, of the University's College of Medicine, Dept of Anaesthesiology, stated, "The goals of the conference were aimed at understanding the basic mechanisms of life and consciousness." He claimed that NATO were merely the sponsor for the event and that their participation was limited to having a few representatives attending the conference and taking notes.

Hameroff believes that the seat of consciousness may be located in "computer-like cytoskeletal polymers within living cells." Phrased more simply; an individual's consciousness may be located within microscopic structures found inside the nuclei of individual brain cells. These structures appear to communicate via "coherent nanosecond excitations", that is, some form of ultra-short wavelength energy coupling. Hameroff goes on to say, "An idea expressed relevant to life 'Beyond 2000' was that brain cytoskeletal proteins could be prepared in an artificial environment which may be capable of containing cognitive functions.."

"An individual may then be able to transfer his or her consciousness to an artificial environment when their body approached expiration. Obviously this raises many philosophical and sociological implications." [Emphasis added].

If we can even begin to conceive of a technique to remove and store human consciousness in an artificial environment (and possibly transfer to another body?) capable of storing cognitive functions, then nobody should be surprised that control of the mind is possible.

**The Technology of Control**

One paper that was delivered at the conference stood out for its different attitude toward the developments under discussion. It was in effect a protest, and a chilling warning to the attending scientists about the potential abuses of their research findings. The subject of the paper: Mind Control. Delivered by private researcher Harlan E. Girard, the paper was entitled "Effects of Gigahertz Radiation on the Human Nervous System: Recent Developments in the Technology of Political Control." It outlines how microwave energy can be, and is being, used to influence and control human behaviour.

In a letter regarding Girard's presentation, Stuart Hameroff states that these "alleged" techniques "utilised nano-second (or faster giga-hertz, microwave, etc.) vibrations, and thus were consistent with the conference theme of consciousness being related to coherent nanosecond excitations in the cyt0-skeleton." The paper itself, however, is far less interesting as science than it is terrifying, if an accurate report on the operational capability of agencies who might be employing such devious and evil technology.

Girard opens the paper by stating, "The United States has developed communications equipment which can make the blind see, the deaf hear and the lame walk. It can relieve the terminally ill of all pain, without the use of any drugs. A man might retain the use of all his faculties up until the day of his death.

This communications equipment depends on a new way of looking at the human brain and neuromuscular system, and gigahertz radiation pulsed at ultra-low frequencies. Some of this equipment is now operational within the Central Intelligence Agency and the Federal Bureau of Investigation. It will never be used to make the blind see and the deaf hear and the lame walk because it is central to the domestic political agenda and foreign policy

.
Domestically the new communications equipment is being used to torture and murder persons who match profiles imagined to be able to screen a given population for terrorists, to torture and murder, to torture and murder citizens who belong to organisations which promote peace and development in Central America, to torture and murder citizens who belong to organisations opposed to the deployment and use of nuclear weapons, and to create a race of slaves called Automatons, or what is popularly called the Manchurian Candidate.

Overseas experimentation is taking place on hostages held by the United States in Canada, Great Britain, Australia, Germany, Finland and France. In addition there has been a long series of bizarre suicides among British computer scientists, all of whom had some connection to the United States Navy.

Considering how recklessly, wantonly and indiscriminately America's new weapons have been used, physicians attending the dead and dying should consider the patient's known political views and associations before making a diagnosis or conducting an autopsy."

**Programmed Mayhem**

Consider the following horrific incidents in the light of what you have just read:

July 1984: Julian Knight, aged 19, no previous criminal record, kills seven people and wounds another 46 in the "Hoddle St. Massacre" in Melbourne. He was carrying 2 rifles and a 12-gauge shotgun. The gunman was arrested by police.

December 1987: Frank Vitkovic, aged 22, no previous criminal record, kills eight people at the Melbourne General Post Office in Queen St., Melbourne. He then jumps 11 stories to his death.
May 1988: Lurie Dann, criminal record unknown, kills one child and wounds five others in a school yard in Winnekta, Illinois. She then commits suicide.

September 1989: Joseph Wesbecker, criminal record unknown, kills eight former co-workers and wounds twelve in the Standard Gravure Building in Luisville, Kentucky. He then commits suicide by turning the gun on himself.

April 1990: Rodney J. Dale, panel-beater aged 27, no previous criminal record, kills one person and wounds 7, firing off a total of 40 rounds on the Gold Coast, Queensland. he was carrying two rifles and was wounded by police.

August 1991: Wade Frankum, aged 33, unemployed, no previous criminal record, kills seven in Strathfield Plaza, Sydney, with a semi-automatic SKK rifle. He then commits suicide by shooting himself in the head. His last words, "I'm sorry."

September 1991: George Henard, aged 35, no previous criminal record, drives his truck through the front window of Luby's Cafetaria in Kileen, Texas. He then kills 23 people, and wounds another 20, in a 10 minute shooting spree with a Glock 9mm semi-automatic pistol. He then commits suicide by shooting himself.

November 1991: Santiago Lopez, aged 42, Mexican, no previous criminal record, is arrested at the United Nations Building in New York carrying a revolver and 100 rounds of ammunition. His intent was to kill.

November 1991: Bradley A. Cooke, chef, aged 32, no previous criminal record, kills one person and wounds another at Airlie Beach, Queensland. Armed with a SKS assault rifle, he then commits suicide by shooting himself.

November 1991: Gang Lu, a Graduate Student with no previous criminal record, kills five people in Iowa City, USA. Armed with a .38 revolver, Lu also commits suicide by shooting himself.

November 1991: Thomas McIlvane, aged 31. Postal worker with no previous criminal record, kills 7 people and wounds seven in Royal Oak, USA. He attempts suicide and is then arrested.

There have been numerous similar incidents in recent years, including at least two multiple-victim massacres in New Zealand, and a recent massacre in South Africa by a gunman. The incident was apparently totally unrelated to any form of racial violence that plagues the country.

So are these individuals really "lone nuts" as the authorities and mainstream media would have us believe? If not, might they have under the influence of some form of mind control?

**The Psychology of Terror**

Would any government, corporation or psychiatrist wilfully promote such horror today, you ask? the answer is quite obviously YES. Governments agencies, and the corporations that work with them towards the New World Order, are prepared to promote anything that will help them to achieve their objective of total social control. History has demonstrated that to us repeatedly, loudly and clearly. As for the question of why; for one thing, if you terrify the public and make them fear for their safety, they will allow you to implement draconian law enforcement practices, disarm them, and keep extensive records on them, and they only have to tell you that it is in all in order to "protect you", of course. And secondly, it promotes the decay of the current form of democratic political system and leads societies to search for alternatives to current political methodology. Of course the alternative has already been planned. It is called "New World Order", and it won't have your safety or interests at heart. As George Bush would say, "read my lips".

Fear has always been used by powerful elites to control and subjugate the masses. The old maxim "divide and conquer" is being played out to limit in every corner of the planet to ensure that everybody is frightened for their personal safety, and scared or suspicious of those around them. This too, is mind control.

**The Unholy Alliance**

One of the most common factors amongst people who have committed these types of crimes is that they were being treated with prescription tranquillisers or anti-depressants during the period immediately prior to committing the crime. John Hinkley, Jr, the gunman who attempted to shoot President Ronald Reagan in 1981, had ingested several tablets of Valium only two hours before the assassination attempt. Neil Bush was scheduled to have dinner with John Hinckley Sr. on March the 31st, 1981 - the very day then President Reagan was shot by John Hinckley, Jr. (the Hinckley Family and the Bush family were both involved in the energy industry). Additionally, the Bush family and Hinckley family are related, both having descended from Thomas Hinckley (born 19 Mar 1619, Hawkhurst, Kent, England; died 25 Apr 1706, Barnstable, MA) who was Governor of Plymouth Colony from 1658-1681.

Frank Vitrovik (listed previous page) had been prescribed an anti anxiety agent called Ativan. According to the Mims Drug Compendium, one of the side effects of Ativan is "rage".

Is this planned Mind Control at work? Far fetched you say? Or does it possibly strike you as more than coincidence that George Bush, after stepping aside as Director of Central Intelligence in 1977, was made director of the Eli Lilly Pharmaceutical Company by the father and family of current US Vice-president Dan Quayle, who owned the controlling interest in the company. The Bush family have also been major shareholders in other pharmaceutical companies, including Abbott, Bristol and Pfizer (whom they are thought to still hold shares in).

It is uncanny how often perpetrators of violent crimes have been prescribed tranquillisers or anti-depressants, such as Valium, Librium, Xanax, Halcion or Prozac, before having committed any offences. Other supposed "anti-psychotic" drugs, such as Haloperidol, have shown strong links to the manifestation of violence. Lawsuits have been brought against major pharmaceutical companies in a number of countries for this very reason and there is an enormous amount of evidence to support the argument that these drugs cause violent behaviour and are not an effective treatment for it.

Eli Lilly are the manufacturers of the controversial anti-depressant Prozac 20, which was being taken by over two million Americans by 1989. The prescription information on Prozac states that the drug can generate "hostility, psychosis, hallucinations, and akathisia", a bizarre side effect that induces patients to commit extreme acts of violence. It sounds like a very strange thing to prescribe a drug that can generate these side effects to a patient who is suffering from depression. Two lawsuits had been brought against Eli Lilly by 1990 in which the side effects of Prozac were thought to have been contributing factors (multiple murder suicide cases).

The author of 'The Encyclopaedia of Modern Murder', published in 1983, observed that senseless and violent crime has only become a major problem in the last three decades. In the introduction to the book, he writes, "We call a crime motiveless if it seems to do no one any good. Before 1960 such crimes were rare, and the few that occurred belong to the end of the decade." Would it be unreasonable to suggest that modern pharmaceuticals and ineffectual psychiatric practices may have some connection to this rise in senseless crime?

Many researchers believe that a large number of individuals in the mental health field are promoting such incidents, and are working hand in hand with pharmaceutical companies and governments to bring a New World Order in which societies are controlled with pharmaceuticals, or should that be chemical weapons?

Consider this quote from psychologist James V. Mc Connell, which was published in a 1970 issue of Psychology Today. "The day has come hen we can combine sensory deprivation with drugs, hypnosis, and astute manipulation of reward and punishment, to gain almost absolute control over an individual's behaviour. It should then be possible to achieve a very rapid and highly effective type of brainwashing that would allow us to make dramatic changes in a person's behaviour and personality... We should reshape society so that we all would be trained from birth to want to do what society wants us to do. We have the techniques to do it... no-one owns his own personality you acquired , and there's no reason to believe you should have the right to refuse to acquire a new personality if your old one is anti-social."

It is worth noting at this point that Dr Ewan Cameron, who conducted extensive mind-control research under the MKULTRA program for the CIA at the Allan Memorial Institute of McGill University, in Montreal, Canada, was at various times President of the American Psychiatric Association, and the World Association of Psychiatrists. Cameron's research (which was covered extensively in the Jan/Feb and March/April issues of Nexus) formed the basis of Dr. Harry Bailey's infamous "Deep Sleep Therapy", which was conducted between 1963 and 1979 at the Chelmsford private hospital in Sydney, and led to the deaths of over 20 patients. Cameron's research followed in the footsteps of English psychiatrist William Sargant, whom he considered to be Britain's leading expert on communist methods of eliciting confessions.

**The Devils Devil**

Manipulation through psychiatry has long played a pivotal role in helping achieve the New World Order's plan for world domination assisted by mind control. Harlan Girard, alleges that it is Dr Louis Jolyon ("Jolly") West, Chairman of the Department of Psychiatry at the University of California at Los Angeles, and director of its Neuropsychiatric Institute, who co-ordinates the United States government's covert mind control program. Girard is not the first, or only, person to make this claim.
West, who conducted extensive research on Korean "Brainwashing" of American POW's, ran a CIA funded LSD research program in the early 60's whilst at the University of Oklahoma. During this period he earned the dubious honour of being the only man ever to administer LSD to an elephant, an

incident which took place at the Oklahoma State City Zoo. The elephant subsequently died. he participated in the 1965 International Congress on Hallucinogenic Drugs, which was run by CIA funded psychiatrists. During this congress, it was proposed that Ministers of Religion be "trained" whilst under the influence of LSD. West is also a renowned anti-religionist, and has made large amounts of money testifying against religions in US courts.

His greatest period of public infamy began on January 11th, 1973, when he announced during his annual "State of the Sate" speech, the formation of a multidisciplinary Centre for the Study and Reduction of Violence. Reagan stated, "This centre will explore all types of violent behaviour, what causes it, how it may be detected, prevented, controlled, and treated." The director of the centre was to be none other than Dr Louis Jolyon West. The plans for the proposed centre were intentionally vague, and jealously guarded, in public at least. Eventually photocopied details leaked out which outlined the centre's proposed programs, which included genetic, biochemical , and neurophysiological studies of violent individuals, including prisoners and "hyperkinetic children", experiments in "the pharmacology of violence-producing and violence-inhibiting drugs"; studies of "life-threatening behaviour during the menstrual cycle"; studies on "hormonal aspects of passivity and aggressiveness in boys"; surveys "to discover and compare norms of violence among various ethnic groups"; and most ominously, the development of tests "that might permit the detection of violence pre-disposing brain disorders prior to the occurrence of a violent episode." The implementation of the plans was to have included "large scale screening" to detect "violence predisposing brain disorders."

West was also keen to try out the "Schwitzgebel Machine", which involved "implanting tiny electrodes within the brain", connecting them to radio transceivers, and manipulating individuals by remote control. Modified missile tracking devices were to be used to monitor the subjects whereabouts. Governor Reagan was keen to implement West's proposals, but met with resistance on a number of fronts. Pressure to veto the proposal increased when the Chairman of the Subcommittee on Constitutional Rights, Senator Frank Ervin commissioned a study of federal involvement in a number of new mind manipulation technologies. When Ervin acquired a letter penned by West, (dated January 22, 1973), to Californian State Director of Health, suggesting that the military may be prepared to turn over a Nike-missile base, located in the Santa Monica Hills, for use as a research facility, considerable suspicion was aroused.

Promoters of the Violence Research Centre could only offer lame explanations regarding the proposed purpose of the facility to the Californian Senate. Not only that, West had never fully defined what constituted "undesirable behaviour", or why it was necessary to work inside a "securely fenced" missile silo. Eventually, the entire proposal came under attack and was quietly dropped. Or was it merely driven underground?

Governor Reagan's support for the concept of behaviour control programs (read: mind control) was not deterred by this incident, and it is almost a certainty that life was breathed into many covert mind control projects of this type once he was elected president. There is every reason to suspect Dr Louis Jolyon West as being a leader in the field of mind control. He's been perfecting his mind control techniques on human subjects for a long time. A CIA memorandum entitled "Interrogation Techniques", dated January 14th, 1953, includes the following passage:

"If the services of Major Louis J. West, USAF (MC), a trained hypnotist, can be obtained, and another man well grounded in conventional psychological interrogation and polygraph techniques, and the services of Lt. Col [deleted], a well-balanced interrogation research centre could be established in an especially selected location."

The CIA proposed that: "This laboratory will include a special chamber, in which all physiologically significant aspects of the environment can be controlled. This chamber will contain, among other things, a broad-spectrum polygraph for simultaneous recordings of a variety of physiological reactions of the individual being studied. In this setting various hypnotic, pharmacologic, and sensory-environmental variables will be manipulated in a controlled fashion and quantitative continuous recordings of the reactions of the experimental subjects will be made."

Aldous Huxley, author of the novel, Brave New World, referred to West in his writing on several occasions. In 1957 he wrote that West has been doing research with hypnosis and mescaline. Later, in 1961 he reported that West had informed him he was now experimenting with sensory deprivation and had some of the best equipped facilities available. Knowledge derived from these monstrous projects, as well as many thousands of others, is being applied to mind control operations today.

**Unidentified Flying Mind Control**

It is worth noting that one of Louis Jolyon West's proteges, Barry Taff, co-wrote an article for UFO magazine suggesting aliens were responsible for this type of activity. Taff worked at the UCLA Neuropsychiatric Institute, and according to Los Angeles based researcher Martin Cannon, has consulted for a large number of government agencies, including the National Institute of Mental Health, Rand Corporation, The Atomic Energy Commission and the CIA The article was entitled Paranormal Phenomena and UFOs, and appeared in UFO, Vol 2 No 4.

Cannon has documented a long list of parallels between supposed Alien Abduction Phenomena and documented mind control experimentation, in a thoroughly researched and impeccably referenced 60-page (approx) paper entitled, The Controllers: A New Hypothesis of Alien Abductions. A condensed version of this paper was published in the October 1990 edition of the MUFON UFO Journal. It left me questioning the entire basis of the UFO phenomena. Might it be the largest mind control project ever? I suggest you examine the evidence carefully before you disregard the possibility.

Incidentally, UFO magazine editor, Vicki Cooper, is the niece of Grant Cooper, who was Sirhan Sirhan's attorney after he allegedly assassinated Robert Kennedy. Theodore Charach's film The Second Gun includes an interview with Sirhan's mother in which she curses her son's attorneys. There is much evidence that Sirhan Sirhan was a victim of mind control.

**Did I do that?**

Dr Leonard Diamond, director for the defence at the trial of Sirhan Sirhan, was extremely surprised when he first placed Sirhan under hypnosis. He noted that the ease with which he entered a deep hypnotic state clearly suggested he had been hypnotised before. Diamond questioned Sirhan, whilst in the hypnotic state, and asked him to write down the answers to his questions, and noted, "Sirhan would act like a robot and keep on repeating a word or a phrase until I stopped him." He showed Sirhan a sample page from his own diary, asking, "Is this crazy writing?", "YES, YES, YES" wrote Sirhan "Are you crazy" asked Diamond. "NO NO" Sirham replied. "Well, why are you writing crazy?" Diamond asked. "PRACTICE PRACTICE PRACTICE" came the reply. "Practice for what?" Diamond questioned. "MIND CONTROL MIND CONTROL MIND CONTROL" is what Sirhan wrote.

Sirhan was given a psychological stress evaluation test by a US intelligence officer, seven years after Kennedy's assassination. he has since been quoted as saying, "Everything in the PSE charts tells me that someone else was involved in the assassination and that Sirhan was programmed through hypnosis to kill R.F.K."

British lawyer Fenton Bressler believes that Mark David Chapman, who won international notoriety for shooting John Lennon on December 8, 1980, was also a programmed assassin. In his book Who Killed John Lennon? Bressler argues the case very convincingly. He contends that Chapman came into contact with the CIA whilst working for the YMCA, an organisation which is reported to have acted as a front for the CIA in many foreign countries. Chapman chose to do work for the YMCA in Beirut, of all places, a city rumoured to be the site of a CIA training camp for assassins. Witnesses to the shooting stated that Chapman assumed something akin to a "combat" position just before pulling the trigger, and the first reaction of the arresting detective, Arthur O'Connor, was that Chapman appeared to be "dazed" and "looked as if he could have been programmed."

**DRUGS TESTED BY THE CIA UNDER PROJECTS BLUEBIRD, ARTICHOKE MKULTRA, AND MKDELTA**

| | |
|---|---|
| 1. Adrenalin | 73. Icoral |
| 2. Aktetron | 74. Indole |
| 3. Alcohol | 75. Indole methylarmine |
| 4. Amphetamine | 76. Insulin |
| 5. Amphetamine Sulphate | 77. Lophop-nine |
| 6. Analasine | 78. Lyscorbic acid |
| 7. Anhalamine | 79. (illegible) |
| 8. Anhalidine | 80. (illegible) |
| 9. Anhaline | 81. (illegible) |
| 10. Anhalonidine | 82. (illegible) |
| 11. Analonine | 83. Manganese chloride |
| 12. Anahalonium | 84. Methy-cocaine |
| 13. Aphyllidine | 85. Metra-ol |
| 14. Aphylline | 86. Morphine |
| 15. Atropine | 87. Morphine hyrdochloride |
| 16. Atrosine | 88. Narco-imal |
| 17. Bambusa | 89. Nambutal |
| 18. Banisterine | 90. Nicotine |
| 19. Barbiturate | 91. Nikthemine (narcotic) |
| 20. Belladonna | 92. Nitrous oxide |
| 21. Benzidrine | 93. Novacaine |
| 22. Bendocaine | 94. Nupercaine |
| 23. Bromoharmine | 95. Pantocaine |
| 24. Bulbocapnine | 96. Pantopone |
| 25. Butyl-bromally- barbituric acid | 97. Parahyx |
| 26. Caffeine | 98. Pellotine |
| 27. Caffeine Sodium | 99. Pentobarbitone sodium |
| 28. Calcium chloride | 100. Pentothal acid |
| 29. Cannabidiol | 101. Pentothal sodium |
| 30. Cannabinol | 102. Percaine |
| 31. Cannabis | 103. Pernoston |
| 32. Cannabol | 104. Peyotl |
| 33. Caramine (narcotic) | 105. Phenactin |
| 34. Carboline | 106. Phenamine |

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|---|---|
| 35. Caroegine | 107. Pehyl-thio-urethanes |
| 36. Chloral hydrate | 108. Picrate |
| 37. Cocaine | 109. Picrotoxin |
| 38. Coffee | 110. Procaine |
| 39. Coramine | 111. Pulegone-orcinal |
| 40. Delvinyl sodium | 112. Pulegone-olivetol |
| 41. Di benzo pyran derivatives | 113. Pyrahexyl |
| 42. Dicain | 114. Pyramidon |
| 43. Dramamine | 115. Quinie |
| 44. Ephedrine | 116. Salsoline |
| 45. Ephetamine | 117. Scolpolmine |
| 46. Epinephrine | 118. Scolpolmine aminoxide hydrobromide |
| 47. Ergot | 119. Scolpolmine-phetamine-eukotal |
| 48. Ergotamine | 120. Sodium (62) |
| 49. Ethyl harmol | 121. Sodium amatyl |
| 50. Eucaine | 122. Sodium barbital |
| 51. Eucodal | 123. Sodium dlelvinal |
| 53. Eunacron | 125. Sodium pentobarbital (nembutal) |
| 54. Epicane | 126. Sodium pentothal |
| 55. Escrine | 127. Sodium phenobarbital |
| 56. Ether | 128. Sodium rhodanate |
| 57. Evipal | 129. Sodium soneryl |
| 58. Evipan | 130. Sodium succinate (77) |
| 59. Evipan sodium | 131. Sodium thioethamyl |
| 60. Evipan sodium (35) | 132. Somnifen |
| 61. Genoscopolamine | 133. Stovaine |
| 62. Harmaline | 134. Strychnine |
| 63. Harmalol | 135. Styphnic acid |
| 64. Harman | 136. Sympatol |
| 65. Harmine | 137. Synhexyl |
| 66. Harmine methiodide | 138. Telepathine |
| 67. Harmol | 139. Tatra-hydro-cannibolacetate |
| 68. Heroin | 140. Tetra-hydro-harman |
| 69. Hexacol | 141. Tetra-hydro-harmine |
| 70. Histadyl | 142. Tropacocaine |
| 71. Hydractine | 143. Tropenone |
| 72. Hypoloid soluble hexabarbitone | 144. Yageine |
| | 145. Yohimbine sulphate |

**United States Patent** ***5,450,859***
**Litovitz** **September 19, 1995**

# Protection of living systems from adverse effects of electric, magnetic and electromagnetic fields


**Abstract**

The disclosed embodiments of the inventions disclosed in this application develop a `protection` electric, magnetic or electromagnetic field or fields which are either superimposed upon an ambient field which is detrimental to the health of living systems, or is incorporated into the electrical circuit of the device which is generating the detrimental field. Either arrangement is successful in `confusing` living cells, and thereby reducing the harmful effects of the otherwise detrimental field.



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| Assignee: | **The Catholic University of America** (Washington, DC) |



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| Appl. No.: | **088034** |
| Filed: | **July 6, 1993** |

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|---|---|
| **Current U.S. Class:** | **128/897**; 600/9 |
| **Intern'l Class:** | A61B 019/00 |
| **Field of Search:** | 600/9-15 128/897-899 |

**References Cited** **[Referenced By]**

*Primary Examiner:* Cohen; Lee S.
*Assistant Examiner:* Lacyk; John P.
*Attorney, Agent or Firm:* Cushman Darby & Cushman


***Parent Case Text***

CROSS-REFERENCE TO RELATED APPLICATION

This application is a Continuation-In-Part of co-pending application Ser. No. 07/642,417, filed Jan. 17, 1991, the subject matter of which is incorporated herein.

## *Claims*

I claim:

1. An apparatus for creating a bioprotective electromagnetic field comprising the combination of:

an electrical coil for generating an electromagnetic field; and

an electrical power conversion device, having an input and an output, for modulating within time intervals of less than 10 seconds one or more fundamental properties of an electrical power source when said electrical power source is applied to said input, said fundamental properties including amplitude, period, phase, waveform and polarity, said output of said electrical power conversion device being coupled to said coil for driving said coil, whereby said coil generates a bioprotective electromagnetic field.

2. An apparatus according to claim 1 wherein said time intervals are random intervals, the largest of which is less than 10 seconds.

3. An apparatus according to claim 1 wherein said time intervals are 0.1 to 1 second.

4. An apparatus as recited in claim 1, wherein said electrical power conversion device modulates the amplitude of the electrical power source.

5. An apparatus as recited in claim 1, wherein said electrical power conversion device modulates the period of the electrical power source.

6. An apparatus as recited in claim 1, wherein said electrical power conversion device modulates the waveform of the electrical power source.

7. An apparatus as recited in claim 1, wherein said electrical power conversion device modulates polarity of the electrical power source.

8. An apparatus for creating a bioprotective electromagnetic field in a hair dryer comprising the combination of:

a hair dryer having a heating coil;

an electrical coil for producing an electromagnetic field, said coil being shaped and positioned so that it surrounds said heating coil of said hair dryer; and

an electrical power conversion device, having an input and having an output coupled to drive said coil, for changing within time intervals of less than 10 seconds one or more fundamental properties of an electrical power source when said electrical power source is applied to said input of said electrical power conversion device, said fundamental properties including amplitude, period, phase, waveform and polarity; whereby a bioprotective electromagnetic field is produced from said coil.

9. An apparatus according to claim 8 wherein said time intervals are random intervals, the largest of which is less than 10 seconds.

10. An apparatus according to claim 8 wherein said time intervals are 0.1 to 1 second.

11. An apparatus as in claim 8, wherein said heating coil and said electrical coil are arranged so as to be parallel and have current flowing in opposite directions, respectively.

12. An apparatus as in claim 8, wherein said hair dryer further comprises a sensing device for sensing the bioprotective field.

13. An apparatus for creating a bioprotective electromagnetic field for a computer comprising the combination of:

a computer having a keyboard;

an electrical coil for generating an electromagnetic field, said coil being positioned inside said keyboard of said computer; and

an electrical power conversion device, having an input and an output coupled to said coil, for modulating within time intervals of less than 10 seconds one or more fundamental properties of an electrical power source when said electrical power source is applied to said input, said fundamental properties including amplitude, period, phase, waveform and polarity, said output of said electrical power conversion device driving said coil, whereby said coil generates a bioprotective electromagnetic field.

14. An apparatus according to claim 13 wherein said time intervals are random intervals, the largest of which is less than 10 seconds.

15. An apparatus according to claim 13 wherein said time intervals are 0.1 to 1 second.

16. An apparatus as in claim 13, wherein said electrical power source is contained within said computer.

17. An apparatus as in claim 13, further comprising a sensing device for sensing the bioprotective field.

18. An apparatus for creating a bioprotective electromagnetic field in a space occupied by humans or animals comprising the combination of:

a space to be protected;

an electrical coil for generating an electromagnetic field, said coil being positioned adjacent a wall in said space; and

an electrical power conversion device, having an input and an output coupled to drive said coil, for modulating within time intervals of less than 10 seconds one or more fundamental properties of an electrical power source when said electrical power source is applied to said input, said fundamental properties including amplitude, period, phase, waveform and polarity, whereby said coil generates a bioprotective electromagnetic field.

19. An apparatus according to claim 18 wherein said time intervals are random intervals, the largest of which is less than 10 seconds.

20. An apparatus according to claim 18 wherein said time intervals are 0.1 to 1 second.

21. An apparatus as in claim 18, further comprising a sensing device for sensing the bioprotective field.

22. An apparatus for creating a bioprotective electromagnetic field surrounding a building comprising the combination of:

a building;

an electrical coil for generating an electromagnetic field, said coil surrounding said building; and

an electrical power conversion device, having an input and an output coupled to said coil, for modulating within time intervals of less than 10 seconds one or more fundamental properties of an electrical power source when said electrical power source is applied to said input, said fundamental properties including amplitude, period, phase, waveform and polarity, said output of said electrical power conversion device driving said coil, whereby said coil generates a bioprotective electromagnetic field.

23. An apparatus according to claim 22 wherein said time intervals are random intervals, the largest of which is less than 10 seconds.

24. An apparatus according to claim 22 wherein said time intervals are 0.1 to 1 second.

25. An apparatus as in claim 22, further comprising a sensing device for sensing the bioprotective field.

26. An apparatus for creating a bioprotective electromagnetic field surrounding a cathode ray tube comprising the combination of:

a cathode ray tube having a screen;

an electrical coil for generating an electromagnetic field, said coil surrounding said screen of said cathode ray tube; and

an electrical power conversion device, having an input and an output coupled to said coil, for modulating within time intervals of less than 10 seconds one or more fundamental properties of an electrical power source when said electrical power source is applied to said input, said fundamental properties including amplitude, period, phase, waveform and polarity, said output of said electrical power conversion device driving said coil, whereby said coil generates a bioprotective electromagnetic field.

27. An apparatus according to claim 26 wherein said time intervals are random intervals, the largest of which is less than 10 seconds.

28. An apparatus according to claim 26 wherein said time intervals are 0.1 to 1 second.

29. An apparatus for creating a bioprotective electromagnetic field surrounding a microwave oven comprising the combination of:

a microwave oven having an outer surface;

an electrical coil for generating an electromagnetic field, said coil positioned adjacent to an outer surface of said microwave oven; and

an electrical power conversion device, having an input and an output coupled to said coil, for modulating within time intervals of less than 10 seconds one or more fundamental property of an electrical power source when said electrical power source is applied to said input, said fundamental properties including amplitude, period, phase, waveform and polarity, said output of said electrical power conversion device driving said coil, whereby said coil generates a bioprotective electromagnetic field.

30. An apparatus according to claim 29 wherein said time intervals are random intervals, the largest of which is less than 10 seconds.

31. An apparatus according to claim 29 wherein said time intervals are 0.1 to 1 second.

32. An apparatus for creating a bioprotective electromagnetic field surrounding a mattress comprising the combination of:

a mattress, having an inside;

an electrical coil for generating an electromagnetic field, said coil being substantially the size of said mattress, said coil positioned in the inside of said mattress; and an electrical power conversion device, having an input and an output coupled to said coil, for modulating within time intervals of less than 10 seconds one or more fundamental properties of an electrical power source when said electrical power source is applied to said input, said fundamental properties including amplitude, period, phase, waveform and polarity, said output of said electrical power conversion device driving said coil, whereby said coil generates a bioprotective electromagnetic field.

33. An apparatus according to claim 32 wherein said time intervals are random intervals, the largest of which is less than 10 seconds.

34. An apparatus according to claim 32 wherein said time intervals are 0.1 to 1 second.

35. An apparatus for creating a bioprotective electromagnetic field in an electrical circuit comprising the combination of:

an electrical circuit;

a modulation device having an electrical input and an electrical output;

a modulation device driver coupled to said modulation device for electrically driving said modulation device; and

a modulation generator coupled to said driver which controls said modulation device driver within time intervals of less than 10 seconds, said time intervals of control of said modulation device driver altering at least one fundamental property of an electrical source applied to said electrical input of said modulation device, said fundamental property being any of amplitude, period, phase, waveform and polarity, said altered electrical source being available at said output of said modulation device, the use of said apparatus in said electrical circuit generating an electromagnetic field which is modulated at said time intervals.

36. An apparatus according to claim 35 wherein said time intervals are random intervals, the largest of which is less than 10 seconds.

37. An apparatus according to claim 35 wherein said time intervals are 0.1 to 1 second.

38. An apparatus as in claim 35, wherein said electrical output of said modulation device is grounded.

39. An apparatus as in claim 35, wherein said apparatus includes a thermostat.

40. An apparatus as in claim 35, wherein said apparatus includes a hair dryer.

41. An apparatus for converting standard household electrical power into a bioprotective power source comprising the combination of:

an electrical circuit for conveying electrical power;

a modulation device having an electrical power source and an electrical power output;

a modulation device driver coupled to said modulation device for electrically driving said modulation device; and

a modulation generator means coupled to said driver which controls said modulation device driver within time intervals of less than 10 seconds, said time intervals of control of said modulation device driver altering at least one fundamental property of said electrical power source of said modulation device, said fundamental property being any of amplitude, period, phase, waveform and polarity, said altered electrical power source of said modulation device being applied to said electrical power outlet of said modulation device, the use of said apparatus in said electrical circuit generating an electromagnetic field which is modulated at said time intervals.

42. An apparatus according to claim 41 wherein said time intervals are random intervals, the largest of which is less than 10 seconds.

43. An apparatus according to claim 41 wherein said time intervals are 0.1 to 1 second.

44. An apparatus for creating a bioprotective electromagnetic field in an electrical circuit comprising the combination of:

an electrical circuit;

a modulating resistance connected in said circuit; and

a modulation control device for changing said modulating resistance into different resistances, said changing into different resistances occurring within time intervals of less than 10 seconds, wherein a bioprotective electromagnetic field emanates from said electrical circuit.

45. An apparatus according to claim 44 wherein said time intervals are random intervals, the largest of which is less than 10 seconds.

46. An apparatus according to claim 44 wherein said time intervals are 0.1 to 1 second.

47. An apparatus as in claim 44, wherein said apparatus includes an electric blanket in which said electrical circuit is placed.

48. An apparatus for creating a bioprotective electromagnetic field comprising the combination of:

an electrical wire for producing an electromagnetic field; and

an electrical power conversion device, having an input and an output coupled to said wire, for modulating within time intervals of less than 10 seconds one or more fundamental properties of an electrical power source when said electrical power source is applied to said input of said electrical power conversion means, said fundamental properties including amplitude, period, phase, waveform and polarity, whereby said wire produces a bioprotective electromagnetic field.

49. An apparatus according to claim 48 wherein said time intervals are random intervals, the largest of which is less than 10 seconds.

50. An apparatus according to claim 48 wherein said time intervals are 0.1 to 1 second.

51. An apparatus for bioprotecting a power transmission line comprising the combination of:

a power transmission line;

a non-power carrying conductor placed so as to be parallel to said power transmission line; and

current generating apparatus coupled to said conductor for causing a current to flow in said conductor, the current being such that a magnetic field induced thereby is equal to or larger than that from said transmission line.

52. An apparatus according to claim 51 wherein said current causing means comprises means for causing current to flow that is turned on for 0.1 seconds in one second intervals.

## *Description*

BACKGROUND OF THE INVENTION

1. Field of the Invention

The inventions described herein relate in general to arrangements (apparatus and methods) for protecting living systems from the adverse effects upon them of electric fields, magnetic fields, and electromagnetic fields. In some instances hereinafter, electric fields, magnetic fields, and electromagnetic fields will all jointly be referred to simply as fields.

More specifically, the inventions are directed to electrical, electronic, electromechanical, and electromagnetic devices, systems, and installations and the effect of their concomitant fields on people, animals, and other living systems. The inventions a non-desired and potentially bioeffecting ambient field into a harmless non-bioeffecting field by either superimposing on the ambient field a `protection` field which sanitizes the ambient field, or changing the electrical operation of the device which is producing the ambient field so that its field emissions become less harmful. Both arrangements are successful in `confusing` the living cell or cells, thereby reducing the potentially harmful effects of the ambient field.

This application incorporates the subject matter set forth in two appendicies, filed herewith entitled: EVIDENCE THAT BIOEFFECTS CAN BE CAUSED BY WEAK ELECTROMAGNETIC FIELDS and A SUMMARY OF DATA DEMONSTRATING THE FACT THAT PROPERLY FLUCTUATING ELECTROMAGNETIC FIELDS CAN BLOCK THE BIOEFFECT OF COHERENT STEADY STATE EM FIELDS. 2. Description of Related Art

For some years there has been a growing recognition and concern that humans are suffering adverse effects, notably cancers, from living and/or working in ambient electromagnetic fields, particularly those fields which are alternating or pulsating at extremely low frequencies, or being modulated at extremely low frequencies. Extremely low frequencies, hereinafter referred to as ELF, are frequencies of the order of 1000 Hz and below. Ambient frequencies particularly identified with an enhanced risk of cancer are power line frequencies, which are 60 Hz in the U.S. and 50 Hz in the U.K., European Continental countries, and elsewhere. Electromagnetic fields existing near devices using cathode ray tubes also are implicated, due to fields generated by the magnetic electron beam deflecting devices included in tube control apparatus.

Various articles have been published on the electromagnetic field problem. Over the past 14 years a series of epidemiological studies have found that low level electromagnetic fields [even as low as 1 .mu.T (1 micro Tesla) produced by 60 Hz power lines can be correlated with increased incidence of certain diseases. The correlation is strongest for those who have lived or worked in this environment for many years. For example, an increased risk of cancer has been found among children who lived for several years close to power distribution lines [Wertheimer, N. and Leeper, E. "Electrical Wiring Configurations and Childhood Cancer" AM J EPIDEMIOLOGY, 109, 273-284 (1979); also, Savits, D. A. et al., "Case Control Study of Childhood Cancer and Exposure to 60-Hertz Magnetic Fields, " AM J EPIDEMIOLOGY, 128, 10-20 (1988); also London, D. A. et al. "Exposure To Electric and Magnetic Fields And Risk of Childhood Leukemia", AM. J. EPIDEMIOLOGY, 135, 1069-1070 (1992); also, Milham, S. Jr., "Increased Mortality in Amateur radio Operators Due to Lymphatic and Hematopoietic Malignancies," AM. J. EPIDEMIOLOGY, 128, 1175-1176 (1988).

The research indicates that children from high electromagnetic field exposure homes have a 50 percent greater risk of developing cancer, particularly leukemia, lymphomas, and nervous system tumors. Other data also show that men working in electrical jobs, such as electricians and telephone lineman are at higher risk for brain tumors and other cancers. In a recent study in the Los Angeles area, S. Preston-Martin and collaborators at the University of Southern California found that men who had worked for 10 Years or more in a variety of electrical occupations had a ten times greater chance of getting brain tumors than men in the control group. [Preston-Martin, S., and Mack, W. and Peters, Jr. "Astrocytoma Risk Related to Job Exposure to Electric and Magnetic Fields," presented at DOE contractors Annual Review, Denver Colorado, Nov. 5-8, 1990.]

A study performed by G. Matanoski of Johns Hopkins University found a dose response relationship for cancers in male New York Telephone employees from 1976 to 1980. [Matanoski, G., Elliot, E. and Breysse, P. Poster presented at the annual DOE/EPRI Contractors Review of Biological Effects from Electric and Magnetic Fields, November 1989, Portland, Ore.] Matanoski measured the average magnetic field exposure among different types of employees including installation and repair workers. A comparison of the cancer rates among the various types of employees showed that cable splicers were nearly twice as likely to develop cancer as those employees who did not work on telephone lines. Among central office workers those who were exposed to the fields of telephone switching equipment the rates of occurrence of cancers were unusually high, although not as high as for cable splicers. The central office workers were more than three times as likely to get prostate cancer and more than twice as likely to get oral cancer as co-workers who were less exposed. There were two cases of male breast cancer, a disease so rare that no cases at all would be expected.

The 60 Hz electromagnetic fields found in residential settings can vary from about 0.05 .mu.T to over 1000 .mu.T. In-vitro experiments have definitely shown that changes in biological cell function can occur in fields as low or lower than 1 .mu.T and as high as 500 .mu.T. R. Goodman and collaborators [Goodman, R. and Henderson, A., "Sine Waves Enhance Cellular transcription," BIOELECTROMAGNETICS, 7, 23-29, 1986)]have shown that RNA levels can be increased by electromagnetic fields ranging in frequency from 15 to 4400 Hz with amplitudes of 18 to 1150 .mu.T. They have shown that the RNA levels can be enhanced by factors of ten or more. Jutilainen and coworkers [Jutilainen, J., Laara, E. and Saali, K., INT>J. RADIAT. BIOL., 52,787-793, (1987)] have shown that 1 .mu.T 50-Hertz electromagnetic fields can induce abnormalities in chick embryos. Thus, electromagnetic fields appear not only to be carcinogenic, but also capable of inducing birth defects. Pollack and collaborators, C. T. Brighton, E. O'Keefe, S. R. Pollack and C. C. Clark, J. ORTH. RES. (to be published), have shown that electric fields as low as 0.1 mv/cm at 60 Khz can stimulate growth of bone osteoblasts. McLeod and collaborators have found that in the region between 1 Hz and 100 Hz, much lower fields are needed to stimulate fibroblast growth than at frequencies above and below this range [McLeod, K. J., Lee, R. and Ehrlich, H., "Frequency Dependence of Electric Field Modulation of Fibroblast Protein Synthesis," SCIENCE, 250, 1465 (1987)].

Other than epidemiologic studies, whole body research on EMF exposure has generally been limited to animals. Adverse effects from electromagnetic field exposure have also been shown demonstrated in this case. For example McLean et al. have presented a paper at the Thirteenth Annual Meeting of the Electromagnetic Society, in June 1991 entitled "Tumor Co-promotion in the mouse skin by 60-Hz Magnetic Fields". They have shown that the number of tumors present is increased by the presence of the magnetic field. Frolen et al. in a paper presented to the First European Congress on Bioelectromagnetism in 1991 entitled "Effects of Pulsed Magnetic Fields on the Developing Mouse Embryo". They show that mice exposed to magnetic fields have significantly more fetal resorptions than those which are unexposed. Since the present inventions negate all electromagnetic field induced bioeffects, all living systems can benefit from its application.

One method typically employed in the prior art to protect living systems from the detrimental effects of fields is to shield the field source. The shielding collects the energy of the field, and then typically grounds it. In practice shielding is impractical because it must completely cover a field source in order to contain the field. The field will radiate through any openings in the shield. In reality, devices cannot be entirely shielded, therefore, while the shielding method can reduce the field it does not entirely eliminate it or its potentially hazardous attributes.

Cathode ray tubes (CRT) are a source of electromagnetic fields to which people are often exposed, for instance television sets and computer screens. Attempts have been made by others in the art to shield the field which emanates from CRT's. One type of shield has been devised to surround the electromagnetic coils of the CRT. Another type of shield has been designed to entirely enclose the CRT. The shields which surround the coils do not, however, eliminate the field completely, nor do the shields which entirely enclose the CRT. These methods are often prohibitively expensive and often do not offer complete elimination of the detrimental effect of the fields.

Another method typically used in the prior art to protect living systems from electromagnetic fields is to balance the field from the source so that the source effectively cancels its own field, thus ideally producing no offending field. For instance, the AC power distribution to homes and industries is typically carried over unshielded bare copper wires, suspended in the air from towers. These lines are usually either two-phase or three-phase. Theoretically these lines can be arranged physically and by phase such that the EMF fields produced by the individual lines are each canceled by the other power line(s). In practice, however, this power cancellation is not complete and an ambient field still results. Also, the costs involved to produce a power distribution system such as this is prohibitively high.

The present inventions have many advantages over the methods employed thus far in the art. Many of the embodiments of the inventions are very inexpensive, they can provide positive protection for the individual, and they can be provided at the control of the individual. There is no need to wait until the power company changes the design of its power distribution system, or wait until the television or computer manufacturer completely shields the product. Some of the embodiments of the inventions enable living systems to have individual protection from the detrimental effects of ambient fields, if and when it is desired. Shielding is not always practical, and even when it is practical it is not always complete. Therefore the present inventions can also provide the user with personal control over the detrimental effects of ambient fields.

To the best of my knowledge, to date no one has heretofore proposed my inventions, although over 12 years have lapsed since the first recognition of the dangers of chronic electromagnetic field exposures to humans. There have been many teachings about the use of electromagnetic fields to treat humans for pre-existing diseases or conditions. For example, U.S. Pat. No. 4,066,065 (Kraus 1978) describes a coil structure to create a magnetic field for treatment of a hip joint. U.S. Pat. No. 4,105,017 (Ryaby 1978) describes a surgically non-invasive method of an apparatus for altering the growth, repair or maintenance behavior of living tissues by inducing voltages and concomitant current pulses. U.K. Patent GB 2 188 238 A (Nenov et al. 1986) describes an apparatus alleged to provide analgesic, trophic and anti-inflammatory effects. Costa (1987) U.S. Pat. No. 4,665,898 describes a magnetic coil apparatus for treatment of malignant cells with little damage to normal tissue. An apparatus for treatment of diseases of the peripheral and autonomic nervous system as well as other diseases has been described by Solov'eva et al. ("`Polyus-1` Apparatus for Low-Frequency Magnetotherapy," G. Solor'eva, V. Eremin and R. Gorzon, BIOMEDICAL ENGINEERING (Trans. of: Med. Tekh, (USSR)), Vol. 7, No. 5, pp. 291-1 (1973).

The above procedures are usually referred to as "magnetotherapeutic" procedures. My inventions focus instead on the prevention of disease caused by long term exposure to ambient time varying electric, magnetic and electromagnetic fields. To date, no other proposals have been presented which utilize modifications of the time dependence of the ambient fields to prevent adverse health effects of ambient electromagnetic fields. Basic to all the patents and articles which describe the treatment of pre-existing diseases by electromagnetic fields (magnetic therapy) is the assumption that electric or magnetic fields (often of large magnitude, e.g. 1 to 100 micro Tesla (Ryaby 1978), if applied for some limited period of time, can beneficially alter the functioning of the cells and tissues within living systems. Now it is known that chronic, long term exposure to even very low level, time varying fields (e.g., magnetic fields as low as 0.5 .mu.T) can cause some of the very diseases which short term therapeutic doses of these fields are used to treat. Methods of protection from the biological effects of magnetic fields have been sorely needed. To find this protection it was necessary for me to recognize that magnetic therapy is carried out by affecting biologic cell function. It had to be realized that if magnetic therapy does not affect the physiological functioning of the living system then no therapeutic effect could result. What was needed, which the present inventions provide, is a method of modifying the ambient fields in which living systems exist in such a way that they have no effect on cell function. This modified field has no utility in the treatment of any disease or biologic malfunction. This modified field is not of any use in magnetic therapy. However, this modified field (because it does not affect the function of the cells and tissues of the living system) has no adverse health effects. Thus, long term exposure to these modified fields will be safe. These modified fields would not, for example, increase the risk of developing cancer.

However, none of the above authors, or anyone else before me, had discovered that periodically changing these very low ambient fields as described elsewhere herein can prevent harmful effects of electromagnetic fields.

SUMMARY OF THE INVENTION

I have concluded that the aforesaid adverse health effects upon living systems (including but not limited to single cells, tissues, animals and humans) may be inhibited by changing in time one or more of the characteristic parameters of the ambient time varying electric, magnetic or electromagnetic field to which the living system is exposed. This may be done in a number of ways, for example, by changes in one or more of frequency (period), amplitude, phase, direction in space and wave form of the field to which the living system is exposed. As for the time period between changes, I have concluded that these time periods should be less than approximately ten (10) seconds, and preferably should not exceed approximately one (1) second. The changes may occur at regular or irregular intervals. If the changes occur at regular intervals the shortest time between changes should be one-tenth (0.1) second or greater. If the changes occur at irregular random intervals the time between changes can be shorter. These changes can be accomplished by superimposing these special time-dependent fields upon the ambient field, or by changing with time the characteristic parameters of the original fields.

The change or changes in the ambient field frequency should be about 10 percent or more of the related characteristic parameters of the field before the change

My proposal to protect living systems from the adverse effects of electric, magnetic or electromagnetic fields by creating special ambient fields as aforesaid is based on my conclusion that something must be done to confuse the biologic cell so that it can no longer respond to the usual fields found in the home and work place. I have discovered that the fluctuating fields mentioned above will prevent the adverse effects of the usual environmental fields. As above stated, these fluctuations can occur either in the amplitude, frequency (period), phase, wave form or direction-in-space of the newly created "confusion" field.

To affect cell function some insult (e.g. drug, chemical, virus, electromagnetic field, etc.) will cause a signal to be sent from receptors (often at the cell membrane) into the biochemical pathways of the cell. Although the exact receptor and signalling mechanism utilized by the cell to recognize the fields is not known, I have discovered that the mechanism of detection of electric, magnetic or electromagnetic fields can be stopped by confusing the cell with fields that vary in time in the ways specified herein.

For example, a 60 Hz electromagnetic field having a magnetic component of 10 .mu.T can cause a two fold enhancement of the enzyme ornithine decarboxylase. If this field is abruptly changed in frequency, amplitude, wave form, direction or phase at intervals of more than 10 seconds, the two fold enhancement persists. If, however, the frequency, amplitude or waveform parameters are changed at approximately 1 second intervals, the electromagnetic field has no effect. The cell does not respond because it has become confused. Similar electric fields in tissue with amplitudes ranging from 0.1 to 50 .mu.v/cm. can be useful in protecting the living system from adverse effects. To create these fields within a living system at 60 Hz the field strength outside the living systems must be about one million times larger (i.e. 0.1 to 50 v/cm.)

I consider that my inventions function best with ambient fields having an electric component of 50 Kv/M or less and/or a magnetic component of 5000 .mu.T or less. As for lesser field strengths, electric components of 0.5 Kv/M and/or magnetic components of 5 .mu.T are exemplary. Good results are obtained when the confusion field is generated by interruption of a coherent signal (e.g. a 60 Hz sinusoidal wave) and the frequency of this signal is similar (but not necessarily equal) to the fundamental frequency of the ambient field. However, when protecting against the effects of modulated RF or modulated microwave fields the confusion field can be effective if it contains only frequency components similar (but not necessarily equal) to those of the modulation. The rms amplitude of the confusion field should preferably be approximately the same or larger than that of the ambient field.

The time between changes in properties such as frequency, phase, direction, waveform or amplitude should be less than 5 seconds for partial inhibition of adverse effects but preferably between one tenth (0.1) second and one (1) second for much more complete protection. When the time between changes is irregular and random (e.g. a noise signal) the time between changes can be less than one tenth (0.1) second. For example I have found that complete inhibition can be achieved with a noise signal whose rms value is set equal to the rms value of the ambient signal and whose bandwidth extends from thirty (30) to ninety (90) hertz.

It is preferred to have the field to which the living system is exposed be my confusion field for the duration of the exposure. However, benefit will be achieved if my confusion field is in existence for only a major portion of the total exposure time.

I have referred above to electric, magnetic and electromagnetic fields because, insofar as they are distinct, ambient fields of each type are capable of causing harm to living systems, but if changed according to my inventions will inhibit the on-set of adverse effects.

I have confirmed the operability of my inventions by several observations and procedures. One observation has been the effect of coherence time (defined herein as the time interval between changes of the characteristic parameters of the fields) of the applied field on bioelectromagnetic enhancement of ornithine decarboxylase (ODC) specific activity. ODC has been found to be intimately linked to the process of cell transformation and tumor growth.

Specific activities of this highly inducible enzyme were examined following mammalian cell culture exposure to electromagnetic fields. Monolayer cultures of logarithmically growing L929 cells were exposed to fields alternating between 55 and 65 Hz. The magnetic field strength was 1 .mu.T peak. The cells were exposed to the fields for four hours. The time intervals between frequency shifts varied from 1 to 50 seconds. See Table 1.

TABLE 1

Role of Time Intervals Between Frequency Chances on the Effectiveness of Electromagnetic Exposure in Modifying ODC Activity

Ratio of ODC activity in Exposed Compared to unexposed cells

| | Time interval between frequency changes (seconds) | | | | |
|---|---|---|---|---|---|
| | 0.1 | 1 | 5 | 10 | 50 |
| ELF (55 to 65 Hz) | -- | 1 | 1.4 | 1.9 | 2.3 |
| Microwaves (modulated alternatively by 55 and 65 Hz) | 1 | 1 | 1.5 | 2.1 | 2.1 |

It can be seen from Table 1, (1), that when the time intervals between frequency shifts in the electromagnetic fields were 10 seconds or greater, the electromagnetic field exposure resulted in a two-fold increase in ODC activity. When the time intervals between frequency shifts (i.e. between 55 Hz and 65 Hz) were shortened to less than 10 seconds, the effectiveness of these ELF (extremely low frequency) fields in increasing ODC activity diminished. At 1 second and below the field has no effect at all (i.e., the activity of the exposed mammalian cells was the same as for unexposed cells). Thus we see that introducing changes in parameters of the electromagnetic field at short enough time intervals prevents any action of the field on cell function.

This finding applies to electromagnetic frequencies as high as the microwave region. Similar data were obtained using 0.9 GHz microwaves modulated at frequencies changing between 55 and 65 Hz at intervals of time ranging from 0.1 to 50 seconds. A 23 percent amplitude modulation was used and the specific absorption rate was 3 mW/g. As can be seen in table 1, when the time interval was 10 seconds or greater, this microwave field also caused a two-fold increase in ODC activity. At shorter time intervals the effect of the field on ODC activity diminished. When the time intervals between changes were one second or less, the field had no effect on ODC activity.

To further demonstrate the protective effect of my confusion fields, I studied the effects of modulation on the ability of exogenous electromagnetic fields to act as a teratogen and cause abnormalities in chick embryos. In experimental methods now described, I modulated the amplitude of a 60 Hz electromagnetic field. Fertilized White Leghorn eggs were obtained from Truslow Farms of Chestertown, Md. These were placed between a set of Helmholtz coils inside an incubator kept at 37.5.degree. C. During the first 48 hours of incubation one group of eggs was exposed to a 60 Hz continuous wave (cw) sinusoidal electromagnetic field whose amplitude was 1 .mu.T. Another group was exposed to a 60 Hz cw sinusoidal electromagnetic field whose amplitude was 4 .mu.T. Another group of eggs was exposed to a 60 Hz sinusoidal electromagnetic field whose amplitude was varied from 1.5 to 2.5 .mu.T at 1 second intervals. Control eggs were simply placed in the incubator and not exposed to an electromagnetic field. After 48 hours of incubation the embryos were removed from their shells and examined histologically. It was found that the control group (not exposed to the 60 Hz magnetic field) exhibited about 8 percent abnormalities. The embryo groups exposed to 1 .mu.T and 4 .mu.T fields had a higher abnormality rate (14 percent) than the controls indicating that these fields had indeed induced abnormalities. Those embryos exposed to the fields modulated at 1 second intervals had an abnormality rate the same as the unexposed eggs. Thus the 1 second modulation (or coherence time) effectively eliminated the teratogenic effect of the magnetic field.

When an ambient field is present (such as 60 Hz field from a power line or electrical appliance) which can not be directly modulated, a confusion field must be superimposed upon the ambient field. I studied this superposition effect in several different types of experiments.

As in the experiments above the ornithine decarboxylase levels were measured in L929 cells which were exposed to a steady state 10 .mu.T, 60 Hz field. They displayed a doubling of ornithine decarboxylase activity after 4 hours of exposure. The exposure was repeated with the simultaneous application of a) a 10 .mu.T 60 Hz magnetic field and b) a random EM (noise) magnetic field of bandwidth 30 to 90 Hz whose rms value was set equal to that of the 60 Hz field and whose direction was the same as that of the 60 Hz field. Under these conditions no statistically significant enhancement of the ornithine decarboxylase activity was observed. As the rms noise amplitude was lowered, increased values of EMF induced ornithine decarboxylase activity were observed. This can be seen in Table 2.

TABLE 2

Effect of EM noise on 60 Hz EMF enhancement of ODC activity in L929 murine cells

| Noise Amplitude rms (.mu.T) | Signal/Noise [signal = 60 Hz] | Percent of 60 Hz Induced Enhancement |
| --- | --- | --- |

| | | |
|---|---|---|
| 0 | .infin. | 100 .+-. 10 |
| 0.5 | 20 | 84 .+-. 12 |
| 1.0 | 10 | 50 .+-. 10 |
| 2.0 | 5 | 36 .+-. 7 |
| 5.0 | 2 | 8 .+-. 11 |
| 10.0 | 1 | 1 .+-. 8 |

It can be seen from Table 2 that when the noise is about equal to the signal (the 60 Hz field) no biomagnetic effect occurs, but as the rms noise amplitude is lowered less protection is afforded by the noise field.

To demonstrate that the confusion field can be perpendicular to the ambient field and still offer protection the ODC experiment using L929 murine cells was repeated again using 60 Hz, 10 .mu.T as the stimulating ambient field, but this time the confusion field was generated by coils aligned perpendicular to the coils generating the ambient magnetic field. The confusion field this time was a 60 Hz field whose amplitude changed from 5 .mu.T to 15 .mu.T at 1 second intervals. No enhancement of the ODC activity was observed under these conditions. The ratio of exposed ODC activity to control ODC activity was found to be 1.03.+-.0.08. Thus even when the confusion field is perpendicular to the ambient field full protection against adverse effects can be achieved.

If one wishes to render harmless the magnetic fields of heating devices such as electric blankets, heating pads, curling irons, or ceiling cable heat sources for the home, the parameters of the current being delivered to these devices should be changed at intervals less than 10 seconds, or preferably at intervals less than 1 second. One method is to turn the current on and off for consecutive 1 second intervals. However this would render the heat source inefficient since it could only deliver half the average power for which the device is designed. In order to improve the efficiency I have shown that when a 60 Hz field is on for a time greater than when it is off it can still confuse the cell and no bio-response will occur. The on time should still be preferably on the order of 1 second. However the off time should not be less than 0.1 seconds for full protection. Listed in Table 3 are the results of ODC experiments using L929 murine cells of the type described above. A 10 .mu.T 60 Hz field was applied to the cells. The field was interrupted every second for varying time durations. It can be seen that even with off times as short as 0.1 seconds the cell is confused and no enhancement of ODC activity occurs. As the off time decreases below 0.1 seconds the cell begins to respond to the magnetic field. For off times as low as 0.05 seconds about 70% of full response occurs. It is clear that the preferable range for off times is from about 0.1 to about 1.0 seconds.

TABLE 3

Effect of Interruption Time on 60 Hz EM Field Enhancement of ODC Activity in L929 Murine Cells

| Off Time (seconds) | On Time (seconds) | Percent of 60 Hz Induced |
|---|---|---|

| | | Enhancement |
|---|---|---|
| 0.1 | 1 | 3 .+-. 9 |
| 0.05 | 0.95 | 33 .+-. 3 |
| 0.025 | 0.975 | 70 .+-. 17 |

From these experiments we see that a device which interrupts the current in heating applications can be at least 90% efficient in terms of utilizing the full capabilities of the heating system, while at the same time providing a bioprotective confusion field.

As described above there is considerable epidemiological evidence that children living near power lines have a significantly higher rate of incidence of childhood leukemia. One method of rendering these fields harmless is to create a fluctuating field by stringing on the poles a pair of wires shorted at one end and connected to a low voltage current source at the other end. The current should fluctuate at the proper intervals (e.g. approximately one second intervals would be quite effective). Because in this case one is often interested in using as little power as possible short duty cycles would be an efficient power saving strategy. For example we have shown that in the experiment described above and reported in Table 3 the effect of 60 Hz exposure on the ODC activity in L929 cells can be mitigated by superimposing a 60 Hz field of equal peak value but which is on for 0.1 s and off for 0.9 s. Thus we save a factor of ten in power in this application relative to the one second on, one second off, regime.

According to my inventions, there are many different arrangements for converting an otherwise harmful field into a non-harmful one. Some of these are as follows:

One embodiment is to create a confusion field in a living space by placing several time dependent grounding devices on metal plumbing pipes. These devices cause fluctuating paths for electric current in plumbing pipe and therefore fluctuating fields in any room in the house or other human or animal-occupied structure.

Another embodiment is to change an otherwise harmful field into a non-harmful one by inserting fluctuating resistance paths in series with heating devices such as electric blankets.

Another embodiment is to create a confusion field by placing devices near appliances which generate harmful field to create fluctuating electromagnetic fields near the appliances. The confusion field is superimposed onto the uncontrolled source of the original harmful field.

Another embodiment is to eliminate the hazards created by the field in the region around electric devices by modulating the electric current flowing or voltage across the device. The modulation can be controlled by means which are external or internal to the device.

Another embodiment is to eliminate the hazards created by the field in the region around electric devices, by modulating the electromagnetic field around the device. This modulation can be caused by means which are external or internal to the device.

Another embodiment is to eliminate the hazards created by the field in the region surrounding electric heating devices, such as electric blankets, heating pads, and electrically heated water beds, by modulating the current and/or voltage in the device. This modulation can be caused by means which are external or internal to the device.

Another embodiment is to eliminate the hazards created by the field in the region around electric power distribution systems by superimposing a modulated electromagnetic field in the region of space to be protected.

Another embodiment is to eliminate hazards created by the electromagnetic fields in the region around the metallic plumbing used to ground electrical lines by superimposing a modulated electromagnetic field in the region of space to be protected. This can be done by passing modulated currents through the plumbing itself or by passing modulated currents through external circuits.

Another embodiment is to eliminate hazards created by the field around cathode ray tube devices such as video display terminals and television sets by superimposing a modulated electromagnetic field. The source of this modulated electromagnetic field can be placed either inside or outside the cathode ray tube device.

Another embodiment is to eliminate hazards created by the field in the region around a microwave oven by superimposing a modulated electromagnetic field in the region of space to be protected.

Another embodiment is to eliminate the hazards created by the field in the region surrounding electrical power lines.

Clearly many of the above procedures may be adapted to protect laboratories, industrial plants, etc., wherein cells not in humans or in multi-cell living systems may exist.

## BRIEF DESCRIPTION OF THE DRAWINGS

I will next describe various techniques and apparatus for carrying out my invention. These descriptions will be aided by reference to the accompanying drawings, in which:

FIG. 1 is a plot of amplitude vs. time of a sinusoidal function modulated as to amplitude.

FIG. 2 is a plot of amplitude vs. time of a sinusoidal function modulated as to frequency.

FIGS. 3a, 3b and 3c provide a representation of the effect of direct modulation on a 60 Hz sine wave using square wave modulation. FIG. 3d is an enlarged view of the signal of FIG. 3c at the point at which it is switched.

FIGS. 4a, 4b, and 4c provide a representation of the effect of direct modulation of a 60

Hz sine wave using DC biased square wave modulation. FIG. 4d is an enlarged view of the signal of FIG. 4c at the point at which it is switched.

FIGS. 5a, 5b, and 5c provide a representation of the effect of direct modulation of a 60 Hz sine wave using a periodically changed waveform. FIG. 5d is an enlarged view of the signal of FIG. 5c at the point at which it is switched.

FIGS. 6a, 6b, and 6c provide a representation of the effect of superimposing a band limited noise signal over a sinusoidal signal whose frequency is within the bandwidth of the noise.

FIGS. 7a, 7b, and 7c provide a representation of the effect of superimposing a band limited noise signal over a sawtooth signal whose frequency is within the bandwidth of the noise.

FIGS. 8a and 8b provide a block diagram representation of the direct modulation implementation of the bioprotection feature of the inventions.

FIG. 9 is a block diagram representation of the in-circuit modulator of the direct modulation implementation of the bioprotection of the inventions.

FIG. 10 is a block diagram representation of the superposition modulation implementation of the bioprotection feature of the inventions.

FIG. 11 is a block diagram representation of the in-circuit modulator of the superposition modulation implementation of the bioprotection feature of the inventions.

FIG. 12 is a diagram of a circuit for modulating electric current through a plumbing pipe.

FIG. 13 is a diagram of a protective circuit for an electric blanket.

FIG. 14 is a diagram of a protective apparatus for use with a video display terminal.

FIG. 15 is a diagram of another form of protective circuit for use with a video display terminal.

FIG. 16 is a diagram of a protective system for use in a space occupied by humans and/or animals.

FIG. 17 is a diagram of a mat for placement on or under a mattress used for sleeping purposes.

FIG. 18 is a circuit diagram of a direct modulation bioprotective converter box.

FIG. 19 is a circuit diagram of a direct modulation bioprotective thermostat.

FIG. 20 is a circuit diagram of an implementation of a bioprotected hair dryer.

FIG. 21 is a circuit diagram of a detection system to detect the presence of a bioprotective field.

FIG. 22 is a heating coil configuration with low magnetic field emissions for a bioprotected hair dryer.

FIG. 23 is a circuit diagram for control of the heating coil configuration of FIG. 22.

FIG. 24 is bioprotection coil for a computer keyboard.

FIG. 25a is coil arrangement for a bioprotection system for a residence or other building.

FIG. 25b is a circuit diagram of another possible implementation of a bioprotection system for a residence or other building.

FIG. 26 is a circuit diagram for a bioprotection system for a residence or other building.

FIG. 27 shows an embodiment of the invention implementing the superposition technique to create a confusion field in the area surrounding a power distribution line.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Any voltage, current, electric field, magnetic field, or electromagnetic field which varies repetitively in time can be described by its waveform, peak amplitude (A), frequency (period), direction and phase. Modulation of the wave refers to the time dependent variation of any of these parameters. For example, pulse modulation of the amplitude of any of the parameters refers to a change in amplitude. Two examples of this modulation are shown in FIGS. 1 and 2. In FIG. 1 the amplitude is modulated by a pulse. Thus, for a period of time, T.sub.1, the amplitude of the sinusoidally varying voltage is A.sub.1. For a second time period, T.sub.2, the amplitude is A.sub.1. The values of T.sub.1 and T.sub.2 need not be equal but they must each be about 1 second or less for best results. Many variations in the modulation of a time varying voltage can be used, such as a sinusoidal modulation of the original sine wave. Thus, a 60 Hz sine voltage could be amplitude modulated by a 1 Hz sinusoidal variation. Another possibility is a saw tooth variation in the amplitude of a 60 Hz sine voltage. In all of the possible modulated fields, at least one of the parameters, such as amplitude, waveform, phase, direction or frequency must not be constant for a time duration of more than about 1 second.

Thus, for example, in FIGS. 1 and 2 the values of T.sub.1 and T.sub.2 must not be longer than about 1 second. For best results, A.sub.1 should be greater than 1.2A.sub.2, and preferably greater than 2A.sub.2.

Whenever a microwave field is being modulated at a frequency of 100,000 Hz or less, steps should be taken to achieve protection according to my inventions by periodic parameter changing as described herein.

Another method of modulating the detrimental field is by using square wave modulation. That is, interrupt the power delivered at a regular interval. The modulation frequency should be preferably of the order of one second, as guided by the Litovitz invention. The interruption time should be preferably between 0.1 and 0.9 seconds, corresponding to a duty cycle between 10% and 90%. FIG. 3 depicts the method of square wave modulation of a sinusoidal waveform.

Referring to FIG. 3a, a sinusoidal signal is depicted. FIG. 3b depicts the controlling sequence to the sinusoidal signal of FIG. 3a using this method, and FIG. 3c is the resulting bioprotected sinusoidal signal. FIG. 3d is an enlarged view of the signal of FIG. 3c at the point at which it is switched.

Another method of modulating the detrimental field is by using DC biased square wave modulation. That is, reduce the power delivered at a regular interval. The modulation frequency and the interval for amplitude reduction should vary in accordance with this specification. Power reduction should be preferably of the order of 50%. FIG. 4 depicts the method of modulation of a sinusoidal waveform by a DC biased square wave.

Referring to FIG. 4a, a sinusoidal signal is depicted. FIG. 4b depicts the controlling sequence to the sinusoidal signal of FIG. 4a using this method, and FIG. 4c is the resulting bioprotected sinusoidal signal. FIG. 4d is an enlarged view of the signal of FIG. 4c at the point at which it is switched.

Another method of modulation of the detrimental field is by using frequency modulation of a square wave periodic signal. That is, change the frequency of the power delivered at a regular interval. The period and duty cycle should be in accordance with this specification. The frequency change should be preferably of the order of 20%.

Another method of modulation of the detrimental field is by using phase modulation of a square wave periodic signal. That is, change the phase of the power delivered at a regular interval. The period and duty cycle should be in accordance with this specification. The phase change should preferably be a multiple of 90 degrees.

Another method of modulation of the detrimental field is by periodically changing the waveform of the detrimental field. The period and duty cycle should be in accordance with this specification. The wave shape change can be for example by full wave rectification. FIG. 5 shows the effect of modulation by periodically changing the waveform by full wave rectification of a sinusoidal waveform.

Referring to FIG. 5a, a sinusoidal signal is depicted. FIG. 5b depicts the controlling sequence to the sinusoidal signal of FIG. 5a using this method, and FIG. 5c is the resulting bioprotected sinusoidal signal. FIG. 5d is an enlarged view of the signal of FIG. 5c at the point at which it is switched.

Another method of modulation of the detrimental field is by changing the detrimental field according to the superposition of a band-limited noise signal with a pass band preferably in the range below 1000 Hz.

When a superposition field source is used, the interference signal may be produced by appropriate modulation of coherent AC signals, or by generation of noise. FIG. 6 shows the effect of the modulation of a sinusoidal waveform by superposition of a band-limited random noise signal.

Referring to FIG. 6a, a sinusoidal signal is depicted. A superimposed bioprotection field source which has an field in the shape of random noise is depicted in FIG. 6b. FIG. 6c is the resulting bioprotected field surrounding the living system because of the combination of the sinusoidal signal of FIG. 6a and the bioprotecting field signal of FIG. 6b.

FIG. 7 shows the effect of the modulation of a sawtooth waveform by superposition of a band-limited random noise signal. Referring to FIG. 7a, a sawtooth signal is depicted. FIG. 7b depicts a superimposed bioprotection field source which has an field in the shape of random noise, and FIG. 7c is the resulting bioprotected field surrounding the living system because of the combination of the sinusoidal signal of FIG. 7a and the bioprotecting field signal of FIG. 7b.

There are essentially two types of embodiments of this invention: (1) direct modulation devices which are placed in the electrical circuit of the source of the detrimental field; and (2) superposition devices which are independent from the detrimental field source but create a confusion field which is intended to be combined with the detrimental field, creating a bioprotected field.

DIRECT MODULATION EMBODIMENTS

The direct modulation embodiments demonstrate the many possible methods of directly modulating a regularly oscillating current to minimize its bioeffecting properties. FIG. 8 is a block diagram which explains the general scheme of the direct modulation technique of this invention.

Referring to FIG. 8a, a standard electrical device contains electrical components which produce field 40 and those electrical components which do not produce field 36. All electrical components require a power source 38 to operate. Therefore, as seen in FIG. 8b, one type of embodiment of the inventions places an in-circuit modulator 42 between the power source 38 and the detrimental field producing components 40.

FIG. 9 is a block diagram which explains further the in-circuit modulator 42 of FIG. 8b. The in-circuit modulator 42 directly modulates the power flowing into an electrical circuit so as to render its emanating field harmless (bioprotected field). A power source 38 supplies power to the field source components 40 and the circuitry of the in-circuit modulator 42. The in-circuit modulator comprises a modulation generator 44 which creates a modulating waveform in accordance with this invention. The Modulation device driver 46 powers the modulation device 48. The modulation device directly modulates a fundamental property of the power source 38, and then the resulting bioprotected power source powers the field source components 40. Because the power source has a fundamental property which is modulated according to this specification, the resulting field from the field source components, which would otherwise be detrimental, is then rendered bioprotected.

The DC power source 38a represents any DC source of electrical power, for example a battery, an AC line transformer, and an AC line capacitively coupled DC power supply. The transformer isolated supply can have large field's in the vicinity of the transformer. However, these fields are mostly localized. The AC line capacitor coupled DC power supplied can become rather inefficient if the power requirement is large. An AC line powered transformer isolated regulated DC power supply is easily constructed using a suitably rated transformer, a half wave or full wave rectifier, a charging capacitor, and a voltage regulator such as one of the LM78XX line manufactured by National Semiconductor. An AC line powered capacitor coupled regulated DC power supply is easily constructed using for example a MAX610 or MAX611 AC to DC converter IC from Maxim Electronics. One disadvantage of the capacitively coupled DC power supply is that it is not isolated from the AC line.

The modulation generator 44 may be implemented as a timing circuit. There are many possible implementations of a timing circuit. One alternative is to use a crystal oscillator to generate a base clock frequency. The period and duty cycle of the control signal may be set by using the appropriate frequency dividers and combinatorial logic. Another alternative is to use a monostable multivibrator circuit such as the one based on a 555 timer. An implementation of this circuit is given in data books published by National Semiconductor, and are well known in the art. The period and duty cycle are easily changed in this circuit in the range 50-100%. The complement of the output signal obtained by means of an inverter, such as the 7404, can be used for values outside this range.

The timing circuit may also be implemented using a microprocessor. Microprocessors and microcontrollers are digital devices which can perform a multitude of arithmetic and logic operations under software control. More complex timing schemes may be achieved using a microprocessor, for instance, the duty cycle of the square wave may be randomly varied, however, there is no inherent advantage in the use of these complex timing sequences as far as the effectiveness of the bioprotecting action is concerned.

The modulation device driver 46 constitutes the interface between the modulation generator 44 and the modulation device 48. This component should ideally provide line isolation to eliminate any possible feedback from the load current to the control logic. A possible implementation is an optoisolated triac/SCR driver such as the MOC3030 made by Motorola.

The modulation device 48 controls a fundamental property of the power source through the load. The modulation device 48 may be a switching device in the case of current modulation, but because of switch cycling and overall operating lifetime requirements, this component must typically have a life time of at least one billion switching cycles. Solid state switches implemented with triacs or SCR's are ideally suited for this application. An example of a suitable triac for 115 V operation is one of the MAC3030 series made by Motorola.

SUPERPOSITION MODULATION EMBODIMENTS

Another technique and device for implementation of the inventions is to superimpose a confusion field signal upon the detrimental field. The source of the confusion field can be a coil driven, for instance, by circuitry similar to that used for the direct modulation scheme. The confusion field created by the coil or otherwise field producing device, is used to superimpose an appropriate confusion field over the ambient detrimental field. The general scheme of this technique is depicted in FIG. 10. Referring to FIG. 10, a confusion field source 50, typically a coil structure, is placed in proximity to the detrimental field and the living system to be protected. The confusion field source 50 is then powered by a current source 38b, with the current from source 38b modulated by at least one fundamental property through an in-circuit modulator 42 of the type described in this specification.

As previously noted, to be effective the amplitude of the bioprotection signal must be at least as large as that of the detrimental field. One approach to meet this requirement is to establish a signal level high enough to cover the normally expected magnetic field fluctuations. Alternatively, in cases where the ambient magnetic field is expected to vary, the bioprotection signal level could be adjusted in response to changes in the average magnetic field.

It has been experimentally shown that the bioprotection field need not be continuously present to be effective. For instance, a bioprotection periodic signal which is turned on and off in subsequent one second intervals is still effective. This property is useful in implementing a bioprotection scheme which is responsive to changes in the magnetic field environment. During the signal off time the bioprotection coil may be used to measure the prevailing magnetic field. A coil can accurately measure only magnetic fields which are uniform across the area circumscribed by the coil. If the bioprotection coil is large it would measure an average magnetic field, that is, the effects of localized fields would, in general, be averaged out. If the prevailing magnetic field environment is in large part due to a source producing a wide range magnetic field, such as a high tension power line, the coil measurement would be more indicative of the actual conditions.

One embodiment of the superposition modulation technique uses the embodiment of the direct modulation scheme, depicted in FIG. 10. In one case the fundamental property of the current from the current source chosen to be modulated would be amplitude, but it could be some other fundamental property such as frequency. But modulated coherent signals, other than line frequency signals, are more difficult to generate and therefore are not a convenient choice.

Another technique of superposition modulation is depicted in FIG. 11. This technique employs a noise generator 52 followed by a band pass filter 54 and power amplifier 56. These devices are powered by a power source 38, and drive a confusion field source 50, e.g. a coil or similar field radiating device. The components of this scheme are described in the following paragraphs.

If the power requirements are low, the power source 38 may be implemented using one of the methods described above. Standard methods described in the literature (e.g., National Semiconductor Linear Applications Handbook) may be used for applications with higher power requirements.

There are many techniques to generate noise signals for use as the Noise Generator 52. The following methods are suitable for situations in which the implementing circuit should not add significantly to the overall size of the application.

A noise signal may be generated by amplifying shot noise from a solid state device such as a zener diode. Electric current is defined as the flow of discrete electric charges. Shot noise results from statistic fluctuations of the current due to the finiteness of the charge quantum. The noise generated in this case is white Gaussian noise. An alternative means to produce noise is using digital techniques. A pseudo random digital sequence may be generated using a bank of n shift registers in which the output register is logically combined with one or more previous registers and feedback to the input register. Long sequences which are apparently random can be generated in this way. The sequence repeats itself after 2.sup.n - 1 shift cycles. It is easily seen that the shift register length can be made large enough to make an essentially random bit generator over the time of use of the sequencer. This circuit has been implemented in a special purpose IC, the MM5437 from National Semiconductor, which can be used as the noise generator for the application described herein.

The effectiveness of a confusion field is based on the premise that the biosystem senses the changing characteristics of the bioprotection signal and does not initiate a bioresponse. Based on experimental evidence, supported by the dielectric properties of biological cells, biosystems are more responsive to ELF fields. Therefore the bioprotection signal is expected to be sensed more effectively when operating in the ELF frequency range. Noise generation as described in the previous paragraph results in a wide band signal which must be filtered to produce a signal in the ELF range. Experimental evidence indicates that a noise signal with bandwidth between 30 and 100 Hz can be effective in inhibiting the bio-response when the rms amplitude of the noise is equal to or larger than the rms amplitude of the coherent signal. A bandpass filter 54 may be implemented either with a passive element network or with op-amp based circuits. The op-amp implementation is simpler having less components for an equivalent filter. There are various types of band-pass filter 54 implementations using op-amps: amongst them Butterworth, Chebyshev and Bessel filters. The sharpness of the response may be increased by increasing the number of poles of the transfer function of the filter. A 2-pole low pass Chebyshev filter designed to have a 0.5 Db ripple on the pass band was found to be one possible adequate implementation for this application. In this implementation the low frequency cut-off for the bandpass filter 54 at the specified frequency of 30 Hz is set up by the natural response of the circuit components.

Because of the ability to perform mathematical operations, a microcontroller may be used as the modulation generator 44. Confusion field signals designed to have amplitude or frequency changes or both over specific ranges of each period may be easily generated under software control. Likewise, a noise signal may be digitally generated with an algorithm which mimics the shift register noise generating implementation described earlier, or using other standard techniques. The bandpass filter 54 may also be performed digitally to reproduce the Chebyshev filter hardware implementation previously described or any other suitable filter implementation. In all these cases the output of the microprocessor controlled modulation generator signal dictates the current signal which is passed from the current source 38b to the confusion field source 50.

Amplification of the modulated signal may be achieved using an amplifier module of the same type already described. A power amplifier 56 may be necessary to power the confusion field source (i.e. a multiple turn wire loop or coil). The output of the bandpass filter 54 is typically not suited to drive a low impedance complex load such as a coil. A power amplifier 56 is needed to allow adequate current flow through this load. The power amplifier 56 design depends on the current requirements. Two power amplifier IC's covering a wide power range are the 7 Watt LM383 and the 140 Watt LM12, both made by National Semiconductor. Other standard op-amp based amplifier circuits are available in the general literature.

The confusion field source 50 must be designed to induce the desired confusion field within the region where the detrimental field is to be bioprotected. It should be noted that experimental evidence shows that the direction of the bioprotecting magnetic field is not important relative to the bioeffecting field. This allows some freedom in the design of the confusion field source 50. The selected configuration for a particular application also depends on space constraints, for instance if the confusion field source is to be incorporated as part of an existing electrical device without changing its general external configuration. In cases where bioprotection from a localized field arising from a small electrical device is sought, the confusion field source 50 would, for instance, be designed to surround the detrimental field source, or be strategically located in the proximity of the detrimental field source. Situations in which the range of the detrimental field is large, for instance with the large heating coils in electrically heated homes, or within power line fields, may require a much larger range of protection. Large coils circumscribing the area to be protected would be adequate in this case. Multiple coils would be necessary when the required range of protection is large in all dimensions as would be the case in a multi-story building.

Protection from leakage currents running through copper plumbing may readily be achieved, as shown in FIG. 12. With reference to FIG. 12, devices 10 are switches either electronically or mechanically controlled which switch on and off at intervals of one second (e.g. one second on and one second off). During the "on" intervals this will cause some of the current flowing past point A and B in the copper pipe 12 to alternately flow through ground rather than entirely through the pipe. Thus, the current flow from A to B (which creates an electromagnetic field in the working and living spaces of the structure) will be modulated (by reduction in current) at intervals of no greater than one second. The number of devices needed will depend on the complexity of the piping.

Protection from electric blankets is readily achieved. FIG. 13 shows the heating circuit of the electric blanket. Device 14 (the protective circuit) is a switch which turns the electric current through the blanket 16 on and off at intervals of one second. The device 14 need not switch the current completely off. It could, for example, reduce the current by 50 percent, and then within one second return the current to its full value. The device 18 is the usual thermostat supplied with electric blankets. Neither the "on" nor the "off" interval should be greater than 5 seconds, and should be preferably one second.

Harmful effects of video display terminals may be avoided, as shown in FIG. 14. Referring to FIG. 14, the video display terminal 20 is protected by a source 22 of electromagnetic field. B.sub.VDT and B.sub.PD are, respectively, the magnetic fields of the video display terminal (VDT) and the protective device (PD). The average amplitude of B.sub.PD at any point in the region to be protected should be greater than 50 percent of the amplitude of the field due to the VDT. Preferably, the average amplitude B.sub.PD should be at least twice the amplitude of B.sub.VDT. If the protective field of PD is in the same direction as the VDT field it will be most effective. If the PD field is perpendicular to the VDT field, it must be five times larger than the VDT field.

FIG. 15 shows a system similar to that shown in FIG. 14, however FIG. 15 shows the PD 24 as a coil mounted around the VTD 20.

The protective device can be any device which generates a time varying modulated electromagnetic field. For example, if a coil with ten turns of wire is to be used, it can be mounted either as in FIG. 14, or in FIG. 15. In FIG. 14 the coil is placed on a surface near the VDT and oriented so that its field intersects the field of the VDT. In FIG. 15 the coil is placed around the outer edge of the front of the VDT. In a typical VDT the coil could be a square about 40 cm on each side. The average current in the coil should be adjusted so that the average field at the front and center of the monitor due to the coil is preferably about equal to that field at the same point due to the VDT. For example, if the average field at the very front of the monitor is 10 .mu.T a 10 turn coil of wire 40 cm on edge could have a 60 Hz cw current of approximately 0.35 amps flowing through it. The current could be alternatively 0.5 amps for 1 second and then 0.2 amps for 1 second.

It will be understood that a standard TV set (one case of VDT) can be protected in the same manner as VDTs or "computers". Oscilloscopes may similarly be protected.

Large areas may also be protected, as shown in FIG. 16. Referring to FIG. 16, large coils of wire 26, 28 (e.g. 7 ft high by 7 ft wide) are mounted on or near opposite walls of a room, or on the floor and ceiling. The latter configuration is more effective than the former when the ambient fields are in a vertical direction. It is assumed that the room is exposed to a cw electromagnetic field that is dangerous to living systems. Modulated current (e.g., "on" and "off" at one second intervals) flows through the coils. The current and the modulation in coil 26 is kept in phase with the current and modulation in coil 28. The pair of coils act as Helmholtz coils and tend to keep the field in the protected region more uniform than if a single coil were used. The average amplitude of the current in the coils should be such that the electromagnetic field produced by the coils at every point in the region to be protected is at least 50 percent of the ambient field and preferably 5 to 10 times the ambient value.

A single coil can be used instead of the a pair of coils. The larger the coil the better; a larger coil will provide a more uniform protected region than a small one.

Special mats containing coils can be used in the home, laboratory, or other living system inhabited place to provide general protection. For example, a large percentage of the time spent at home is by a human sleeping on a bed. Thus, it would be useful for those who live near power distribution lines to use a device which puts the human in a protective "confusion" field during the time during which he is lying on the bed. FIG. 17 shows the use of a coil structure to produce a confusion field in a mattress.

As shown in FIG. 17, this can be done by embedding a many turn coil of wire 30 in a mat 32 and placing this mat either on or under the mattress 34, but near the head of the bed for maximum protection of the vital organs. The wire should be of low resistance, since it would be used year round and should not have significant heating of the bed or its occupants. This coil of wire would have the modulated current flowing through it during all seasons. The modulated electromagnetic field would protect the occupants of the bed from the ambient electromagnetic fields in the room. For example for a queen size bed a square coil of wire with 10 turns approximately 60 inches by 60 inches square and with 0.14 amperes of current flowing will yield at the center of the coil a magnetic field in the vertical direction of about 1 micro Tesla. If the bed is over 100 feet away from a power line 20 feet in the air, the ambient magnetic field due to the power line is also in the vertical direction. Thus, we have an optimum alignment of the field of the coil and that of the power line. To create a confusion field the current in the coil should vary from about 0.03 amperes to 0.07 amperes and back at least once every second yielding a coil field at the center which fluctuates between 0.5 and 0.2 .mu.T. Assuming that the power line is 1 .mu.T, the total field near the center will (if the coil field is in phase with the power line field) change from 1.2 .mu.T to 1.5 .mu.T and back every second. If the fields are out of phase the net field will vary from 0.5 to 0.75 .mu.T every second. Either of these conditions would protect the occupants from exposure to the power line field. The above coil could be combined within an electric blanket so that the blanket would serve a dual purpose of heating and protecting.

Such mats also may be adapted for use with chairs, or placed on tables or kitchen counters, or wherever humans or animals spend considerable time.

CONVERTER BOX EMBODIMENT

The converter box is an embodiment which employs the direct modulation technique of this invention. Electrically powered devices operating at power line frequencies and using resistive type elements to generate heat are always surrounded by a magnetic field induced by the flow of electric current through the heating element(s). The magnitude and range of the magnetic field emissions are a function of the geometry of the heating element(s) and the amplitude of the current passing through it. The present embodiment makes use of the direct modulation technique in a general purpose device which converts line power into a minimally bioeffecting format. Because of its function the device is herein after called the `converter box`. Its use is as an add-on bioprotection module for standard resistive type heating devices.

FIG. 18 shows the circuit diagram for a converter unit which modulates the fundamental property of amplitude of standard household electrical current, for use by an external appliance. Referring to FIG. 18, the converter box is designed for connection to a standard household power line outlet, for instance a 120 V, 60 Hz outlet, either directly through an integral plug or via a power cord 74. The line power is then modulated within the converter box using one of the methods for direct modulation previously described and made available in its modulated form through a power outlet on the converter box. The electric and magnetic field emissions from a resistive type heating device operating from the modulated outlet of the converter box are similarly modulated and therefore become negligible bioeffectors.

The converter box may be used, for example, with electric blankets, electric heating pads, curling irons, and other low power resistive heat devices. Use with devices incorporating fan motors or other inductive loads is not recommended, because line power modulation may cause improper operation of an inductive load. One possible circuit implementation of the converter box is shown in FIG. 18. This implementation uses a 1 second period and a 90% duty cycle. If no power loss is desired from the bioprotection modulation the switching device may be implemented as a DPDT switch connecting either to the line frequency or to a full wave rectified line frequency signal.

The converter box is plugged into a power source 74, e.g. a household circuit. The switching device 76 intercepts the hot line 80 of the power source 74, while the neutral line 78 is jumpered directly between the power source 74 and the bioprotected outlet 72. The switching device 76 resides between the hot line 80 of the power source 74 and the hot line 82 of the bioprotected outlet 72. The converter box implements a control signal generator 68 and a switching device driver 70 in conformance with the disclosure of direct modulation methods described herein.

BIOPROTECTED THERMOSTAT EMBODIMENT

In-line thermostats are devices used to control current flow in response to changes in temperature relative to a set level. Although many circuit designs are possible to implement the inventions described herein, one will be described. The circuit for an embodiment of a thermostat is depicted in FIG. 19. In this embodiment, current control is achieved by means of a modulation device 92. Control of the modulation device 92 is achieved through the use of a modulation device driver 90, along with a temperature control circuit 84, and modulation generator 86. The temperature control circuit 84 and the modulation generator 86 are NANDed together and input to the modulation device driver 90. One possible implementation of the modulation device driver 90 uses a triac, such as the MAC3030 or MAC3031 made by Motorola or another suitably rated unit, for the switching device. The modulation device driver 90 would be controlled by logically NANDing a signal from a temperature control circuit 84, (e.g. a circuit using an LM3911 temperature controller made by National Semiconductor), and a signal from a modulation generator 86. The modulation generator 86 may be implemented using a 555 timer connected as a monostable multivibrator. The simplest method to implement the bioprotection feature is by periodically switching off the field. A duty cycle of 90% with a period of 1 second could be used to minimize the effect of the modulation on the heating efficiency. If no heating loss is desired from the modulation, the latter may be implemented by switching between no rectification and full wave rectification. However, in this case the modulation device 92 controlled by the temperature control circuit 84 would be connected in series with the modulation device driver 90 and would operate independently from the latter. The lines 94 and 96 into the modulation device 92 complete the circuit to the load for which thermostatic control is desired.

BIOPROTECTED HAIR DRYER

(Superposition Modulation Technique) Embodiments

Hair dryers, like other electrically powered devices operating at power line frequencies and using resistive type elements to generate heat, cause magnetic fields induced by the flow of electric current through the heating element(s). Most hair dryers operate by blowing heated air through a large nozzle. The air is heated as it passes through a set of heating coils mounted within the nozzle. The primary sources of magnetic field emissions are the heating coils, and the fan blower motor. In normal operation the nozzle of the hair dryer is pointed towards the head. Therefore, the magnetic field emissions from the heating coil at the head of the user, are often larger in magnitude than those from the fan motor. The magnetic field emissions from most standard hair dryers are of relatively high amplitude and are therefore bioeffecting fields. The embodiment described in this section incorporates the bioprotection features of the inventions into a standard hair dryer. In addition, a heating coil arrangement designed to have low magnetic field emissions is described.

In the present application the bioprotected feature may be incorporated either by direct modulation of the current that passes through the heating coils or by superposition modulation. In the case of direct modulation, the current passing through the heating coils can be modulated using one of the methods described in the direct modulation section, or the method described in the thermostat example above. In standard hair dryers, it is common to use a low voltage DC motor to drive the fan. The current through the motor is limited by a heating coil connected in series with it. When direct modulation is employed, as prescribed in this invention, the design of the hair dryer may require that the modulation be imposed in such a way that it affects only the current passing through the heating coils which are not connected in series with the motor.

A circuit similar to that of FIG. 19 would be appropriate, with a modulation device driver 90 selected to handle the power requirements of the hair dryer, e.g. incorporating the MAC3030-15 triac, manufactured by Motorola.

When the superposition method is used, the confusion field may be imposed using a confusion field source, in this case a coil structure, slipped over the heating coil(s) located within the nozzle of the hair dryer. The modulation device which drives the external coil may be modulated using any of the methods described herein for superposition modulation. One possible circuit implementation of the bioprotected hair dryer with superposition modulation is shown in FIG. 20.

FIG. 20 depicts a noise generator 98, with its resulting signal fed through a low pass filter 100, and then amplified enough by a power amplifier 102 to power the confusion field source 106 (in this case a coil structure).

A sensing circuit which detects, for indication to the user, that a confusion field is present can be implemented in any of the embodiments described herein. One possible circuit diagram for such a sensing circuit is shown in FIG. 21.

Referring to FIG. 21, the sense input 108 is a signal received from the confusion field source 50, such as the coil 106 in FIG. 20. In this embodiment, the existence of the confusion field is indicated by an LED 112.

To reduce the power requirement to the confusion field source coil 106, it is preferable to design the heating coils for low magnetic field emissions. One possible configuration which achieves this goal is shown in FIG. 22. FIG. 22 shows the coil structure formed around a structure 114 made of mica. The coil H3 runs anti-parallel to coil H2.

FIG. 23 shows a circuit for controlling the heating coils of FIG. 22. In this configuration two heating coils, H2 and H3, are connected in parallel in such a way that equal currents run in opposite directions in each coil. This arrangement reduces the magnetic field emissions since magnetic fields are induced in opposite directions thus partially canceling each other. Coil H1 allows the use of a low voltage motor for the fan.

To most effectively inhibit the bioeffecting potential of the magnetic field from the heating coil, the external coil should produce a magnetic field oriented along the same direction as the heating coil field. This may be accomplished by winding a solenoidal type coil over the reflector shield which provides a thermal barrier between the heating coil and the nozzle plastic body. For a fixed number of turns, the external coil resistance may be adjusted by the choice of wire gauge. For instance, the driving circuit of FIG. 20 can produce a suitable bioprotection field when driving a 280 turn, 2 inch diameter, 14.5 .OMEGA. solenoidal coil made with 28 gauge wire.

## BIOPROTECTED KEYBOARD EMBODIMENT

Video display terminals use magnetic deflection coils to control the vertical and horizontal scans. The magnetic field from the deflection coils are typically sawtooth waves oscillating in the neighborhood of 60 Hz and 20 KHz. The lower frequency emissions produce magnetic fields of the order of 10 .mu.T at the center of the display screen. These fields are quickly attenuated with distance away from the screen. However, users often sit within a foot or so of the face of the monitor where the magnetic field can be in the range 0.4-2.4 .mu.T (Hietanen, M and Jokela, K., "Measurements of ELF and RF Electromagnetic Emissions from Video Display Units", Work with Display Units 89, Ed. Berlinguet L. and Berthelette D., Elsevier Science Publishers, 1990). The higher frequency emissions, which fall within the RF range, produce magnetic fields which can be as large as 0.7 T at the center of the display screen. These fields decay to around 10-1010 nT at 12 inches from the face of the monitor (Hietanen '90). As previously noted, experimental evidence indicates that the bio-effecting potential of electromagnetic fields is more significant at lower frequencies. It has been shown that magnetic fields of the type used for the vertical scan control in video display terminals can produce biological effects even with levels as low as 0.5 .mu.T .

The embodiment described in this section makes use of the superimposition principle delineated in the superposition modulation section to create a device which provides the bioprotecting effect of a confusion field in the region where a user would ordinarily be exposed to the magnetic field emissions from a video display terminal or other sources in the vicinity of the terminal. The device forms an integral part of a computer keyboard and is consequently referred to as a bioprotected keyboard. The coil structure for a keyboard of this embodiment is shown in FIG. 24.

Referring to FIG. 24, this device uses a coil 134 as its confusion field source 50, installed within a computer keyboard 136 and operated by circuitry integral to the circuitry of the keyboard. Power to operate the coil is derived from the host computer via the standard keyboard interface connection 138. The presence of the coil 134 does not interfere with any of the operations of the keyboard 136 and is transparent to the user except for an indicator LED 140 which advises the user of the proper operation of the bioprotection feature. Electric current, modulated as per the methods described herein, is passed through the coil 134 to induce a confusion field designed to bioprotect the field emissions from the monitor at the user location without interfering with the proper operation of the monitor. The coil 134 is driven by a in-circuit modulator 42 designed to inject suitable power into the coil 134 using one of various possible methods.

The range of protection of this device is ideally within approximately a foot or so from the keyboard, therefore it is most effective when the keyboard is held closest to the user. In some cases the detrimental field emissions from the monitor may be too high to be adequately bioprotected by a coil 134 powered from the standard keyboard power supply. In these situations it may be advantageous to drive the coil with an external power source. In the latter case the power driven through the coil can be made as high as necessary to produce the required confusion field according to this invention. A possible limitation to the power applied to the coil 134 is the possibility of jitter created on the screen display by the proximity of the coil 134.

The confusion field source may be implemented as a coil 134 concealed within the keyboard 136 as in FIG. 24, or it may be placed on top or near an existing keyboard. In general it would be advantageous to make the coil 134 as large as possible as this would increase the range of the magnetic field and decrease the power requirements. One possible means to increase the size of the coil 134 is by fitting the keyboard 136 with a large base to house the coil. In addition the coil resistance should be small enough to allow sufficient current flow from the available power source. As an example, a 6.5 inch by 17.25 inch 50 turn rectangular coil made with 28 gauge wire has a resistance of about 13.OMEGA.. This coil can be satisfactorily driven with the circuit of FIG. 20.

## HOME BIOPROTECTION SYSTEM EMBODIMENT

Another embodiment of the superposition modulation technique is the home bioprotection system. Most homes have numerous sources of field, including all electrically operated devices. In addition, residences located in the proximity of high voltage tension lines are also subjected to the field emissions from those lines. These emissions can be significant in the vicinity of power lines of high current carrying capacity. Another source of field results from the flow of leakage current through ground paths. These leakage currents can in some cases be relatively large when they are caused by current imbalances created by unequal current usage between two phases of a circuit. In general, the high and low leads of a circuit run parallel and in close proximity to one another. This type of electric cable, e.g. Romex cable, is most often used in residential installations. Current flow through this type of cable induces magnetic fields of relatively short range. The magnetic fields decrease with distance away from the conductors as the inverse of the cube of half the distance between the leads. If the hot and neutral leads of a circuit run separated from one another, the flow of current through such a circuit can generate field which cover a wider range. These field emissions are relatively uniform within the area circumscribed by the wires and extend relatively unattenuated within a distance equal to one third the loop radius above and below the plane of the loop. The present embodiment describes a technique to negate the detrimental nature of these field fields by providing a blanket type protection covering the entire living area of a home.

The home/area bioprotection device consists of a large multiturn coil positioned in the perimeter of a residence, playground or other area to be protected. Two possible coil configurations for use in the protection of a home or large area are shown in FIGS. 25a and 25b. FIG. 25a depicts an underground coil structure 124 which surrounds the area desired to be protected. The control unit 126 is typically placed inside the house, or outside in a weatherproof container. The home bioprotection system coils 128 and 130 of FIG. 25b are of a helmholtz configuration, as described earlier. One coil 128 is placed above the living area, while the other 130 is placed below it. The control unit 132 is similar to the control unit 126 of FIG. 25a, however it typically drives two coils instead of just one.

Electric current, modulated as prescribed in this invention, is passed through the coils

124, 128 and 130 to induce a bioprotection magnetic field. The coils are driven by an in-circuit modulator 50 designed to inject a suitable current into the confusion field source (in this case a coil structure). The coil 124, 128 and 130 current may be generated using any one of the methods described above. One possible circuit implementation is shown in FIG. 26.

FIG. 26 depicts the circuit diagram for a superposition technique which creates a confusion field to bioprotect an entire living area. The modulation generator 116 implemented in this embodiment generates a random noise signal. This signal is then passed through the low pass filter 118, pre-amplifier 120 and power amplifier 122. The confusion field source which is driven is a coil structure 150.

The range of protection of the home bioprotection system device depends on the magnitude of the current passing through the coil and the radius of the coil. The induced confusion field within the area circumscribed by the coil at the plane of the coil is relatively uniform. The confusion field decreases with distance along the coil axis, however, the attenuation is not significant within a distance of the order of 1/2 the coil radius. Therefore the protected area includes a cylindrical region circumscribing the coil and extending a distance approximately equal to 1/2 the coil radius above and below the plane of the coil. For a given current rating and number of turns of the coil the confusion field at the plane of the coil increases with decreasing radius. Therefore for larger areas a larger current rating is required to maintain a confusion field with adequate amplitude to afford bioprotection of the entire area. In general, the device should be designed to produce a confusion field suitable for the "average" regularly oscillating detrimental field measured within an area to be protected. A confusion field of 1 .mu.T is suitable in most situations. The detrimental field emissions in the proximity of devices with motors can be much larger, but they generally drop off quickly away from the source. When the time of exposure in the proximity of a detrimental field source is large, a device affording localized protection would be more suitable, e.g. the bioprotected keyboard, the bioprotected hair dryer, and the converter box unit.

POWER DISTRIBUTION LINE BIOPROTECTION SCHEME EMBODIMENT

In a multi-user system, electric power from a central station is delivered to each user via a network of distribution lines. Such a network might consist of a series of primary trunks from which secondary lines branch out in successive steps to the final distribution points. The flow of current through each branch of the network depends on the power demands of all users drawing current from that branch. It is easy to see that in large power distribution systems the primary trunks must be capable of handling very large power requirements. The voltage and the current in these power transmission lines are the source of large electric and magnetic fields. Since the voltage is referenced to ground level, the line voltage establishes a large electric potential between it and ground. Line voltages of 500 KV and 230 KV are typical for transmission lines leaving a primary distribution station. A 500 KV line is typically hung 42 feet from the ground therefore establishing an electric field of 39 KV/m beneath it. Experimental evidence indicates that electric fields of this order of magnitude can affect biological function [Freed, C. A., McCoy, S. L., Ogden, B. E., Hall, A. S., Lee, J., Hefeneider, S. H., "Exposure of Sheep to Whole Body field Reduces In-Vitro Production of the Immunoregulatory Cytokine Interleukin 1" Abstract Book, BEMS Fifteenth Annual Meeting, 1993].

The flow of current through a power transmission line causes the induction of magnetic fields on planes perpendicular to the direction of current flow. The magnetic field is oriented tangential to circular paths around the conductor. At distances far removed from a single conductor, the magnetic field decreases in proportion to the inverse of the distance. In single phase circuits two transmission lines are required to deliver power, one to carry the current to the load and another one to return the current to the source and complete the circuit. If the two lines were placed immediately next to each other, the magnetic field from the transmission line pair would tend to cancel because induced by currents of equal magnitude but opposite direction. In practice transmission lines with high voltages must be separated by a minimum distance to prevent dielectric breakdown of the air between the conductors. Consequently, the magnetic fields do not cancel. For example, in the case of 50 KV lines which are typically positioned 30 ft. apart, the magnetic field at the edge of the right of way can be of the order of 3 .mu.T during peak power consumption intervals when the current is of the order of 1000 Amperes. The width of the right of way is usually 150 ft. so that the horizontal distance from the edge to the nearest conductor is 60 ft. Residences located at the edge of the right of way can be exposed to relatively high magnetic fields. Experimental evidence previously referred to shows that magnetic fields as low as 0.5 .mu.T can cause bioeffects.

The magnetic fields from transmission lines can be rendered harmless by superimposing a bioprotection field. In one embodiment of this invention, the bioprotection fields can be induced by current passing through one or two additional conductors running parallel to the transmission line conductors. The bioprotection current must be such that the magnitude of the induced bioprotection magnetic field is equal to or larger than that from the transmission lines. This can be achieved for example with a line frequency signal (e.g. 60 Hz) which is turned on for 0.1 seconds in subsequent one second intervals. The modulation would be imposed at the power station or substations using a low voltage current source. The power consumption of the bioprotection field is limited by the fact that this field is on only ten percent of the time as well as by a lower voltage rating for this line relative to the main high voltage transmission line. Assuming that a current equivalent to that flowing in the transmission line is required to produce the bioprotection field, and a 100 V line is used for the protection circuit for a 500 KV line, the power consumption of the bioprotection circuit would be fifty thousand times lower than that of the main transmission line. FIG. 27 shows one implementation of the superposition technique to create a confusion field in the area surrounding a power distribution line.

Referring to FIG. 27, a power distribution line 154, 156 is strung overground, through the use of electrical insulators 162 supported by poles 168. A static wire 152 is seen as a protection from lightning. The confusion field is generated by the bioprotection wires 158 and 160, which form a single loop coil structure. The bioprotection wires 158 and 160 are also hung from insulators 162. The bioprotection wires 158 and 160 are hung below the static wire 152.

# TACTICAL INFRASOUND

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JASON was asked to assist the U.S. Army's National Ground Intelligence (NGIC) in finding ways to enhance the effectiveness of infrasound monitoring. In addition, we were also tasked with determining whether infrasound monitoring was likely to provide information of value in other intelligence venues.
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Tactical Infrasound
Contents

# 1 EXECUTIVE SUMMARY

JASON was asked to assist the U.S. Army's National Ground Intelligence Center (NGIC) in finding ways to enhance the e.ectiveness of infrasound monitoring. In addition, we were also tasked with determining whether infrasound monitoring was likely to provide information of value in other intelligence venues.

## Findings

The tactical application of sound monitoring over ranges of 0-100 km is a qualitatively di.erent problem from either the use of infrasound for nuclear weapons treaty monitoring purposes, or the tactical monitoring of acoustical energy at frequencies above 100 Hz. For treaty monitoring, which exploits sound propagation over thousands of kilometers, the sound is predominantly transmitted by refractive ducting from the upper layers (z~100 km elevation) in the atmosphere. The strong frequency-dependence of acoustic attenuation in this regime has appropriately led the treaty monitoring community to consider frequencies above a few Hz as uninteresting. On the other hand, the current generation of battlefield acoustical sensors concentrate on frequencies above 100 Hz.

Tactical infrasound sensor arrays trace their heritage to the instruments used for nuclear weapons treaty monitoring. Their sensitivity rolls o. at frequencies above about 20 Hz. Local pressure noise is suppressed by the use of spatial filters over scales d~10 m. In the tactical case however, for ranges of order 100 km or less, there are a number of factors that favor consideration of frequencies as high as 100 Hz, which has traditionally been considered the regime of acoustics.

These factors include:

1. The acoustic power spectrum emitted by many of the sources of interest is a rapidly increasing function of frequency, with considerable energy emitted at frequencies of tens of Hz to a few hundred Hz,

2. Atmospheric propagation over ranges of up to 100 km often transmits energy at frequencies well above the classical infrasound frequency band,

3. The pressure noise against which the detection system is fighting falls rapidly with frequency.This report encourages closing the gap between "infrasound" sensors, which lose sensitivity above 20 Hz, and the "battlefield acoustical" sensors, which emphasize frequencies above 100 Hz. Acoustic propagation over scales of 100 km is a complex phenomenon, and it depends sensitively on the detailed temperature and wind profiles of the atmosphere. In particular, since wind speeds can often be an appreciable fraction of the sound speed in air, a strong wind can give rise to anisotropic ducting mechanisms from fairly low in the atmosphere (z<~ 50 km). As shown below, this "low-duct" mechanism allows for propagation of sound at frequencies as high as 100 Hz.

The sensitive dependence of acoustic energy propagation on time-variable atmospheric conditions presents a challenge. Since the detected signals (their power spectrum and angle of arrival) depend on both the source power spectrum and the details of atmospheric propagation, the interpretation of the signals would be much easier if the propagation were well characterized.

As stressed in the body of the report, a comprehensive understanding of the source power spectrum, of the anisotropic ducting and attenuation due to the atmosphere, and of the di.erent noise sources, all as a function of frequency, should guide the optimization of tactical sound monitoring systems. As detailed in the recommendations, full exploitation of the deployed apparatus would benefit from a program to map out these parameters. JASON considers the application of sonic monitoring to intelligence problems to have considerable potential, and we advocate an investment in a deployed system as an opportunity to develop and refine this technique, in a real-world setting.

Recommendations

Recommendation #1. Some Near-Term Ideas for Enhancing Monitoring Systems that also include Tactical Infrasound.
We have some specific suggestions that might enhance the e.ectiveness of these systems:

• Increase the upper limit in frequency coverage by re-arranging the existing filter hoses and increasing the sampling rate.
• Use emplaced sound sources to dynamically calibrate and characterize atmospheric propagation.
• Use infrasound data from the International Monitoring System (IMS), and seismic data from the various sensors near a tactical system to "veto" against sound sources that are not within the region of tactical interest.
• Break the sound barrier: Fuse and correlate infrasound data with acoustic data.

Recommendation #2: Support A Vigorous Program of Source and

Noise Characterization
We advocate a program to obtain and archive calibrated sound signatures, from infrasound to acoustic frequencies, from both targets of military interest (trucks, tanks, etc.) as well as potential sources of "clutter" (tractors, commercial aircraft...). In addition we consider it imperative that the sources of noise be fully characterized as a function of frequency, particularly the spatio-temporal coherence of the pressure field fluctuations. A major motivation here is to determine the optimum area over which to average in order to best suppress pressure fluctuation noise, while retaining sensitivity to high frequency sound. This should be part of an ongoing e.ort to maintain and strengthen the linkages between the program's scientific leadership and those charged with the oversight of the operational arrays. To the extent that source signature archives already exist, access to these should be broadened.
3
Recommendation #3: Characterize the Propagation Path.
The variability of the near-zone propagation mechanisms is a major impediment to fully understanding and exploiting the measured signals. This motivates a program to measure the atmosphere's transmission properties at a deployed site, on an ongoing basis. This can be done either directly, by emitting a known sound from a known location, or indirectly, by measuring meteorological parameters that can be used in conjunction with models to predict sound propagation. Take proactive steps to engage the scientific community in better understanding the propagation and detection of sound over distances of order 100 km.
Recommendation #4: Investigate Alternative Sensors.
A diversity of sensors can be used to monitor sound in the frequency range of interest. Given the likely importance of energy at frequencies above the classical infrasound regime, we consider it important to carry out a survey of sensor technology, both mature transducers and ones under development, paying particular attention to their noise properties. This information will be important in assessing the price/performance tradeo.s in acoustic arrays, which we describe next.
Recommendation #5: Take a Fresh Look at Array Design, Deployment and Systems Optimization.
The tension between maintaining good sensitivity to high frequencies and averaging over large areas to suppress pressure noise motivates the consideration of arrays of relatively inexpensive sensors. We advocate establishing a sound array test bed, co-located with a "classical" infrasound array, to

facilitate the evaluation of di.erent technologies and layouts. This evolution can exploit recent DoD and commercial advances in wireless, distributed sensor networks, and these networks could be rapidly deployed to provide useful information in tactical situations. Such field measurements will be essential to understanding systems trades in future operational sonic arrays.
4
Recommendation #6: Broaden the infrasound/battlefield-acoustics communities.
In our view these two scientific communities are currently too small (within the US) to produce a healthy and vibrant flow of new ideas, new implementations, and new people. The DoD would derive tangible benefits from fostering more academic participation in this field, and maintaining close links to those e.orts.
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2 INTRODUCTION
Using sound as a source of intelligence in a tactical setting has a long military tradition. Our study was undertaken to assess how this technique might be exploited in contemporary settings, in particular at at tactical infrasound arrays.
Infrasound is defined to be below audible frequencies, less than about 20 Hz. The only characteristic frequency in this range is the local buoyant Brunt-Vaisala frequency of a stably stratified atmosphere, ù2
BV ˜ g/h, where
h is the atmospheric scale height (7-8 km), and g is the local gravity. This gives a frequency íN ˜ 6mHz, far below the range we will be studying here.
The unit for measuring sound amplitudes is the dBSPL, or sound pressure level in decibels, which is defined as
dBSPL = 20log10(Prms/Pref) (1)
where Pref = 20 ìPa (di.erent than what is used in the ocean case). One atmosphere (one bar) is 105 Pa, so atmospheric pressure at sea level is 194 dB. A few other numbers for reference: a rock concert is 120 dB, 3 m from a jet engine is 140 dB and a vacuum cleaner is 100 dB (threshold of hearing at 1 kHz is 0 dB). The energy flux in sound is ˜ P2
rms/ñc, so that for spherical
spreading Prms . 1/d, so a factor of ten in distance leads to a 20 dB loss. (Henceforth all dB values should be interpreted as dBSPL.) In practice the dimensionality of the system of interest is somewhat less than 3, and so the geometrical loss is less than that expected for 3-d spreading. Pressure levels of interest for infrasound monitoring are typically at the level of a microbar, or about 75 dB.[1]— [6]
In the sections that follow we consider the sound spectra emitted by sources of interest, the propagation of the sound through the atmosphere, the various sources of noise against which the signal detection competes, the signal to noise considerations that influence an optimized design, and the problems of source discrimination and characterization. We close the report with a list of recommendations.
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We were fortunate to receive briefings from a number of leading scientists in the infrasound community, listed in Table 1. We are most grateful for their willingness to contribute to this study, and to answer our follow-up questions.
Table 1: Study Briefers

| Speaker | A.liation |
|---|---|
| Robert Grachus | NGIC, Army Intelligence<br>Charlottesville VA |
| Anthony Galaitsis | BBN, Inc<br>Lexington MA |
| Rod Whitaker | Los Alamos National Laboratory<br>Los Alamos NM |
| Michael Hedlin | Scripps and IGPP<br>University of California, San Diego |
| Mark Zumberge | Scripps and IGPP<br>University of California, San Diego |

The basic notion that sonic information has tactical value is demonstrated by the availability of a commercial tactical helicopter detection system, made by an Israeli firm.[7] The ‘Rafael Helispot’ system (web site is www.rafael.co.il/web/rafnew/products/air-helispot.htm) is an array of microphones, and claims the ability to detect and discriminate helicopters at ranges of tens of kilometers. This mobile system is shown in Figure 1, and its claimed success certainly motivates a careful and thorough exploration of the use of sonic information.

Figure 1: The Rafael Helispot system is an example of modern tactical use
of sonic information. The microphone array has demonstrated the ability to
detect and classify helicopters at ranges of a few Km, at acoustic frequencies.
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3 SOURCES OF INTEREST AND THEIR
SONIC SIGNATURES
3.1 Introduction
In order to understand what kinds of acoustic information may be most
useful for tactical applications, it is essential to know the characteristics of
the potential sources of interest. In particular, to optimize the usefulness
of existing detection systems and to successfully engineer future systems, it
is vital to know the spectral energy distributions of acoustic and infrasound
energy emitted from each type of source. In this section we show examples of
acoustic energy spectra from specific battlefield-related sources; we discuss
the general characteristics of these spectra together with their implications
for detection systems; and we conclude with recommendations concerning
the compilation and analysis of sonic signatures in the future.
3.2 Typical infrasound and acoustic spectra
The infrasound community has been gathering signatures data on sources
such as large explosions, bolides, and space shuttle launches for quite a few
years. Infrasound from sources such as these can be detected at large distances
(e.g. thousands of km), and can be geolocated using data from multiple
IMS sites. An e.ort is now beginning to create an unclassified Global INfrasound
Archive, or GINA ([2] and [8]) to raise the profile of this field and
encourage wider participation from the research community. As of March
2003 this archive was in prototype form, with participation from the Geological
Society of Canada and the Royal Netherlands Meteorology Institute.
We view this development very favorably.
However for the tactical application considered in this study, we are
interested in detecting, locating, and identifying acoustic sources at much
closer range: from a few km to a few hundred km distance. We are also
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interested in a di.erent suite of sources: trucks, tanks, and armored vehicles,
helicopters and UAVs, artillery and short-range rocket launches, cruise
missiles, and similar tactical threats.
Traditionally, information on such tactical sources is obtained and archived
by groups interested in battlefield acoustics. We understand from papers in
conference proceedings [9] that the Army Research Laboratory's Acoustic
Automatic Target Recognition Laboratory maintains an acoustic and seismic
signature database. However based on our experience during the Summer
Study and on conversations with academic experts in atmospheric acoustics,
we have the impression that access to this database is not readily available
to scientists outside ARL. Thus we have not been able to ascertain whether
this database includes signatures with frequency coverage down through the
infrasound range, nor have we been able to access actual digital signatures
from this database. We did, however, obtain graphical representations of
such spectra in analogue form from Dr. S. Tenney, ARL, [10] and from a
variety of conference proceedings which we accessed via the world wide web.
We base our discussion of signatures and spectra on the analogue graphical
data we have been able to obtain from these sources.
3.2.1 Vehicles
On physical grounds one would expect the acoustic radiated power from
a vehicle to fall o. at low frequencies, i.e. for acoustic wavelengths that are
much larger than the vehicle size. For example if a vehicle of interest is 10
meters long, the acoustic power should fall o. at the rate of 6 dB/octave for
frequencies f (330 m/sec) / (10 m) = 33 Hz. Indeed land and air vehicles
such as trucks, tanks, helicopters, and UAVs typically have a continuous
acoustic power spectrum that extends from a few hundred Hz down to a few
tens of Hz. Many such vehicles also show distinct narrow-band acoustic signatures,
e.g. at harmonics of a gasoline engine's RPM, at tire-slap intervals,
or at tread-slap intervals.
We were not able to obtain quantitative estimates of the residual acoustic
power at frequencies below 20 Hz, the traditional infrasound region. How-
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ever we note that the newer generation of microphones used in both the
infrasound community and the battlefield acoustics community do have sensitivity
down to a Hz or below, and so the low-frequency power spectrum
for sources of interest could be measured at the same time as signals in the
traditional "acoustic" range, f > 20 Hz.
Trucks: Figure 2 shows the acoustic signature of a large truck. Once sees

Figure 2: Acoustic power spectrum of a truck, from S. Tenney, ARL. The red lines represent narrowband signals from tire noise. The turquoise lines represent harmonics generated by the firing of the engine's cylinders.
significant power in the continuum from above 250 Hz down to about 25 Hz. In addition there are distinct narrowband features at frequencies representing the rotary motion of the engine's cylinders and the periodic slap of slightly asymmetric tires as they role along the ground. Narrowband features such as these can be used in signal-processing algorithms to enhance detectability and to allow vehicle categorization (e.g. [11]).
Tanks: Figure 3 shows the acoustic power spectral density generated by an M60 tank under way. As in the case of the truck, this tank has significant acoustic energy in the continuum from 200 Hz down to 20—25 Hz, as well as engine harmonics and track-slap signals at 150 Hz and below.
In the case of moving vehicles with narrowband spectral features, one can use the Doppler shift of one or more of these features to obtain a radial velocity measurement. With multiple sonic detectors at di.erent locations
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Figure 3: Acoustic power spectrum of an M60 tank, normalized to its maximum signal. From S. Tenney, ARL.
one can estimate the vehicle's direction of travel and range. These techniques are in use and are being refined in the discipline of "battlefield acoustics," that is with emphasis on frequencies larger than 10—20 Hz. However many of these methods would be useful on the battlefield for signals in the whole range between a fraction of a Hz and a few hundred Hz.
Helicopters: Figure 4 shows the sonic power versus time and frequency
Figure 4: Sound intensity as a function of frequency and time, for a UH-1 helicopter flying past the acoustic detector. From S. Tenney, ARL.
emitted by a UH-1 helicopter. The narrow orange lines show the Dopplershifted harmonics from the engine and/or the rotors. Harmonics are present
12
up to frequencies of a kHz, and down to 25 Hz or less. These orange harmonic lines are not straight, due to the motion of the helicopter towards and away from the acoustic detector. The shift of a harmonic's frequency with time gives the line-of-sight velocity (radial velocity) via the well-known expression .f/f = vr/c where f is the frequency, vr the line-of-sight velocity, and c the speed of sound.
The Israelis have developed two acoustic systems that detect helicopters and have capacity to discriminate between specific helicopter models based upon their tail-to-main-rotor frequency ratio and other distinctive harmonic patterns. One of these systems, HELISPOT, is a mobile land-based microphone array; the other, HELSEA, is a sea-based buoy carrying a microphone open to the air (see http://www.rafael.co.il/web/rafnew/products/nav-helsea.htm). The detection range of HELISPOT is specified to be 4 — 6 km, but in recent tests detections have been made up to 15-20 km away ([7]).
Unmanned Air Vehicles (UAVs) also have characteristic sonic signatures. Gasoline-powered UAVs show continuum emission up to about 400 Hz, and narrowband emission at even higher frequencies, as shown in Figure 5. They can be detected up to ranges of 4 km or more. Electrically
Figure 5: Left panel: acoustic power spectrum as function of time, for gasoline-powered UAV. Right panel: same, for electric-powered UAV. Source: Dr. S. Tenney, ARL.
powered UAVs are much quieter, as might be expected, with typical detec-
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tion ranges of less than 1 km. But even electrically powered UAVs still show distinctive narrowband harmonics of the blade rate.[10]
3.2.2 Impulsive sources
Impulsive acoustic sources such as rocket launches, explosions, and artillery have broad-band spectral energy distributions, extending to lower frequencies than are produced by vehicles. Because of their low-frequency spectral content, their signals are able to propagate over longer ranges without absorption and are promising targets for detection by tactical acoustic/infrasound sensors at larger stand-o. distances.
Artillery and tactical missile launches: Figure 6 shows the acoustic frequency content as a function of time for artillery (left panel) and for a Multiple Launch Rocket System missile (right panel). Both show a broadband acoustic signature for frequencies of 10—20 Hz and below, with strong signals below 5—10 Hz, well into the traditional infrasound range. According to Dr. S. Tenney of ARL, these spectra were measured at a range of about 9 km. Because of the strong spectral content at low frequencies there is good reason
Figure 6: Left panel: Acoustic spectrum as a function of time (in seconds)

of an artillery launch seen from 8.6 km. The launch took place at a time of about 40 sec on this plot. Right panel: Acoustic spectrum of an MLRS missile launch seen from 9 km. This launch (or launches; the documentation was unclear on this) took place at about 34.6 sec. Source: S. Tenney, ARL.
to believe that the sonic signals would be detectable at considerably longer
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ranges than this, at least under some atmospheric conditions.

Scud launches: The launches of longer-range missiles such as Scuds are even more promising for acoustic/infrasound detection at tens of kilometer stand-o. distances. Figure 7 shows the acoustic frequency content as a func-

Figure 7: Acoustic spectrum of a Scud missile launch, measured at a range of 27 km. The launch took place at a time a bit less than 150 sec on this plot. Source: S. Tenney, ARL.

tion of time for a Scud launch, measured at a range of 27 km. The actual launch in this case took place at a time a bit less than 150 seconds, where a broadband acoustic signal extends from 1—2 Hz up to 25 Hz (and possibly beyond).

### 3.2.3 Steady sources: bridges and structures

It has been known for more than 25 years that bridges can emit strong infrasonic signals. In 1974, Donn et al. showed that the strong 8.5 Hz signal that frequently appeared on their infrasound detector at the Lamont-Doherty observatory on the palisades above the Hudson River was generated by the Tappan Zee bridge more than 8 km to the north.[12] Since that time there have been occasional journal articles on infrasound from other bridges and highway structures (e.g. [13]). The consensus seems to be that the vibrations generating the infrasound are driven by tra.c on the bridge,
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but wind remains a possible exciter as well. By analogy, other large structures may also be either persistent or occasional emitters of infrasound.

A characteristic infrasound signal from a fixed location such as a bridge may well be useful to a tactical sonic detection system. The changing apparent direction and location of a sonic signal from a known bridge (which will vary due to atmospheric propagation variations) can aid in deriving the location of transient moving sonic sources by determining their relative position with respect to the known bridge or other structure. With modern sonic detection systems it should be possible to pick up signals from large structures at distances considerably greater than the 8 km reported in [12]. Improvements such as this are discussed further in Section 9.

## 3.3 Implications for the design of sonic detection systems

The frequency spectra from the various sources discussed in this section have signals that span the range from ~ 1 Hz all the way up to a few hundred Hz. While a single sonic source is not likely to have strong spectral content over this whole frequency range, the ensemble of sources of tactical interest calls for detectors both in the traditional infrasound range (< 20 Hz) and the traditional acoustics range (~ 50 Hz to hundreds of Hz). Moreover, as we shall discuss in a later section of this report, the frequency dependence of propagation in the atmosphere strongly selects for lower frequencies when the propagation path is long.

All of this implies that an optimal sonic detection system should include sensors and arrays for both low-frequency (infrasound) and higher-frequency (acoustic) signals, preferably collocated. We note that microphones are available today that span the entire desired range, but systems considerations may point towards using two types of sensors under some circumstances.

Further, signal analysis software and hardware should be aimed at fusing together data from the infrasound and acoustics frequency bands, so that common algorithms for geolocation, direction-finding, and moving tar-
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get characterization can be utilized.

## 3.4 Compilation and analysis of sonic signatures

We strongly encourage the compilation of one or more publicly accessible archives containing well-documented sonic signatures of both man-made and natural sonic sources, with spectra spanning the infrasound and acoustic spectral ranges (i.e. from sub-Hz to hundreds of Hz). The infrasound and acoustics communities will benefit from encouraging an infusion of new young investigators who can base their research on digital data from such an archive.

We learned of two databases/archives that are under way. The first, Global Infrasound Archive, or GINA [2, 8] has recently gotten under way, with sponsorship from the Geological Society of Canada and the Royal NetherlandsMeteorology Institute. The second, with emphasis on battlefield acoustics, is maintained by the Army Research Laboratory's Acoustic Automatic Target

Recognition Laboratory ([9]) and is intended for both acoustic and seismic
signature data.
We applaud these e.orts. However several issues will need to be vigorously
addressed:
1) In order to advance the field vigorously, the databases/archives must
be publicly accessible. This will mean that classified signatures will
have to be stored elsewhere.
2) There will need to be calibration data (microphone response functions,
target distance, meteorological conditions if available) stored along with
each source signature.
3) There will need to be a common data format for acoustic signature
exchange. We understand that NATO Task Group 25 on Acoustic
and Seismic Technology has begun to develop a standard for acoustic
signature exchange. This e.ort (or similar ones if the NATO work has
not progressed since its inception in 2001) should be supported by US
expertise and, if necessary, funding.
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We note that there are several successful examples of public data archives
today: the Hubble Space Telescope Multi-Mission Archive, or MAST
(http://archive.stsci.edu/hst/index.html), NASA's Earth Science Data and
Information System (http://spsosun.gsfc.nasa.gov/eosinfo/Welcome/index.html),
or NASA's HEASARC archive (http://heasarc.gsfc.nasa.gov/docs/corp/data.html).
Millions of dollars have been spent by these groups (and others) developing
software tools and user interfaces. Most function very well. We think that
the acoustics community should benefit from this extensive experience base,
rather than spending substantial resources on developing these kind of capability
anew.
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# 4 ASOUNDPROPAGATIONPRIMER

The goal of this section is to summarize the properties of propagation
of infrasound through short distances for tactical applications. Since infrasound
has traditionally been used for large distance signals (CTBT), the
discussion will di.er in several important respects from the traditional one.
In general, the properties of sound propagation in the atmosphere depend
most sensitively on two atmospheric properties: (a) the temperature profile
of the atmosphere, which sets the variation of the sound velocity with height;
and (b) dissipative processes, which determine which acoustic frequencies can
propagate. In what follows we will discuss each of these properties in turn,
and then discuss the consequences for short-distance sound propagation.

## 4.1 Ducting due to Sound-Speed Variations

### 4.1.1 Windless atmosphere

In the absence of winds, the way in which outward going sound is returned
to the Earth's surface is through variations in the sound speed with
altitude. In the WKB limit, the dispersion relation for the sound wave is
ù = ck. Evolving at fixed frequency through a medium of changing sound
speed constrains the dispersion relation, ù = c(k2
z + k2
.)1/2, so that k2
z is
the changing quantity as the sound moves to higher altitudes. If a region of
higher sound speed is encountered, then, at fixed ù, the radial wavenumber
will decrease. A turning point can occur when k2
z = 0. Following the normal
convention from the literature, we designate è as the angle of propagation
relative to the vertical, so that kz = k cos è and k. = k sin è.
Now consider propagation through a medium of changing c. Since k.
is conserved, we get k1 sin è1 = k2 sin è2, and the fixed frequency constraint,
k2c2 = k1c1, yields Snell's law
sin è1
c1
=
sin è2
c2
, (2)
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which is then used to trace the ray through the medium of changing c. Imagine
sending a wave up into a medium of increasing sound speed, so that
sin è2 = c2 sin è1/c1 increases with altitude. This refraction of the ray towards
the horizontal can turn the ray around at the location where c2 > c1/ sin è1.
The sound speed decreases with height in the troposphere, up to the

tropopause (at an altitude of 10-14 km for mid-latitudes), after which the sound speed increases again. For sound sources in the tropopause, there is a natural duct for sound, but this duct will usually not trap sound that originates at the surface. Above the tropopause, the temperature increases through the stratosphere, reaching a local maximum at about 50 km, but still about 20 m s-1 less than that on the ground (this is true at the equator and mid-latitudes; it nearly matches the ground speed at the pole [34]). It is not until an altitude of ˜ 110 km that the sound speed exceeds that at the ground. At this location (the thermosphere) the sound speed is nearly linear with altitude, so we write a simple relation locally valid near the first location where a return can occur, ho, as

$$c(z) = c_o + (h - h_o)dc/dz \quad (3)$$

where $c_o$ ˜ 340 m s-1 is the sound speed at the ground. The measured value of the derivative (dc/dz) is about 7.5 m/sec over one km ([1]). This linear increase in c does not continue forever, as the temperature at high altitudes eventually becomes constant (with altitude), though with large day/night excursions due to changing solar irradiance. For an average temperature of about 1000 K above 250 km altitude, the maximum contrast with the ground sound speed is ˜ 1.8, requiring an initial launch angle è1 > 33 degrees for a return to the Earth's surface. Figure 8 illustrates the annual mean sound speed as a function of altitude, in the troposhere, stratosphere, and thermosphere.

The thermospheric bounce is always present. Using equation (3), we can find the minimum downrange distance, which is ˜ 200 km. That ray reached an altitude of nearly 150 km, and so likely would be strongly attenuated at high frequencies. We will consider these e.ects quantitatively below. If the losses were simply transmission and the sound were spherically spreading out

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Figure 8: Typical sound speed vs. elevation, from Hedlin [34]

.

to this distance from a source dimension of 1 meter, the transmission loss would be 106 dB.

A well documented example is a blast at an explosives factory in France, at Billy-Berclau on March 27, 2003. The DBN array "heard" the infrasound from the explosion at an amplitude of ˜ 0.1 Pa (74 dB) from a distance of ˜ 400 km. The sound was also detected at arrays in France and Germany. Presuming spherical spreading (1 bar = 194 dB) from 100 m to 400 km. Intensity on a 100-m sphere surrounding the source was 146 dB.

4.1.2 Ducting due to Wind Shear

Under the ray tracing approximation and in the absence of scattering, the only way to receive a strong signal at a downrange distance of less than 200 km is to have favorable winds duct the sound. To understand how this can help, we first note the dispersion relation of sound in a wind of transverse velocity v = voˆx, where ˆx lies in the horizontal plane. Call kx the component

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of k in ˆx direction, then we get (ù -kxvo)2 = c2k2. For the case of vo c, we expand this, assuming, ù ˜ kc, to reach a new relation ù ˜ ck+kxvo = ce.k, where

$$c_{e.} = c + v_o \frac{k_x}{k} = c + v \cdot \hat{n}, \quad (4)$$

is the familiar relation for an e.ective sound speed ce. .

This relation makes clear that the wind speed acts to e.ectively increase the sound speed when the wind blows in the direction of source to listener. Hence, ducting can occur once there is an altitude where ce. exceeds that on the ground. The most likely altitude for this to occur is around 50 km, where there is a peak in the thermal sound speed that allows a favorably aligned 20-40 m/sec (depending on season) wind to create a duct. See Figure 9, which shows (via red lines) the e.ective sound speeds Ce. for two directions of propagation. The vertical black line shows that the e.ective sound speed

Figure 9: Sound speed vs. elevation in windy conditions. From ([34]

at ~ 38 km equals that at 0 km. The advantages to this duct are numerous: primarily, the ducted sound will return to the ground at much shorter dis-

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tances, hence less transmission loss will occur. Hence, not only are the sites audible, they are also louder.

4.1.3 Ray Trajectories

The ray trajectories in the ducted atmosphere follow from supposing that the sound field is represented by the velocity potential Ö = eiø(x). Then the normal to the wavefront points in the direction ˆn = dx/ds = .ø/|.ø|. Straightforward algebra then implies that the normal vector obeys the equation

d
ds xs
ce. = -.ce.
ce.
. (5)

If we assume that ce. depends only on z, then this equation reduces to the following equation for the trajectory z(x) of the ray:

d2z
dx2 = -
ce.(0)2
sin2 ö
dce./dz
c3
e.
, (6)

where ce.(0) is the sound velocity at ground level, and ö is the initial angle the ray is launched (relative to the vertical).

The equation for z(x) is identical to Newton's laws for the position z of a particle of unit mass moving in an e.ective potential Ue. = -(2/ sin2 ö)(ce.(0)/ce.)2. By equating the total energy z2
x/2 + Ueff at the top and bottom of the trajectory we recover the turning condition ce. = ce.(0)/ sin(ö) derived above.

If the peak in ce. near z=50 km has ce. = c(0)+., then the rays bend back to earth in the range ð/2 - ./ce.(0) _ ö _ ð/2. The range is given by

x = 2 zmax
0
dz sin(ö)
ce.(0)2/ce.(z)2 - sin2(ö)
. (7)

Figure 10 shows a calculation of ray trajectories for infrasound in the N-S and E-W planes, for a representative profile of temperature and sound speed. Ducting at ~ 100 km, ~ 35 km, and in the troposphere can be seen.

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Figure 10: Model calculation of sonic propagation. Note the low-elevation duct in the lower panel, due to ambient wind. From [1]

4.2 Attenuation

A burst of sound on the ground will send out rays in all directions. The loudest sounds that are received depend on attenuation. We have already mentioned the fact that there is attenuation due to spherical spreading, which causes the sound intensity to decrease by 20 dB when the distance from the source increases by an order of magnitude, independent of the frequency. However the dominant loss mechanism is through dissipative processes, which cause the energy in a sound wave to decrease exponentially with distance. The characteristic length scale over which this energy loss occurs is given by

L-1 =
ù2
ñc3 4
3
ç + æ , (8)

where ñ is the density of air, c the sound velocity, and ç, æ the shear and bulk viscosities. This formula exposes the prime advantage for low frequency acoustic propagation: the attenuation length increases dramatically with decreasing frequency.

For infrasound propagation, it is important to examine the altitude dependence of this propagation length. This can be obtained by noting the

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shear viscosity is given by ç/ñ ~ c, where is the mean free path between the air molecules, whereas the bulk viscosity æ/ñ ~ ô c2, where ô is the relevant relaxation timescale (typically these depend on vibrational relaxation of molecules N2,O2, etc.) We have discussed above the fact that the sound velocity changes by about ten percent with altitude. Therefore, we expect that the change in the bulk viscosity æ will be roughly at the twenty percent level (the molecular vibration timescale is not altitude dependent). On the other hand the shear viscosity will increase strongly with altitude, because the mean free path increases with decreasing density (as ñ-1). Force balance in the atmosphere implies that the gas density decreases exponentially with height ñ = ñ0e-z/La. Thus we expect the shear viscosity to increase as í(z) = ç/ñ(z) = í0ez/(La), where í0 is the viscosity at ground level. Data

(CRC) demonstrate that the viscosity increases by seven orders of magnitude from ground to 100 km. Between the ground and 20 km,   increases from 10-5cm to 10-4 cm with a corresponding ç/ñ change from 0.1 cm2/sec to 1 cm2/sec. At 100 km,  ˜ 102 cm, and the viscosity is 106cm2/sec! A fit to the data yields La ˜ 6 km. This is in reasonable agreement with the isothermal atmospheric scale height c2/g = 11 km.

### 4.2.1 The dominant rays

We are now in the position to calculate the attenuation of a sound ray. Let us suppose that the ray travels along the path z(x) through the atmosphere. The viscous attenuation of this ray is by the factor

exp(-Ã) = exp -  path
ds
ù2
c3  4
3
í(z) + æ   (9)

The attenuation factor Ã is clearly dominated by the high altitude part of the path, owing to the exponential increase in í(z). If we expand z(s) = zmax - s2/R around the top of the ray path, we find that

Ã ˜
4 3
ù2
c3 ímax   ds exp(-s2/R ) ˜
4vð
3
ù2
c3 ímaxv R. (10)

Now, from the previous section, we know that the radius of curvature of the
25
path R-1 = |zxx| = c  e./c3
e.ce.(0)2/ sin(ö), so that the attenuation factor is

Ã =
4vð
3
ù2
c3 ímax sin(ö)
c3
e.
c  e.ce.(0)2 . (11)

We are interested in the ray of minimum attenuation. On the surface equation (8) implies that this occurs for the ray with minimum deflection angle ö = ð - ./c(0). However, at the minimum deflection ray, formula (8) breaks down, because at this point R-1 vanishes since c  e. = 0. The problem can be corrected by noting that for the minimum deflection ray, z(s) = zmax - Cs4, where C = c    e.ce.(0)2/c3
e./sin2(ö). If we write c    e. =
(c(0) + .)/ 3
a, then we find (in the limit of small .)

Ãmin =
4vð
3
ù2
c3
e.
ímax sin(ömin)   3
a 1/4
. (12)

Interestingly, the attenuation properties of the atmosphere imply that attenuation of the ray is essentially independent of the range (other than the dependence of viscosity on altitude í(z))! The atmosphere is a low pass filter. (This fact must be known from CTBT, as the same argument applies to the 120 km reflection point).

We now are in the position to determine the useful frequency range for both the 50 and 100-km ducts. Figure 11 plots the attenuation as a function of frequency for both of these ducts. For the 100-km duct, the transmission drops by an order of magnitude at about 2 Hz, whereas for the 50-km duct, the transmission drops by an order of magnitude at about 100 Hz.

### 4.2.2 Turbulent Eddy Viscosity and Acoustic Attenuation

Turbulence is present at a variety of altitudes and can contribute to the attenuation of sound if the e.ective eddy viscosity, íeddy, exceeds the molecular

viscosity. In the absence of detailed measurements, we will estimate
íeddy by presuming isotropic turbulence with Kolmogorov scalings (see [14]).
In this view of turbulence, the prime driver is a large-scale shear that leads
to a local energy dissipation rate (due to molecular viscosity at the smallest
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Figure 11: Attenuation as a function of frequency (in Hz) for scattering into
the 50- and 100-km ducts.
eddy size)
 =
.v3
l
, (13)
where .v is the characteristic shear velocity (roughly equivalent to the largest
eddy speed) at the largest length scale, l (or largest eddy size). These quantities
will vary with altitude in the atmosphere. The velocity of a turbulent
eddy of size ë is vë ˜ ( ë)1/3, giving
íeddy ˜ ëvë . ë4/3, (14)
which clearly increases with the length scale of turbulent eddies that are
allowed to contribute, and if allowed to go to the outer scale would yield
íeddy ˜ .vl. Something like this viscosity is shown in Figure 40-3 of [15]
and was a cause of concern, as this number is quite large, possibly íeddy ~
1-100 m2s-1 at an altitude of 50 km, leading to an attenuation of the sound
that would be more dramatic than that from molecular viscosity.
However, we feel that the turbulent viscosity relevant to acoustic at-
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tenuation should only include those eddies which turn over on a timescale,
teddy ~ ë/vë . ë2/3, shorter than the wave period. This then defines a
maximum ë,
ë2/3
cut ˜
2ð 1/3
ù
, (15)
which then yields a frequency dependent eddy viscosity for acoustic attenuation
íeddy ˜ 2ð
. 2
, (16)
and a cancellation of the frequency dependence in the attenuation formula,
L ~
c3
íù2 ~
l
4ð2 c
.v 3
. (17)
Now, what does this give us? It seems that at most, the turbulent velocity
amplitude is 0.1c ˜ 30 m s-1, and that the length scale is of order 1 km. For
those scalings, we get L ~ 25 km for the scalings, including the 2ð etc. This
estimate of the eddy viscosity is still likely a high guess and would not be
present over the whole region.
An alternative scaling (though we don't feel is likely appropriate) is
to use all eddies of wavelengths smaller than the acoustic wavelength, ës
(remember, these eddies will not overturn during the wave passage). In that
limit, the scaling for the attenuation length becomes L ~ (c/.v)(ë2
sl)1/3,
which for a 1 Hz wave and l = 1 km gives a 5 km range or so. It might well
be possible to eliminate such a viscosity scaling with direct measurements.
4.3 Detections in the Shadow Zone
There are documented instances (particularly in the Netherlands; see
the excellent website of Evers [16]) where infrasound detections have been
made in the "shadow" zones, where ray-tracing predicts that there is no
propagation path to this location. These have been at frequencies near 1 Hz
and at separations ranging from 3 km(Utrecht explosion in an o.ce building)
to 70 km (Fireworks factory explosion in Holland). In these publications,
passing mention is made of turbulence in the Earth's atmosphere as the
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cause of "spurious" reflections, but we have found few quantitative theoretical
calculations of this e.ect.
It is generally acknowledged that there are two basic mechanisms that
contribute to acoustic scattering in the shadow zone: di.raction, and the

turbulent scattering of sound.[17] Here, di.raction refers to corrections to the geometric optics approximation. In general we expect that di.raction will be most important at low frequencies (since the size of di.ractive e.ects will be of order the ratio of the wavelength of sound to the scale over which the sound velocity is varying).

The frequency range where turbulent scattering can dominate depends on the characteristics of the turbulence; it is generally acknowledged that scattering of sound from turbulence involves fundamentally scattering o. of the vortices in the flow (see, e.g. [18]). If the wavelength of sound is much smaller than the size of the vortex, then a "geometrical optics" approach can be formulated; the wavefront is bent by the interaction with the vortex (see, e.g. the appendix of Colonius et. al.[18]). If the sound wavelength is much larger than the size of the vortex, the scattering is essentially isotropic and the Born approximation is appropriate.

It is unclear which of these two contributions dominates the turbulent scattering into the shadow zone: on one hand, the Born scattering is isotropic, so the amplitude is diminished relative to the scattered signal of shorter wavelength sound, where geometrical optics applies. On the other hand, the magnitude of the scattering is enhanced by larger vortices. As described above, most of the energy in a turbulent flow is in the larger scales. There is clearly a balance between these two e.ects where the dominant scattering will take place, though the optimal condition is not known.

We believe that there could be a significant opportunity for further research here, as developing an understanding of what dominates scattering into the shadow zone could well provide the needed insight for starting to use shadow-zone detections to identify sources. The opportunity is significant, because by definition, acoustic waves in the shadow zone have shorter path lengths, and reach lower altitudes, than their counterparts in the high altitude

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ducts. The resulting lower attenuation should therefore allow even higher frequencies to become accessible.

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# 5 CHARACTERIZING THE PROPAGATION PATH

The propagation of sound energy over the distances of interest, from a few km to perhaps a hundred km, is highly variable as it depends on the wind and temperature profiles of the atmosphere along the path from the emitter to the detector. In order to properly understand the nature of a detected source of sound, or (of equal importance!) to properly interpret the absence of detections, it is vital to understand the propagation properties of the atmosphere.

Infrasound's traditional use has been for monitoring of atmospheric explosions over large distances across the Earth's surface and it is under active development and use for CTBT monitoring at the present time. On these 1000-5000 km length scales, the dominant propagation e.ects are from the changing temperature profile in the atmosphere, and global winds. As such, it is usually treated as a global problem, although local topography/ meteorology does play a large role. There are abundant examples of the successful application of global (seasonally adjusted) atmospheric models to the problem of locating sources of infrasound.

The frequencies that are typically of interest are in the range of 0.1 to 100 Hz (wavelengths of 3 km to 3 meters), and the propagation calculations are nearly always carried out by ray-tracing. Hence, the changes in all atmospheric quantities are assumed to occur over length scales much longer than a wavelength. Alternative approaches are presently under development.

The pressure signal detected by the sensor system contains the combination of the source's sonic power spectrum and the distortions (in both spectrum and wavefront direction) introduced by the atmosphere. In order to extract the source characteristics from the data, and to properly translate angle of arrival information into a location, the atmospheric contribution must be understood.

We therefore consider a program of path characterization as an essen-

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tial ingredient in successfully exploiting tactical sonic signatures, over the ranges of interest. There are two possible approaches to this problem: 1) direct acoustic measurement of the atmosphere's propagation characteristics, and 2) indirect techniques that blend meteorological measurements with atmospheric modeling. The two are not mutually exclusive, and it makes sense to us to pursue them both.

## 5.1 Direct Path Characterization: Acoustic Tomography

By installing sources with known sonic spectra at known locations, the propagation character of the atmosphere can be measured directly. We have in mind a set of emitters that produce sonic waves, probably in the 1-10 Hz band, which are in continuous operation, perhaps with complementary time-domain sharing duty cycles. One could imagine installing sources at the tactical array sites, or at other advantageous locations. Ships at sea may well provide very valuable platforms from which to test atmospheric propagation properties. It may also turn out that monitoring the atmospheric propagation in accessible regions surrounding an array may produce valuable information about the propagation properties in inaccessible regions surrounding an array. Constructing a source of pressure waves that e.ciently couples energy into the atmosphere is by no means trivial, but we stress that knowing the source characteristics (location and frequency) should ease detection. We recommend that some experiments be done to determine the viability of real-time acoustic tomography.

## 5.2 Indirect Path Characterization: Meteorology and Models

Given su.cient knowledge of the wind and temperature structure of the atmosphere, its acoustic propagation properties could be calculated. If terrain e.ects are also taken into account, a complete real-time model for

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propagation, including attenuation, could be developed. This model could then be used to compensate for variations in path propagation properties. Unfortunately the relevant section of the atmosphere extends up to 100 km above the surface, and includes regions of the atmosphere that are not typically measured by radiosonde sensors, since they don't have much e.ect on weather at the Earth's surface.

The G2S (ground to space) project at the Naval Research Laboratory (NRL) is an ambitious e.ort [1] to integrate low level real-time meteorological data with empirical models of the upper atmosphere. This project, or perhaps a suitable modification with appropriate grid sizes, could prove very useful in calculating near-zone sonic propagation through the atmosphere. Incorporating this sort of model into the ray tracing infrasound source location software presently being used is a sensible goal. Figure 12 shows how the G2S model splices lower level data onto validated models of the upper atmosphere.

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Figure 12: Combining low elevation meteorology with upper atmosphere models. This figure is taken from reference [1], and shows (in the lower panel) the substantial e.ect of topography and meterological data.

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# 6 SIGNAL TO NOISE CONSIDERATIONS, AND OPTIMAL FREQUENCIES

The optimum frequency range over which to listen for sound from sources of interest is determined by 1) the sound spectrum emitted by the source, 2) the frequency-dependent attenuation along the propagation path, and 3) the noise spectrum seen at the sensor. As shown in Section 3 above, most of the sources of interest have emission spectra that rise steeply with increasing frequency. On the other hand, atmospheric transmission imposes an e.ective cuto. frequency that depends on the maximum elevation reached by the ray bundle.

The noise at the sensor includes contributions from

- Intrinsic thermal noise in the sensor,
- Non-sound fluctuations in the ambient pressure field, including sensorinduced turbulence,
- Detector artifacts, such as thermal and seismic feedthrough,
- Sound noise, including wind-generated sound from terrain and structures, and sounds emitted by uninteresting sources of both natural and man-made origin.

Each of these noise terms has a particular frequency dependence. Furthermore, the di.erent noise mechanisms exhibit di.erent dependence on wind speed and direction. We will defer the consideration of the nuisance acoustic sources, perhaps more properly termed 'clutter', until the section on source discrimination and characterization.

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## 6.1 Sensor Noise

Thermodynamics imposes a limit on the performance of any sensor system, at both the transducer and (in a well designed system) at the preamplifier. For any capacitive sensor, as long as there is not an electrical resonance within the passband of interest, the RMS voltage fluctuations will

obey VRMS = kT/C, where T is the temperature of the transducer, C is its capacitance, and k is Boltzmann's constant. This can be converted into an equivalent RMS pressure noise by dividing this quantity by the transducer's sensitivity S, in Volts/Pa. These fluctuations have a flat spectrum in equivalent acoustical energy per unit bandwidth (up to a cuto. frequency fcutoff ) at a level given by P2(f) = kT
2ðRC2S2 where R is the parallel resistance seen by the sensor, and the other variables are as defined above. Other sensor types will have some other, but similar, fundamental limit to their performance.
The noise characteristics of the preamplifier, typically parameterized in terms of input voltage noise and current noise, in conjunction with the source impedance of the transducer, also must be taken into account. As shown below, at frequencies up to a few Hz, the sensor properties seldom limit system performance. At higher frequencies, however, in quiet conditions a noisy sensor can limit detection thresholds.
We note that there is a wide range in the thermal noise properties quoted for various sensors, di.ering by orders of magnitude. This observation, coupled with the realization that frequencies above the traditional infrasound regime are likely of great interest, motivates our recommendation that the DoD maintain an ongoing assessment of pressure transducer technology, bearing in mind the cost-performance tradeo..
6.2 Pressure Noise, and Spatial Filtering
We define pressure noise as those fluctuations in the pressure field at the sensor which do not obey the wave equation. These fluctuations arise from turbulence and other complex e.ects, usually with a strong dependence on
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wind speed. Figure 13 shows typical noise power spectra measured with an IMS sensor, parameterized by wind speed.[19]
Figure 13: This figure shows the acoustical energy per unit bandwidth, in Pa2/Hz, parameterized by wind speed. For appreciable wind speeds the energy per unit bandwidth falls at 1/f3. At low wind speeds the 'microbarom' of geophysical origin is clearly visible. Note also the sensor noise floor at 3 × 10-7. From [34].
We can provide a rationalization for the frequency dependence of the pressure fluctuations in the context of turbulence. Fully developed Kolmogorov turbulence has a characteristic scaling relation such that the typical rms velocity on a scale ë (over a logarithmic scale range) goes as
v ~ ë1/3
37
We can use this to estimate the fluctuations this causes in a pressure sensor. The turnover frequency time for an eddy ù at this scale size is related to the scale and velocity as
ë ~ v/ù
which leads to
v ~ ù-1/2
The pressure fluctuation associated with characteristic rms velocity v goes as v2 from the momentum and rate of delivery of momentum, so
P ~ v2 ~ ù-1
The acoustic power spectrum then is
dP2
d ln ù ~ ù-2
or
dP2
dù ~ ù-3
The acoustic power density characteristically rises as f-3 at low frequencies. Note also that we would expect the amplitude of the power density to increase with increasing wind velocity at least as v4, and probably somewhat faster than this because higher wind speeds will increase the scale of the shear above the ground, which can couple energy into the Kolmogorov turbulence from larger length scales. This picture is in agreement with the features seen in Figure 13.
The combination of increased source strength and decreasing pressure noise at higher frequencies provides a compelling motivation to listen for sources at frequencies right up to the atmospheric cuto.. Under atmospheric conditions where the sound is returned from elevations z < 50 km, this cuto. frequency can extend up to 100 Hz. We think there is considerable merit in extending the frequency coverage of the DMZ systems into this frequency regime.
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6.2.1 Spatial Filtering, and Coherence Functions

Sensor arrays that average over a scale Dnode ˜ 40 ft have a reduced sensitivity to horizontal audio waves at frequencies above 25 Hz [3]. One would expect the variance in observed pressure, when averaged over an area A, to scale as

ó2 = ó2
0/(1 + A/A0),

where ó2
0 is the variance in pressure seen without spatial averaging, and A0 is a typical area over which the pressure noise is coherent. We will return to the pressure coherence length, which determines A0, below.

Acoustic sensors are more concerned with higher frequencies, where instrument-generated noises dominate, and have traditionally used foam or other materials to move the turbulent boundary layer away from the sensing element. This is an e.ective way to reduce the wind-driven noise that plagues microphones at audible frequencies.

There is clearly an upper limit to the area over which pressure measurements should be averaged. As soon as the averaging scale Dnode approaches the acoustical wavelength of interest, ë, the system begins to average over a wavelength and sensitivity is suppressed. For example, a circular averaging area of diameter Dnode has a null in sensitivity for horizontally propagating sound at frequencies with ë = 0.82 × Dnode.

The sensor arrays in place at the DMZ presently average over a scale Dnode ˜ 40 ft and therefore have reduced sensitivity to horizontal audio waves at frequencies above 25 Hz. Note that the propagation considerations outlined earlier in this report indicate that the sounds of interest will be arriving at fairly low angles from the horizon, and that we strongly suspect that there is interesting information at frequencies above 25 Hz. Our recommendations therefore propose re-arranging the hoses to enhance the existing system's sensitivity at higher frequencies. A bow-tie configuration would retain directional sensitivity to sounds, and would enhance signal strengths at higher frequencies.

A determination of the optimal spatial averaging scale requires knowl-
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edge of the coherence properties of the pressure field. We were somewhat surprised to learn that this is not an area of current activity within the sound monitoring community, and strongly encourage more basic work on this topic. We did find one nice example of the sort of work we have in mind, which is shown in Figure 14.[20]

Figure 14: Pressure Field Correlation Measurements. This figure, from [20] shows how the pressure field correlation depends upon the separation (in meters) between two sensors. In order for spatial averaging to be e.ective under these conditions, the system must average over length scales of many meters.

Both field experience and the noise power curves shown earlier suggest that at frequencies above 20 Hz the dominant source of pressure noise is microphone-generated turbulence. In fact, in order to retain sensitivity to sounds at frequencies of 5 KHz, an audio microphone's averaging length must conform to Dnode < ë/2 < c/2f < 35 mm. This accounts for the small characteristic length scale of typical microphones. The acoustic ba.ing used around microphones is e.ective because it moves the turbulent boundary
40
layer away from the sensing element. The dominant noise at these frequencies, namely the microphone-induced (non-sound) pressure fluctuations, fall o. exponentially in distance away from the boundary layer, and their e.ect at the sensing element is correspondingly suppressed.

Since the power spectrum of the pressure noise, and its spatial and temporal coherence, is a major factor in designing an optimized system, we strongly endorse the idea of mounting a vigorous program of both theory and measurement to better understand the pressure noise against which the detection of tactical sources of interest must compete. Specifically, we suggest a program to measure the pressure field's power spectrum, and its spatial and temporal correlation properties, at tactical infrasound array sites, over frequencies from 0.01 to 100 Hz, under a variety of wind conditions.

### 6.3 Overcoming Detector Artifacts

The pressure signals of interest are very subtle, and the instruments used to detect them are very sensitive devices. At some level the pressure sensors act as thermometers and seismographs, for example. We learned that the data stream from the existing systems su.ers on occasion from artifacts due to thermal e.ects, seismic sensitivity, and the like. We suggest that a sensible approach to overcome these gremlins is to use an identical transducer that has no sensitivity to pressure, but that retains its instrumental sensitivity to the other confounding factors. For a di.erential pressure transducer this can be accomplished by pneumatically 'shorting' the two inputs together, for example. An absolute pressure sensor could be fitted with a series of cascaded pneumatic low pass filters with very long time constants, say ô > 5000 sec, which would greatly suppress its sensitivity to pressure fluctuations in the passband of interest. By measuring one such 'dummy' transducer's output as an integral part of the data set from each array site, these detector artifacts can be identified and largely eliminated.

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# 7 DETECTION SYSTEM OPTIONS

## 7.1 Introduction

The charge for the 2003 JASON Summer Study on Tactical Infrasonics included determining whether infrasonic monitoring was likely to provide broader intelligence value. As part of this task, a survey and comparison of existing infrasonic sensor systems and conventional acoustic systems was conducted to identify the state of the art in sensor system technologies. Results of the surveys were then used to explore options for future infrasonic sensor system designs. This section first describes conventional infrasonic sensor systems; then, tactical acoustic sensor systems are reviewed and compared to the infrasonic systems. Finally, a preliminary design approach for a new tactical infrasonic sensor system is described.

## 7.2 Conventional Infrasonic Sensor Systems

During the 2003 Study, JASON received briefings on a variety of infrasonic sensor systems. Materials were also received from the 2001 and 2002 Infrasonic Technology Workshops and results of an internet and literature search. From this information, three distinct groups of activities related to infrasonic monitoring were found: international monitoring stations, Army's monitoring program, and a group of experimental systems. This section will briefly describe each activity.

### 7.2.1 Comprehensive Test Ban Treaty/International Monitoring Stations

In 1996 the Comprehensive Test Ban Treaty (CTBT) was endorsed at the United Nations banning all explosive tests that lead to a nuclear chain reaction [21]. In order to verify compliance with the treaty, the Interna-

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tional Monitoring System (IMS) consisting of seismological, hydroacoustic, radionucleide, and infrasound monitoring stations was established. The infrasound network consists of sixty stations equipped with microbarographs distributed all over the world (Figure 15). These sensors use infrasonics to detect nuclear—weapon scale detonations thousands of kilometers away. The mission is at the strategic level and the sensor clusters are spaced on the order of thousands of kilometers apart. IMS cluster installation costs are on the order of $470,000 and consists of a microbarometer and digitizer monitoring frequencies of 0.01-10Hz (Figure 16) [22]. Elements within each cluster are spaced at one to three kilometers and the power and communications infrastructure are fixed. The IMS stations are intended to be permanent, long-term facilities with extended mission lifetimes.

Figure 15: Infrasonic monitoring stations, from www.seismo.ethz.ch/bsz. (Note the IMS stations near the Korean peninsula.)

### 7.2.2 The Army's Infrasonic Collection Program

The Army maintains several infrasonic monitoring stations [23]. Sensors use infrasonics to detect threat activities; the mission is at the tactical/operational level and the targets are transient explosions, missile launches, underground facilities, and possible vehicles. The range is intended to be less than 100 km and the sensors monitor frequencies less than 20 Hz. Elements are spaced at about seven meters (20 ft) and the clusters are approximately 30 km apart. Power and communication subsystems appear to be fixed. The

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Figure 16: Infrasonic monitoring station layout, from [22]

stations appear to be relatively long—term with an extended mission lifetime.

### 7.2.3 Emerging Infrasonic Systems

A variety of research laboratories (Army Research Laboratory, Los Alamos National Laboratory, etc.) are developing a new generation of experimental infrasonic sensor systems, as illustrated in Figure 17. This generation of systems appears to be designed to detect transient events (such as explosions and missile launches) with ranges of 250 to 1,000 kilometers [24]. One system has clusters of sensors spaced on the order of hundreds of kilometers at the national laboratories. Within each cluster the elements are spaced approximately 20 meters apart and monitor frequencies below 50 Hertz. The

current systems appear to be large and may require long—term, fixed facilities to operate.
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Figure 17: A prototype infrasound array, from [24]
7.2.4 Conclusions
The survey of infrasonic sensors revealed a variety of systems that can be grouped into three categories of International Monitoring Stations, the Army's program, and a new generation of developmental infrasonic systems. Most systems were found to be developed to detect long—range transient events such as explosions and missile launches. It was found that the majority of these systems have strategic missions and require long—term, fixed facilities and are not considered tactically deployable
7.3 Tactical Acoustic Sensor Systems
JASON also collected information on tactical acoustic systems. Our objectives were to determine the state of the art in tactical acoustic sensor systems and to provide a benchmark for comparison to infrasonic systems. The
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survey was conducted through briefings, discussions, and literature searches. The scope was limited to three groups of acoustic sensor systems: Conventional remote sensor systems, emerging distributed ground sensor systems, and future ubiquitous sensor systems.
7.3.1 Conventional Remote Sensor Systems
Acoustic sensing in unattended ground sensors has a long history beginning back with naval sonobouys in the 1950's and the 'McNamara Line' of ground based sensors in the 1970's. Today, currently fielded systems such as the Remote Battlefield Sensor System (REMBASS) and the Tactical Remote Sensor System (TRSS) are hand emplaced and provide early warning of enemy vehicular activity [25]. These sensor packages detect, classify, and report direction of travel of vehicles up to a range of 350 meters. They employ acoustic, seismic, magnetic, and infrared sensors and have a mission lifetime of 30 days.
Helicopter detection systems using acoustics to detect and locate helicopters are also currently available, as illustrated earlier. Targets are rotary wing aircraft and ranges are advertised up to 20 km. The sensor system is co—located with the monitoring station and requires two people to set up. Sensor elements are spaced up to 12 meters apart and monitor frequencies from 30 to 375 Hz. While currently available systems are not autonomous the next generation system is advertised to be autonomously deployable with ranges up to six kilometers.
7.3.2 Emerging Distributed Ground Sensor Systems
Emerging systems such as the Future Combat System's Unattended Ground Sensors (FCS UGS) and the Defense Advanced Research Projects Agency's Micro—Internetted Unattended Ground Sensor (DARPA MIUGS) system are air-deployable, autonomous, and capable of providing targeting information for the networked battlefield, as illustrated in Figure 18 [27]. These tactical systems use self—organizing radio frequency (RF) networks
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to detect, identify, and track targets out to three kilometers. The sensors monitor the acoustic spectrum at frequencies above 100 Hertz. Sensor elements are spaced less than one meter apart and the nodes are spaced about 0.5km apart. These systems are short—lifetime tactical sensors designed for the fast—moving battlefield.
Figure 18: DARPA's MIUGS program, from [27]
The Self Healing Minefield is another DARPA program that aims to develop a networked anti—vehicle minefield that detects when one of the mines detonates, then rearranges itself to close the gap [28]. Densities are on the order of 10 meters and the deployed minefield has a lifetime on the order of one month. Aside from sensing when a target vehicle is near, the minefield does not share sensor information and is in a sense not truly a distributed
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sensor system. However, it has many characteristics similar to a distributed ground sensor system in that nodes frequently communicate to each other to detect and react to changes in the network.
7.3.3 Future Ubiquitous Sensing Systems
Future sensor systems are often described as ubiquitous because they are inherently coupled to the environment which they are sensing. Future military sensor systems will be coupled to the battlefield by being closely linked to munitions to create e.ects. Trends in future sensor systems indicate that sensor density will increase as the sensor nodes themselves will shrink. The SensIT program is another DARPA e.ort that is developing the self—forming

and dynamic networking software that is required to operate large fields of wireless sensor nodes [29]. Goals of the program include the development of algorithms and software enabling cheap, smart, micro—sensors for rapid and accurate detection, classification, and tracking.

Smart Dust is a private corporation that originated from a DARPA project and aims to develop extremely small distributed sensor nodes [30]. Commercial o. the shelf designs incorporate communications, processing, sensors, and batteries into a package about a cubic inch in size, as shown in Figure 19. Future visions include RF communication nodes that are short range (1-100m), low power (10nJ/bit), and low bit rate (~ 100 kbps).

7.3.4 Comparison of Infrasonic Systems to Tactical Acoustic Systems

One issue to be considered in the evaluation of a potential tactical infrasonic system is the ability to develop sensors that collect long—range information (such as the IMS system) through a tactically useful form factor (such as the UGS system). To assist in this evaluation, three systems considered in this study are compared in Table 2: the IMS system, the Army's infrasonic system, and a nominal UGS system. As shown, the Army's infrasonic system appears to be appropriately scaled, in terms of cluster and element spacing,

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Figure 19: Commercial o. the shelf wireless nodes from the Smart Dust group

between the IMS and UGS systems. However, it is also shown that in order for a system to be tactically useful, with rapid deployment, additional work in areas of deployability, autonomous operation, smaller form factor, and tactical communication links is necessary.

7.3.5 Conclusions

The survey to assess the state of the art in acoustic sensors revealed several fieldable systems. Objects that are detected by these systems include ground vehicles, helicopters, and snipers, and ranges are on the order of tens of kilometers. The systems were found to be rapidly deployable, autonomous, and have short lifetimes. A comparison of the Army's infrasonic system shows that the geometry appears appropriate but is not tactically deployable. A logical next step would be to explore whether such a system is technically feasible.

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Table 2: Comparison of nominal infrasonic and acoustic sensor system characteristics

| Metric | IMS | Army's | UGS |
|---|---|---|---|
| | Infrasound | Infrasound | Acoustic |
| Targets | Nuclear explosions | Transients, vehicles | Vehicles |
| Detection range | 1,000's kms | 30 km | 3 km |
| Cluster spacing | 1,000's kms | 30 km | 0.5 km |
| Element spacing | 1,000 m | 100 m | 1 m |
| Cost per cluster | $470,000 | $10,000 | |
| Detection frequency | <10 Hz | <20 Hz | >100 Hz |
| Deployment mode | Manual | Manual | Autonomous |
| Lifetime | Permanent | Permanent | 14 days |
| Form factor | Large | Large | 120mm dia |
| Geolocation | Manual | Manual | Automatic |
| Initialization | Manual | Manual | Automatic |
| Self—organizing | Manual | Manual | Automatic |
| Communication range | Fixed | Fixed | 5 km |

7.4 A Design Approach for a Future Tactical Infrasonic Sensor System

This section describes a procedure used to briefly explore the technical feasibility of a tactical infrasonic sensor system. First, requirements for the system are estimated. Then, a design approach based on a tactical acoustic system is used to identify nominal system requirements. Finally, these requirements are compared to existing and emerging systems to estimate feasibility.

7.4.1 Requirements

Requirements of a sensor system begin with the signature of the target. For this e.ort, consider an M60 tank which has an acoustic harmonic of approximately 10 dB less than peak at approximately 25 Hz [31]; also, assume the peak sound pressure level of a tank is approximately 100 dB.

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The spherical propagation model is given by

$$P_r = \frac{P_t c^2}{4\pi r^2 f^2} \quad (18)$$

where Pr is the signal power received at the sensor, Pt is the source transmitted power, c is the speed of propagation, r is the range, and f is the frequency.

From this simple estimate, and assuming a background noise level of 16 dB, the tank acoustic harmonic at 25 Hz and 90 dB would begin to be detectable approximately 35 km away.

For the sensor system to provide useful intelligence information, the location of the target must be estimated. One approach to localization is multiple bearing estimation (triangulation) where the bearing accuracy of a cluster is given by

$$\sigma_\theta = \frac{c}{2\pi f r \sqrt{\rho M N}} \qquad (19)$$

where $\sigma_\theta$ is the bearing error, $\rho$ is the signal to noise ratio per element, M and N are the number of elements and number of estimates measured together (assumed to be 4), c is the propagation speed, f is frequency, and r is the array size. The MIUGS system, described above, located targets with an accuracy of 20 m. An infrasonic system operating with two clusters spaced 30 km apart, containing 200 elements within a 50-m cluster diameter would be able to locate the above example target 30 km away with approximately a 46-m accuracy. This is roughly consistent with the ARL system, which uses multiple hose ports to average four microphones over a triangle spaced about 40 m apart.

Another requirement to consider is deployability. The tactical acoustic sensor systems reviewed above were all deployed via air platforms such as the Volcano or Gator deployment systems. Aside from the di.culties in deploying and arranging the conventional hose filtering system, other system requirements can be determined from the launch platform. The Volcano is capable of deploying 800 anti—tank mines and 160 anti—personnel mines, weighing 1.7 kg and 1.44 kg, respectively, bringing the total payload to 1,590 kg. The Gator is a fixed-wing air—deployable mine system that can carry 72 anti—tank and 22 anti—personnel mines for a total payload of 154 kg.

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Payload volumes are 650,880 and 63,732 $cm^3$, respectively. Finally, the last requirement on the system is lifetime, which may be estimated from the acoustic system lifetimes of approximately 30 days.

### 7.4.2 Design Approach

The goal of this design exercise is to replace a soaker—hose filtering system with a rapidly deployable sensor system. As reviewed in the acoustic sensor system section, wireless sensor networks are becoming widely available. Requirements of the system, as stated above, are to distribute approximately 200 elements in a circle of 50 m radius with the whole system weighing less than 154 kg and containing less volume than 64,000 $cm^3$. The system is to last 30 days.

One widely available wireless networking system that may be able to meet these requirements is the MICA2 system from Crossbow Technologies, shown in Figure 20 [32]. The system is a third generation module used for enabling low—power, wireless, sensor networks. Various sensor and data acquisition boards can connect to the MICA2 through a 51—pin connector. The communications capabilities enable a 38.4 kb rate over a distance of 167 m (500 ft). Each node requires two AA batteries and weighs 18 grams and 13 $cm^3$, and the batteries weigh a total of 48 grams. Hundreds of these wireless nodes could fit into the Gator deployment system described above and may be able to meet the platform requirements of a tactical infrasonic system.

## 7.5 Sensor Options

Although the Army's infrasonic system uses the venerable Chapparal microphone, for the reasons outlined above we consider it prudent to consider other potential sensor options. This section demonstrates that there is considerable merit in pursuing alternative approaches, and gives specific examples that may be worth further evaluation and development.

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Figure 20: The Crossbow MICA2 wireless node

### 7.5.1 Semiconductor Di.erential Pressure Sensors

Recent developments in semiconductor transducers have produced sensors that may be useful in acoustic monitoring applications. An example is the DUXL10D, marketed by Honeywell [33]. This device can be used in conjunction with a single low power integrated circuit, the INA125 from Burr Brown (now Texas Instruments) to make di.erential pressure measurements in the frequency range of interest. Figure 23 shows the DUXL10D.

Figure 21: One potential low cost sensor, the Honeywell "Ultra-Low Di.erential Pressure Sensor" is shown.

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Although semiconductor sensors that measure absolute pressure are available, we favor configurations that are sensitive to pressure di.erences. By connecting one of the two di.erential ports to an appropriately spatially filtered pressure signal, and the other to a temporal low pass filtered version of the pressure field, the dynamic range of the sensor can be used to full advantage for varying pressure over short (ô < 10 sec) time scales, rather than slow changes in barometric pressure. This can be accomplished using a volume V fed by a pneumatic conductance G such that the characteristic time constant G/V ˜ 100 sec.

During the course of the JASON study we procured both the Honeywell DUXL10D and the INA125 instrumentation amplifier, and the infrasound group at Scripps/IGPP has begun a program of sensor evaluation and characterization.

7.5.2 Microphones with Low Frequency Response

One way to bridge the infrasound/acoustics gap is to use microphones at frequencies below the traditional acoustic regime. Bruel and Kjaer markets a low-noise microphone, their type 4193, which responds at frequencies as low as 0.05 Hz. This device costs around $2,000, and has impressive noise properties. Used in conjunction with an appropriate spatial filter, with a judicious choice of preamplifier, this sensor could be a cost-e.ective choice for nodes in an acoustical sensor array.

7.5.3 Optical Fiber Infrasound Sensor

The Scripps team has developed an innovative sensor, the Optical Fiber Infrasound Sensor (OFIS), that measures the average pressure along a linear sensor using di.erential path length changes along a tube around which is wound an optical interferometer.[34] The OFIS system is straightforward to model, as there is no propagation delay of pressure along the pipe. The detector's directional sensitivity can be tuned by an appropriate choice of geometry.

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The developers of the OFIS sensor have claimed a noise performance that is superior to that of the Chaparral sensor (M. Zumberge, JASON briefing).

7.6 Observations Regarding Development Potential for Tactical Sonic Monitoring Systems

In this section the results of surveys of infrasonic and conventional acoustic sensor systems were reviewed. Infrasonic systems were found to be mostly large, strategic monitoring stations requiring fixed facilities, power, and communication subsystems. It was concluded that conventional infrasonic systems are not tactically deployable. Acoustic sensors were found to be mostly tactical systems with rapid deployability and autonomous operation abilities. A comparison of the Army's system to these two benchmarks showed that the geometry appears to be appropriately scaled but additional work would be needed to make the system tactically useful. Finally, a design approach was described that could be used to examine the feasibility of a distributed, networked, and wireless tactical infrasonic system. Recent advances in wireless networks may enable development of a tactically deployable infrasonic sensor system.

There is ongoing development activity within the academic infrasound community, and we consider these development e.orts worth fostering, especially in the context of arrays and noise characterization.

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8 IMPROVED DISCRIMINATION AND CHARACTERIZATION OF SOURCES

Once a source is detected with high confidence, the challenge of extracting intelligence begins. This requires locating and characterizing the sound source. It is sobering to realize that a large fraction of the infrasound sources detected by IMS stations are of unknown origin. The location and spectral character of the source are both important in understanding its origin and nature. We stress the point that simple angle of arrival information is inadequate in determining unambiguous source location, due to variations in atmospheric propagation.

We expect that in order to fully exploit the intelligence value of sound data, representative source spectra and real-time propagation path properties will both need to be well understood. In the interim, in order to reduce the time spent analyzing uninteresting sources, we propose to take full advantage of the limited geographical region of interest. By definition, the objects of tactical interest are within 100 km of the sensor arrays. Any information that can be used to determine source location is therefore extremely valuable.

8.1 Improved Discrimination Using "Veto" Channels

We propose that the discrimination of sound sources would be much improved by incorporating all available relevant information on detected events, to better identify those of most tactical interest. A joint analysis of the Army's infrasound data with seismic data, infrasound data from the IMS system and other sensors, and acoustic information from microphones will provide significant added value.

Any infrasound event that produces a measurable signal in the IMS sensors is unlikely to be of tactical interest. This information can be used to "veto" events that arrive from sources that are outside the tactical region of interest. Figure 15 shows IMS infrasound and seismic monitoring stations.

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This infrasound veto can be supplemented by similar data from seismic and acoustic sensors. Joint analysis of seismic and infrasound data obtained by the academic community demonstrates the value of comparing seismic and sonic arrival time di.erences in constraining event locations.

By concentrating on those events that produce coincident detections in the Army's infrasound arrays, but which do not have corresponding detections in the "veto" channels, the intelligence analyst e.orts can be concentrated on events of tactical interest. This will require some development, in order to provide the analysts with a means to access, visualize and interpret the data from these other sensor systems.

## 8.2 Di.erential Source Localization?

One possible way to empirically compensate for variation in apparent angle of arrival due to changes in atmospheric propagation is to take advantage of any fixed locations that reliably produce a detectable signal. The apparent azimuth bearings of these sources can then be used to make real-time corrections to the bearing of sources of intelligence interest. This di.erential source location technique of course requires some at least intermittent sources of known location. These acoustic sources could include essentially anything at a known position, including perhaps airports, wind-driven excitations of bridges or other structures, wind-driven sound from terrain features, or industrial activity, as examples. This approach essentially amounts to using natural sources to perform a modest amount of acoustic tomography of the atmosphere. We think it may be worthwhile to search the existing data for evidence of sources that may be useful in this fashion.

## 8.3 Constraining Range by Sonic Spectroscopy?

The spectral content of a detected signal provides an important clue to its distance. In general, the farther away the source is, the stronger the atmospheric attenuation at high frequencies, and the lower the atmospheric

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cuto. frequency. In order to fully exploit this phenomenology, the spectral energy distribution of the source must be known. Even in the absence of full knowledge of the source's spectral characteristics, however, we suspect this "spectral ranging" approach may be of considerable value. Sources that show little sonic energy content above 1 Hz are likely to have been detected via high-atmospheric returns, and are most probably outside the tactical region of interest. We know of no man-made source that shows a falling spectrum at frequencies of 1-100 Hz.

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# 9 REGARDING THE BROADER UTILITY OF SONIC INFORMATION IN INTELLIGENCE PROBLEMS

Infrasound instrumentation was an active field of research in the early era of nuclear weapons development [35]. More recently, the value of infrasound in monitoring test ban treaties has led to a resurgence of interest.

A number of academic groups are pursuing infrasound research as a multidisciplinary tool to investigate phenomenology ranging from avalanches to meteorites. The deployment of tactical monitoring arrays is an innovative step, and we encourage refinement of the deployed system capabilities.

The JASON group thinks there is considerable merit in supporting continued development of sonic monitoring tools and techniques, ranging from sensor development to atmospheric modeling, in anticipation of their application to intelligence problems. An array of low power robust sensors could be used to monitor diverse activities from a distance. Sonic data could provide strategic information to corroborate rocket launches that are detected by other means, including perhaps location information for mobile launch vehicles. Activity levels at military airfields could be monitored from a safe distance. Real time bomb damage assessments could be augmented with sonic data; particularly when attacking targets below the surface, listening for the explosions can help identify instances when the ordinance fails to detonate. These are but a few examples of the potential utility of sonic monitoring in the intelligence arena.

A tactical infrasound system would provide an interesting test-bed for a real-world application of this approach. As described elsewhere in this report, there is considerable opportunity to enhance the performance of a tactical infrasound system by refining both the sensors and the data analysis tools. A community investment in addressing the outstanding issues faced by a tactical infrasound system will pay dividends throughout the intelligence community, as we learn how to better exploit new applications of sonic monitoring.

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10 RECOMMENDATIONS

Our recommendations fall into two categories. We have collected the suggestions that might provide a near-term enhancement of the e.ectiveness of a tactical infrasound system into Recommendation #1. The other suggestions point out research opportunities that should accrue benefits over a longer term.

Recommendation #1. Near-Term Ideas for Enhancing Tactical Infrasound Monitoring Systems

1.1 Increase the upper limit in frequency coverage, by rearranging the filter hoses and increasing the sampling rate.

Given the likely increase in signal to noise ratio at frequencies up to the (variable) atmospheric cuto., we suggest that the spatial filter be rearranged to provide more sensitivity at high frequencies, that any low pass filter on the sensor be modified to pass frequencies up to 100 Hz, and that the sampling rate be increased to 200 Hz. The existing passband can always be reconstructed by performing a low pass operation in software. Although a parallel arrangement of the spatial filter hoses may not provide quite the same suppression of pressure noise as a star configuration, we suspect the higher frequency information will more than compensate. We recognize that this arrangement will introduce directionality in the array's beam pattern, but we consider this to be a good thing!

1.2 Use emplaced sound sources to dynamically calibrate and characterize atmospheric propagation.

An ongoing calibration of the propagation path would provide important input to interpreting tactical infrasound data. We suggest picking perhaps 6 sites where sources could be permanently installed, some even perhaps as far as 100 km apart, and driving the sources at about 10 Hz. This frequency should be largely inaudible to people, and will be heavily attenuated before reaching any IMS stations that surround the tactical array. They don't need to be on continuously, but only need sample the atmosphere periodically. It

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would also be a good idea to make a mobile source, and to run exercises in locating it from the tactical infrasound data set.

1.3 Use infrasound data from the International Monitoring System (IMS), seismic and other data from the surrounding area to "veto" events that are outside the region of tactical interest.

The limited geographical region of interest can be exploited, by rejecting sonic events that are detected across much wider regions and that have origins outside the zone of interest. There is much to be gained by declaring certain events to be uninteresting because they fall outside the zone of interest. A combined analysis that joins locally sonic data stream with other regional infrasound, seismic and acoustic information should help determine which events reside outside the area of tactical interest, and should be ignored. We note that by increasing the bandwidth of the sensing system, the spectral character of the signal from a sonic event can provide important information

1.4 Break the sound barrier: Fuse and correlate infrasound data with acoustic data.

Recommendation #2: Support A Vigorous Program of Source and Noise Characterization

We advocate a program to obtain calibrated sound signatures from both targets of military interest (trucks, tanks, etc.) as well as potential sources of "clutter" (tractors, commercial aircraft...). In addition we consider it imperative that the sources of noise be fully characterized as a function of frequency, particularly the spatio-temporal coherence of the pressure field fluctuations. A major motivation here is to determine the optimum area over which to average in order to best suppress pressure fluctuation noise, while retaining sensitivity to high frequency sound.

Recommendation #3: Characterize the Propagation Path

The variability of the near-zone propagation mechanisms is a major impediment to fully understanding and exploiting the measured signals. This

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motivates a program to measure the atmosphere's transmission properties around the tactical array, on an ongoing basis. This can be done either directly, by emitting a known sound from a known location, or indirectly, by measuring meteorological parameters that can be used in conjunction with models to predict sound propagation. Take proactive steps to engage the scientific community in better understanding the propagation and detection of sound over distances of 100 km.

Recommendation #4: Investigate Alternative Sensors

A diversity of sensors can be used to monitor sound in the frequency range of interest. Given the likely importance of energy at frequencies above the classical infrasound regime, we consider it important to carry out a survey of sensor technology, both mature transducers and ones under development, paying particular attention to their noise properties. This information will be important in assessing the price/performance tradeo.s in acoustic arrays, which we describe next.

Recommendation #5: Take a Fresh Look at Array Design and Deployment

The tension between maintaining good sensitivity to high frequencies and averaging over large areas to suppress pressure noise motivates the consideration of arrays of relatively inexpensive sensors. We advocate establishing a sound array test bed, co-located with a "classical" infrasound array, to facilitate the evaluation of di.erent technologies and layouts. This evolution can take exploit recent DoD and commercial advances in wireless, distributed sensor networks.

Because of the vagaries of atmospheric propagation it will probably be useful to install arrays over a wide geographic band. The pattern of intensity over this band can be such that high intensity may occur further from the source at times.

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References

[1] Drob D. et al., The Global Morphology of Infrasound Propagation, JGR Atmospheres, in press (2003).

[2] Evers, L. G. et al., Listening to Sounds from an Exploding Meteor and Oceanic Waves, Geophys Res Lett 28, 41 (2001)

[3] Daniels, F. B., Noise-Reducing Line Microphone for Frequencies Below 1 cps, Jour Acoust Soc Am 31, 529 (1959)

[4] Emberton, T. F. W., Tutorial on Sound Propagation Outdoors, J. Acoutical Soc. Am. 100, 31 (1996)

[5] Attenborough, K. Sound Propagation Close to the Ground, K. Attenborough, Ann. Rev. Fluid Mech. 34, 51 (2002)

[6] LePichon, A. et al., Acoustic Propagation and Atmospheric Characteristics Derived from Infrasonic Waves Generated by the Concorde J. Acoustical Soc. Am. 111 629 (2002)

[7] Srour, N. "HELISPOT MKII Evaluation of Helicopter and Ground Vehicle Detection", US Army Research Laboratory, undated briefing.

[8] McCormack, D. and Evers, L. 2003, In InfraMatics, The Newsletter of Subaudible Sound, number 1, March.

[9] Nguyen, A., Sim, L., and Kvavilashvili, R. 1999, "The U.S. Army Research Laboratory's Acoustic and Seismic Database and User Interface Software." Available in PDF format at www.arl.army.mil/sedd/acoustics/reports.htm

[10] Tenney, S., private communication.

[11] Lake, D. 1998, "Harmonic Phase Coupling for Battlefield Acoustic Target Identification", Proceedings 1998 IEEE Conference on Acoustics, Speech, and Signal Processing, Seattle, paper SSAP4.9.

[12] Donn, W. L., Balachandran, N. K., and Kaschak, G. 1974, "Atmospheric infrasound radiated by bridges," J. Acoust. Soc. Am. 56, 1367.

69

[13] Kobayashi, Y. 1999, "Infrasound generated by a highway bridge," BUTSURI-TANSA (Geophysical Exploration) 52, page 54.

[14] Landau, L. D., and Lifshitz, E. M., Fluid Dynamics, Course in Theoretical

Physics Volume 6, Pergamon Press, Elsnsford, New York, 1977.
[15] Gossard, E. E. and Hooke, W. H., Waves in the Atmospheric, Elsevier Scientific, New York, 1975.
[16] www.knmi.ni/~evers.
[17] W. E. Mcbride, H. E. Bass, R. Raspet, K. E. Gilbert, J. Acoust. Soc. Am., 91 1336 (1992).
[18] T. Colonius, S. K. Lele and P. Moin, J. Fluid Mech, 260, 271-298 (1994).
[19] IMS Sensor output
[20] Talmadge et al., 2001 Infrasound Technology Workshop, see http://www.isla.hawaii.edu/meeting2001 program.html.
[21] www.seismo.ethz.ch/bsv.
[22] Veloso, A. et al., Progress on the establishment of the CTBT IMSinfrasound network. Abstract in Infrasound Technology Workshop at Kona, Hawaii, 2001.
[23] Grachus, R. J., MASINT collection and exploitation. Briefing to JASONs June 18, 2003.
[24] Rod Whitaker. Infrasonic monitoring. Briefing to JASONS June 18, 2003.
[25] Intelligence and Information Warfare Directorate (Chief Exec. O.cer Robert Foresta). Tactics, Techniques, and Procedures for the Remotely Monitored Battlefield Sensor System (REMBASS). Fort Monmouth Report FM 34-10-1, June 18, 1991.
[26] Nino Srour. HELISPOT MKII evaluation of helicopter and ground vehicle detection. Briefing labelled IRIS Acoustics 1999.
70
[27] Michael Mattice. DARPA MIUGS program brief. Program brief dated 2002.
[28] www.darpa.mil/ato/programs/SHM/index.html.
[29] Sri Kumar. SensIT PI Meeting. Briefing dated April 17, 2001.
[30] robotics.eecs.berkeley.edu/ pister/SmartDust/.
[31] Nino Srour. Battlefield Acoustic Sensing. Briefing labeled December 1999.
[32] www.xbow.com.
[33] Honeywell DUXL10D. www.intertechnology.com/PDF/Data Instruments/ DUXL Series.pdf
[34] Michael A. H. Hedlin. Infrasound Monitoring of Anthropogenic and Natural Atmospheric Phenomena. Briefing to JASONS June 18, 2003.
[35] Panofsky, W. K. H., private communication (2003)
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# Appendix

II

# <u>Appendix</u>

## ***R*ecommended reading list of additional patents, threads and leads to check out…**

***US1749090 Apparatus for obtaining criminal confessions***
***US2227902 Carrier Frequency Signal System***
***US2304095 Method and apparatus for inducing and sustaining sleep***
***US2498242 Control System – Bell Labs – Westinghouse Electric Corporation – John R. Boykin***
***US3060795 Apparatus for producing visual stimulation***
***US3278676 Apparatus for producing visual and auditory stimulation***
***US3393279 Nervous System Excitation Device***
***US3398810 Ultrasonic Sound Beam***
***US3557899 Security apparatus with audible alarm of enhanced urgency***
***US3568347 Psycho-Acoustic Projector***
***US3576185 Sleep inducing method and arrangement using modulated sound and light***
***US3612211 Method of producing locally occurring infrasound***
***US3613069 Sonar System***
***US3629521 Hearing Systems***
***US3647970 Method and system for simplifying speech wave forms-Neurophone***
***US3712292 Method and apparatus for producing swept FM Audio signal patterns for inducing sleep***
***US3773049 Apparatus for treatment of neuropsychic & somatic diseases with heat light sound & VHF electromagnetic radiation***
***US3782006 Means & methods to assist people in building up aversion to undesirable habits***
***US3884218 Method of inducing and maintaining various stages of sleep in the human being***
***US3967616 Multi channel system for & multi factorial method of controlling the nervous system of a living organism***
***US4006291 Three dimensional television system***
***US4141344 Sound Recording System***
***US4227516 Apparatus for Electro-Physiological Stimulation***
***US4315501 Learning Relaxation Device***
***US4315502 Frequency Stimulation Device***
***US4349898 Sonic Weapon System***
***US4388918 Mental Harmonization Process***
***US4395600 Auditory subliminal message system and method***
***US4572449 Method for Stimulating the falling asleep and/or relaxing behavior in a person***
***US4616261 Method and apparatus for generating subliminal visual messages***
***US4686605 Method and apparatus for altering a region in the earth's atmosphere, ionosphere, and/or magnetosphere***
***US4692118 Video Subconscious Display Attachment***
***US4699153 System for accessing verbal psycho-biological conditions of a subject***
***US4712155 Method and apparatus for creating an artificial electron cyclotron heating region of plasma***
***US4717343 Method of changing a person's behavior***
***US4734037 Message Screen (Subliminal)***
***US4777529 Auditory subliminal programming system***
***US4821326 Non-Audible Speech Generation Method & Apparatus***
***US4834701 Apparatus for inducing frequency reduction in brain wave***
***US3852519 Video and Audio encoding-decoding system employing***
***US3848608 Subject Integument Spatial Stimulator- July 1973***
***US3628193 Tactile Image Projection System 1969***
***US3612061 Flexible Cutaneous Electrode Matrix 1969***
***US3499437 Method and Apparatus for treament os organic structu***
***US 3389382 Electron Beam Readout of Stored Information- april***
***US3182259 Submodulation Systems for Carrier Re-Creation***
***US3147437 Single Sideband Radio Carrier Retrieval System***
***US3081376 Subscription Television System - B.D. Loughlin***
***US3032029 System controlling apparatus and method -reduce hum***
***US2968302 Multibeam Focusing Irradiator (Sound) 1956***
***US2902030 Alertness indicator***
***US2860627 Pattern Photic Stimulator***
***US2721316 Method and Means for Aiding the Blind- 1953***
***US2703344 Cutaneous Signaling -1949***
***US2703344 Cutaneous Signaling 1949***
***US2409033 Electro encephalograph device***

# E N D

II