Response of Physiological Parameters to Low Frequency and Low Intensity Pulsed Magnetic Fields

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Abstract

There are many questions about biological effects and consequences of electromagnetic and magnetic fields and their possible harmful, benign, or beneficial effects. In this paper, we address effects of these fields on humans and discuss their possible beneficial effects. The purpose of the research was the following: first, to determine the possible direct and rapidly varying effects of physiological response in adult humans correlated with external pulsed magnetic and electromagnetic fields and to objectify these responses; second, if affects are observed, to characterize what field wave forms, frequency mixes, and intensities produce these effects; third, to note any behavior change; and fourth, to develop theoretical models and mechanisms to understand such effects. Particular attention is made for looking for beneficial effects.

Electromagnetic Fields and Life

Living entities and, in fact, the planet itself, is a mechanical, chemical, electrochemical, and magnetic system.[1,2,3,4] The current view of life and, in particular human beings, is to treat them conceptually as a chemical and electrochemical as well as a mechanical system, particularly from a medical view point. That is, medication is primarily chemical and antibiological, electrolytic balancing and the mechanical setting of broken bones, etc. are some of the essential treatment modalities in modern medicine.

We live in an environment of a ubiquitous "sea" of natural and man-made electromagnetic fields. We humans and all life on earth are involved in electromagnetic, electric, and magnetic fields and in a little over 100 years, we have increasingly been "bathed" in man-made fields from nonionizing radiation such as radio frequency (RF) to ionizing radiation such as X-rays.[1] In this paper, we will concern ourselves with non-ionizing radiation. The energy of nonionizing radiation is low enough that ionization and most cases thermal effects do not occur. Ionizing radiation, unlike nonionizing radiation, is capable of removing electrons from atoms and breaking molecular bands and causing direct cellular and genetic damage.[5]

Some researchers have stated that low frequency and low intensity fields, both natural and man-made, which do not produce thermal or ionizing effects should have no biological consequences yet other researchers and results of their work published in a sizable body of scientific literature present results demonstrating a variety of biological effects on humans and other organisms produced by certain specific frequencies and intensities of electromagnetic and magnetic fields.[6-16]

Background Purpose of Our Experiment

In this paper we briefly present our research on biological effects of specific frequencies, multiple frequency mixes, and waveforms of magnetic and electromagnetic field emissions from a specifically designed multi coil emitter probe designed by one Bise. The primary frequency range that we utilized in this study was from approximately 3 Hz (or cycle per second) to 76 Hz.[15,18-25] We have conducted extensive experimentation involving field effects on such physiological parameters as electroencephalogram (EEG), EKG, and GSR by externally generated, low frequency, low intensity, magnetic, and electromagnetic fields. We have also developed a theoretical model that describes some aspects of the process of information processing in the human body. This work has been conducted over the last 20 years and may give new insights into central and peripheral nervous system functioning as well as cardiac physiology.[5,15-25]

By way of comparison, at a 45-degree latitude (about the San Francisco Bay area latitude) the earth's steady-state magnetic field strength is about 0.5 Gauss and is relatively constant. The field strength we utilized in these studies was anywhere from 2 thousandths of a Gauss or a μG to about 15 Gauss. But these fields are complex, i.e., consist of many combinations of different frequencies, waveforms, and intensities.[12,16] Furthermore, they are time-varying as opposed to constant such as the earth's relativity steady-state fields. The reason we

believe these fields can have effect on biological processes in humans, as well as canines and rats (which we have also studied) is that they match some of the natural electromagnetic signals used in transfer of information associated with life processes, which is what we could term biocybernetics.

We have found significant variations in the alpha brain wave amplitude and shifts in alpha power spectrum dominant frequency under the influence of certain very specific fields. Most importantly, some of these changes have been observed under strict double-blind conditions in which neither the experimental subject nor the person interacting with him knew whether the entraining fields were turned on or off, treated and control runs respectively.[15-25] We believe that producing such effects, that is utilizing fields to make contact with the human neurologic and hemodynamic system,[17,18] will allow us to enhance biologic functioning particularly to overcome neurologic deficiencies and abnormalities.[24,25]

The specific manner in which external fields effect a biological system as beneficial, harmful or benign depends on several factors. Beneficial or harmful effects occur when contact is made in such a manner where the external field informational content matches within a certain range of the internal signal processing. By way of analogy, mammals need a certain amount of salt to survive that is beneficial, too little or too much salt "does not match" the requirements and hence is harmful. The nonlinearities of external fields and biological processing makes these systems potentially incredibly sensitive to external fields.

"Science knows no country because knowledge belongs to humanity and is the torch which illuminates the world."

—Louis Pasteur

Motivation For the Current Study

A previous extensive pilot study was conducted by Bise[12] using RF emitter antennae. This study was conducted with 10 adult human subjects 23 to 48 years of age who were volunteers from the Oregon State Health Division. Low intensity 0.1 to 960 MHz X-band continuous wave and 8.5 to 9.6 GHz pulse-modulated frequencies were emitted to the test subjects. This frequency range has a wave length from about 2000 M at the low end to about a tenth of a meter at the upper end. EEG brain wave alpha amplitudes were observed to increase or decrease changing to 6 Hz irritability waves at different emitted field frequencies in all subjects with a P value of less than .001. We utilized a similar protocol to examine possible extremely low frequency (ELF) fields on EEG in human adults.[12]

Our interest was to examine the possible effects on EEG as well as EKG of extremely low frequency fields. We were encouraged to do so since the effects of RF fields had such specific effects on human EEG and we are exposed to both natural and man made ELF signals. These are extremely low frequency signals and often relatively low intensity.

Methodology for ELF Field Effects on Human Brain Waves

In the study we report in this paper, we examine the effect of ELF effects on human EEG brain waves. Extremely low frequency radiation occurs below 300 Hz.15 An emitter probe was placed one half meter (.5M) from the left tempo-

ral lobe of healthy adult human volunteers, ages 22 to 56 years of age. Volunteers were colleagues and psychology graduate students at John F. Kennedy University, Orinda, CA. Brain wave EEG electrodes were attached and records taken for artifact reduction and to characterize each individual brain wave particularly their alpha rhythm. Both eyes open and eyes closed were recorded. Single- and double-blind sessions were conducted and subjects' ears and eyes were blocked so that they were unable to know if the emitter condition was on or off. Most were placed in a separate laboratory rooms from the emitting and recording equipment. Experimental sessions were less than two hours and treatment with the active emitter probe were conducted twice per session at different intervals to avoid any clueing and lasted less than two minutes.[15] It was determined in the previous pilot study[12] that maximum effects were observed cross the hemispheres so that the active electrodes were the left frontal parietal, FP1(-) and right occipital O2(+) using the right frontal parietal, FP2 as the reference audio, and in some cases video, records of each session and subjects comments was made. Single and mixed frequencies of two signals were emitted by an array of three solenoid coils with field a strength of 680 μG at the subjects' head or about one milli Gauss or one one thousandth of one Gauss. Frequencies ranged from 3 to 78 Hz consisting of sine, triangle, and square (of between 25 to 50% duty cycle) waves. The duty cycle is the relative signal on time compared to its off time.

The emitter or radiator probe coil system contained multiple coils that were energized by an irrductive signal source that consisted of variable frequency or frequencies. The size of the probe was about 2x3x12 cm3. See Figure 1 for an example of a domain display of an emitted signal from three coils for a 7.6 Hz signal at 50% duty cycle and a 35 Hz signal at a 25% duty cycle. Data were acquired, observed, and recorded on a Brush-Gould 260 six channel chart recorder, a Tektronix 5103-N-D10 dual trace oscilloscope that records a signal in the time domain or as it changes in time and a Spectral Synamics SD-335 real time spectrum analyzer that displays the frequency domain or what frequencies are present and their relative intensities.

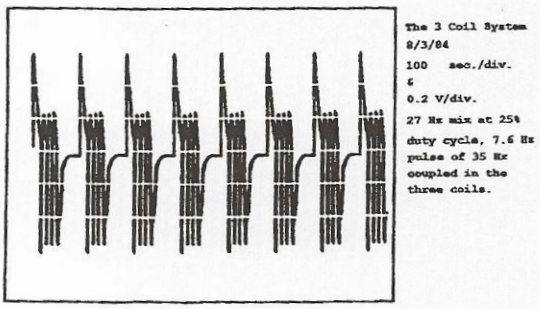

Figure 1: A time display of the emitted signal from a probe containing three coils. Signals are a 7.6 Hz signal and a 35 Hz signal mixed frequencies.

Permanent data recording of the emitted signal and brain waves were made on chart recorders, Polaroid instrument cameras of the oscilloscope tracings, or spectrum analyzer frequencies. Also video cameras were sometimes used to record the data. Also subjective impression were recorded of subjects in real time in our ELF pulsed magnetic field effects on human EEG. Video or audio recordings of each session were made that lasted from 60 to 90 minutes. Control or treatment runs were conducted and emitter probe on or off conditions were unknown to all subjects.

Results

Twenty six experimental runs were made and EEG responses to external ELF fields were found in 91% of the subjects. Diminished alpha amplitude by 50% or more and desychronizations were observed as compared to control runs. In one case, brain wave amplitude was reduced 75% from a 52-year-old female subject for 30 seconds. As soon as the emitter probe signal was turned off, the brain waves returned to normal in all subjects. Also, in some cases behavioral changes were noted.

In Figure 2 is displayed ELF dominate frequency radiation of a 9.41 Hz signal mix changed to a 9.25 Hz signal mix. The subject was a 22-year-old healthy male. In the lower two traces are displayed his EKG and EEG with eyes closed. At the left during exposure to the 9.41 Hz signal we see a normal μV (micro volt) amplitude alpha frequency of 9.45 Hz. During radiation with a 9.25 Hz signal, his alpha displayed 2 to 6 Hz irritability waves with a low amplitude of

10 to 15 μV. After the emitter was turned off at the right of the display in Figure 2 the subject's brain waves returned to normal. It is very interesting to note that natural 9.41 Hz signals are generated by proton interactions in the upper ionosphere from solar flares.

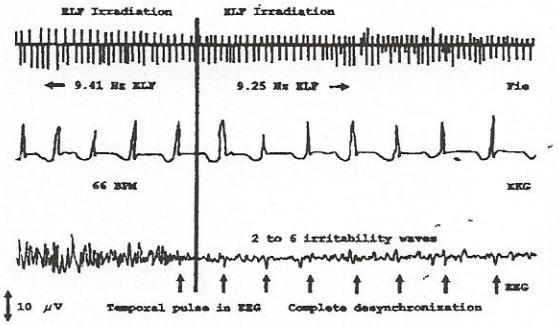

Figure 2: The top trace is the output of the emitter probe from a single frequency of 9.41 Hz at the left and a 9.25 Hz frequency at the right. The lower two traces are the EKG and EEG traces from a 22 year old male subject, eyes closed corresponding to the emitted signal. No changes in the EKG record are noted but 85 μV alpha wave of about 9.45 Hz and during radiation to a 15 μV brain wave with 2 to 6 Hz Gray Walter irritability waves. The signal was turned off at the right and his brain waves returned to normal.

In Figure 3 is displayed the signal for the probe deactivated or off and in the second trace is his normal brain wave trace from the right hemisphere of a normal healthy 42-year-old male volunteer with eyes closed with a normal alpha of 10 Hz with a 70 μV amplitude. In the right hand part of the trace the emitter probe is on or active, generating a complex signal of 38 to 40 Hz and the subjects alpha now shows a 3, 7 and 12 Hz components from 20 to 80 μV amplitude. After the probe was turned off his brain wave returned to normal.

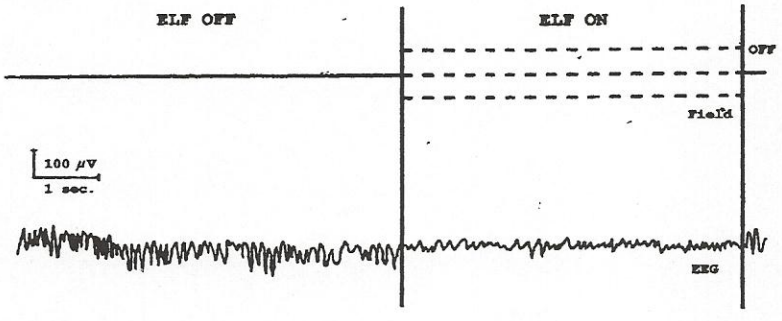

Figure 3: Displayed is the probe signal off at the left and on at the right top trace is a frequency complex of 38 to 40 Hz signal. The EEG trace is from a 42 year old male subject with a normal 70 μV, 10 Hz alpha with eyes closed and no generated signal. When the signal is generated we see 3.7 and 12 Hz components from 20 to 80 μV which returned to normal when the emitter probe signal was turned off.

"The origin of life is a subject for the scientist who has everything, but that hasn't stopped many of us from speculating about it. ... Most are variations of one theory 'warm soup and lightning.' "

—Robert O. Becker, M.D.

In Figure 4 we display four traces, stepped down left to right, top to bottom of an EEG of a 25-year-old female volunteer. These brain wave traces are correlated with an ambient signal detected by the Rauscher-Bise sensitive magnetic field detector[26] from the July 1981 major solar flair. The ambient signal is about 9.41 Hz from the proton interactions in the ionosphere. The EEG and ambient signal appear very similar and are "phase locked." Lead configuration was from left frontal parietal to left occipital with reference of RFP.

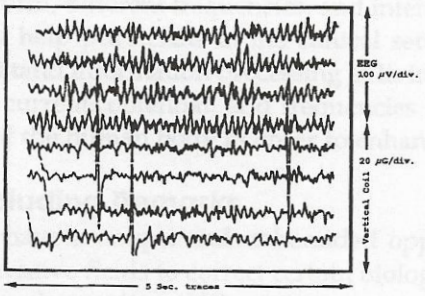

Figure 4: The top four traces from left to right stepped down are the EEG of a 25 year old female subject, eyes closed. These four traces correlate with the bottom four ambient magnetic field. Traces having a dominate 9.41 signature from the proton interaction during a major solar flair. The correspondence is remarkable.

Theoretical Mechanisms of ELF Effects on Biological Systems

We briefly describe some of the main issues related to biological sensitivity to certain specific electromagnetic and magnetic radiation. Biological systems are (1) coherent collective self-organizing systems with low dispersive losses in neuronal activity, (2) nonlinear and non-equilibrium systems, (3) resonant to internal and certain specific external signals, (4) dynamic or process oriented, and (5) can be treated as cyberdynamic informational systems. According to current theory, ELF waves have extremely long wave lengths. Our study of the effects of ELF on EEG and EKG leads us to believe that these waves act as a chain of impulses, hence, having an effective shorter wave length than by conventional linear electrodynamical theory.[14]

The human organisms maintains its homeostasis by a dynamic informational exchange between its various body systems and the environment. Indeed, the more highly developed life forms can be recognized by an increasing order of complexity or information. Those processes that enhance this negentropy (for example, avoidance of pain, stress, biological insult from damaging radiation fields, etc.) may be considered health enhancing to the organism whereas processes that tend to increase the disordered information increase entropy of the human organism are disease promoting.[27]

In this cybernetic systems view of man, informational exchange occurs at all levels in the organism. In recent years it has become clear that in living systems there are far from equilibrium processes that appear to be sensitive to low intensity electromagnetic signals. As an example, the human eye can sense the energy of a single photon. Certain discrete power windows and specific wave forms and frequencies of the electromagnetic spectrum appear to be able to initiate, enhance, or diminish informational signaling. Protein bound water and other fluid systems of the body, especially the blood, seem to be important carriers of this bioinformation. Certain paramagnetic substances in the blood can also act much like a magnetic informational storage system, carrying and delivering information throughout the tissues of the body. The replicable and significant reproducible changes produced by low-intensity electromagnetic and magnetic fields observed in EEG and EKG will allow us to better understand this cooperative organization that normalizes and maintains homeostasis in living systems. Also, disruption of the homeostatic condition by external influences can be better understood. In general, the effects we found were similar across human as well as animal adult populations; that is, although human and animals respond physiologically to different fields then animals within each species the response was similar.

Other Related Research on Beneficial Effects of ELF on Humans

Two specific aspects that have come out of our research are two Food and Drug Administration approved studies. The first study involved a clinical test of a pain reduction system that we have developed and patented. This system utilizes pulsed magnetic fields emitted from small coils that can be placed over the site of injury or chronic pain patients or areas sensitive to manual palpitation. This first study had four patients with chronic lower back pain who were treated over a two-month period and were blind as to whether the device, called a magnetic pain reduction system, the MPR-7644 device, was operating or not. When treatments were delivered with the device operating normally, we designated such treatments as "Active Treatments." On the other hand, when the treatments were given with the device turned off (unknown to the

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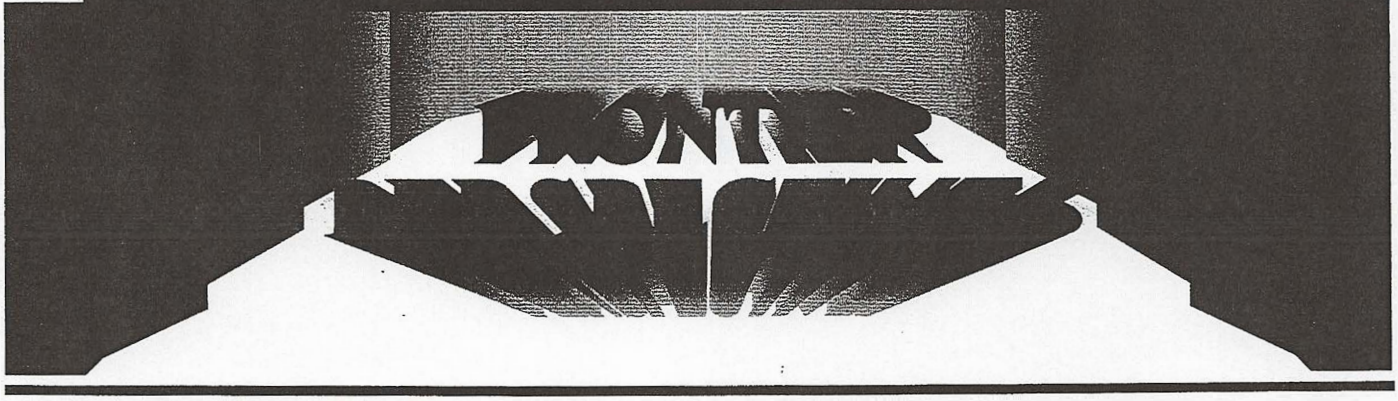

Volume 8, Number 2 Fall 1999

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