Effects of 6 to 10HZ on brainwaves
Article by David Walonick

There is evidence that ELF magnetic waves can affect brain waves. These set of experiments were designed to study the effects of ELF rotating magnetic fields on the brain.

The specific ELF frequencies I was interested in studying are 6-10 Hertz. These frequencies are the same as those produced by the human brain in the theta and alpha states. Generally, specific brain wave frequency ranges can be associated with mood or thought patterns. Frequencies below 8 Hertz are considered theta waves. While these seem to be some of the least understood frequencies, they also seem to be associated with creative, insightful thought. When an artist or scientist has the "aha" experience, there's a good chance he or she is in theta. Alpha frequencies are from 8 to 12 Hertz and are commonly associated with relaxed, meditative states. Most people are in an alpha state during the short time immediately before they fall asleep. Alpha waves are strongest during that twilight state when we're half asleep and half awake. Beta frequencies (above 12 Hertz) coincide with our most "awake" analytical thinking. If you are solving a math problem, you're brain is working at beta frequencies. Most of our waking hours as adults are spent in the beta state.

A question of importance is: "If we can electronically shift the brain wave frequencies to alpha or theta, will a person's moods or thought patterns change to those commonly associated with those frequencies?". In other words, if we can electronically move a person's brain waves to the alpha frequencies, will they become more relaxed? Will their state of consciousness change to coincide with their brain waves, even if those brain waves were electronically induced? These are important questions with far reaching implications.

When I began these experiments, I was well aware of the possible ethical implications involved in ELF research. For example, if I were carrying an ELF transmitter operating at alpha frequencies, would the people around me be affected as well? Would they unconsciously gravitate toward me because they'd become more relaxed as they moved closer to me? Would they like me more because they felt "good" when they were around me? What if a salesman were carrying an ELF transmitter? Would people be influenced to buy something because they were more relaxed around the salesman? Could
entire populations be influenced to be comfortable with ideas they would normally reject? These, and many others, are serious ethical considerations involved with ELF research. They cannot be taken lightly.

I decided to undertake this research with full knowledge of the ethical implications. While there is the potential for misuse, a desire for knowledge and understanding are part of being human, and the potential benefits to humanity are great. What if we could treat depression, insomnia, anxiety, stress and tension with ELF magnetic fields? What if we could increase intelligence or improve learning? As in any scientific endeavor, there are both positive and negative potential uses for any discovery. One only need look at the development of atomic energy to understand the benefits/misuse dichotomy. It is my personal belief that the potential benefits to humanity justify the research.

I began by collecting all the available research on ELF fields. Lana Harris, a secondary research specialist, did an excellent job in acquiring virtually all the available research in this area. In addition to a multitude of published journal articles, several military and NASA research reports were ordered. A review of the research showed that most studies had been performed to determine the effects of 50-60 Hertz high voltage power-line fields. Since these are the frequencies of most of the world’s electrical power distribution systems, the importance of understanding the effects on plant and animal life are evident. To a much lesser degree, a few researchers had concentrated on lower power and lower frequencies (the focus of this study).

Equipment

The equipment required for this research was easily attainable, with the notable exception of a stable frequency counter with .01 Hertz resolution. Accurate frequency measurements were essential for this research, so I designed and built a digital frequency counter capable of measuring frequency to the hundredth of a Hertz (plus or minus .005 Hertz). A 100 KHz crystal Colpitt's oscillator (calibrated with WWV) was used as a time base and divided by ten to the seventh power to attain the desired resolution.

Other equipment used is: a Biosone II Brainwave Monitor and Myosone 404 EMG Monitor (Bio-Logic Devices, Inc., 81 Plymouth Rd., Plainview, NY 11803); a Model 3011 Digital Display Function Generator (BK Precision Dynascan Corp., 6460 West Cortland St., Chicago, IL 60635); and IBM PC compatible computer with a clock speed of 7.16 MHz (the faster the clock
speed the better); a SAC-12 A to D signal acquisition board (Qua Tech, Inc., 478 E. Exchange St., Akron, OH 44308); a Codas II video board and software release 3 (Dataq Instruments, Inc., 825 Sweitzer Ave., Akron OH 44311); a Fluke 77 digital multimeter (John Fluke Mfg. Co., Inc., PO Box C9090, Everett, WA 98260); and StatPac Gold statistical analysis software (Walonick Associates, Inc., 6500 Nicollet Ave. S., Minneapolis, MN 55423).

The transducer was a 24" diameter hand-wound coil, consisting of 1000' of #25 magnetic wire. The coil had a DC resistance of 32.4 ohms. It was mounted on a 26" square piece of bakelite board for stability. Two dowels were mounted with plastic ties onto the board so they extended 24" from opposite sides of the board and the entire apparatus was secured by two microphone stands.

**Experimental Design**

All twenty-two subjects were friends or acquaintances of the author. There was no remuneration to participants. The excitement or novelty of participating in a brain wave research experiment seemed to provide sufficient reward in and of itself.

Subjects were sent a pre-experiment letter briefly describing the intent of the experiment and what they could expect. They were asked not to use any drugs or alcohol for 24 hours before their appointment, and not to wear any metal jewelry. (It was thought that metal jewelry might distort the magnetic field, thus creating uncontrolled inconsistencies between subjects.)

Upon arrival at the laboratory, participants were given a short orientation to the procedure and any questions they had were answered. They were hooked up to the EEG monitor (frontal to occipital, midline) and then allowed to listen to a relaxation tape for five minutes. The purpose of the relaxation tape was to establish a "relaxation level" baseline and to relieve some of the anxiety associated with the experiment. At the end of five minutes, the headphones were removed and the subject was told they were at a relaxation level of 5 on a scale from zero to ten (0 being very tense and 10 being very relaxed). This was the baseline they were to use for reporting their relaxation level following each ELF exposure. Subjects were told that they could choose to stop the experiment at any time.
Each ELF exposure consisted of a ten second, sine-wave transmission separated from one another by 45 - 60 seconds of no exposure. The voltage fed to the coil was 3.1 VAC (RMS). The coil was positioned 18" in front of the subject's head. The outputs from the ELF transmitter (function generator) and the brain wave monitor were fed directly into the computer A to D board, allowing both to be displayed on the computer monitor (and recorded on disk) simultaneously. The sampling rate of the A to D converter was set at 2000 samples per second for the entire experiment. This was sufficient to visually detect differences of .1 Hertz between the ELF and brain wave frequencies. Subjects were not told when a transmission was beginning. However, at the end of each transmission, they were asked to "report". This was their current relaxation level based on the zero to ten scale. They also reported any feelings they had experienced and these were recorded verbatim. Twenty-one frequencies were presented to each subject (from 6 to 10 Hertz in increments of .2 Hertz. For half the subjects, these frequencies were randomly selected. For the other subjects, they began at 10 Hertz and were decreased by .2 Hertz with each transmission. Subjects were not told the order of frequencies that would be presented to them.

Post acquisition software was used to visually examine the coherence (frequencies) and synchronously (phase relationship) between the transmitted ELF and prominent brain waves.

Results

Examination of the computer data revealed substantial differences between subjects. Some subjects showed lock-on (entrainment) over a wide frequency range, while other subjects showed no lock-on whatsoever. In general, lock-on occurred most frequently from 8.6 to 10 Hertz and less frequently below 8.6 Hertz.

One subject displayed lock-on for all frequencies from 7.4 to 10 Hertz. Two subjects displayed no lock-on over the entire frequency range. While I did not test a sufficient number of subjects to be statistically significant, I suspect that susceptibility to ELF entrainment follows the normal (bell-shaped) curve. At this time, I do not have any hypothesis that would allow us to predict who is susceptible and who is not.

Several interesting observations were readily apparent. Lock-on generally occurred very rapidly... within a quarter of a second in most cases. If lock-on did not occur at a specific frequency in the first second, it didn't at all. When
the brain did lock on, the amplitude of the brain waves increased to nearly double their normal size. This is typical for naturally (non-ELF) produced alpha patterns. The brain locked on to higher frequencies (9-10 Hertz) more readily, and maintained the lock-on for the entire duration of the transmission. As the frequency was lowered (below 8.6 Hertz), lock-on for most subjects occurred in bursts, rather than being continuous. For example, there might be immediate lock-on for two seconds; then the brain would "fight" the ELF frequency for a quarter of a second, and then lock-on again for another few seconds, etc.. I use the word "fight" because it looked like the brain was fighting the ELF to maintain its own frequency. The "fight" was characterized by low amplitude beta frequencies in the 15-20 Hertz range. These may, of course, have simply been analytical type thoughts, but they were not observed when the frequency was in the 9-10 Hertz range. This "fight" became more frequent as the frequency was lowered, until no lock-on was observed at all.

None of the subjects were able to consciously detect the presence of the ELF field. One female subject was able to detect whenever the field started or ended, but could not accurately say when if it was on or off at any given time. In other words, she was able to detect the change in the magnetic field, but not the presence or absence of the magnetic field itself. She thought she felt it because it aggravated her sinuses. When lock-on occurred, the brain waves lagged behind the transmitted ELF. This appeared to have been the "reaction time" of the brain to the ELF waves (approximately 60-80 milliseconds). More accurate experimentation is needed to explore this relationship.

Subjects verbatim reports were quite revealing. (Keep in mind that none of the subjects actually said they felt the ELFs.) The most common verbatim reports occurred between 8.6 and 9.6 Hertz. Common statements were subtle "tingling" sensations in the fingers, arms, legs, teeth, and roof of the mouth. Two subjects reported a "metallic" feeling in their mouth. One subject reported a "tightness" in the chest and another subject reported a "tightness" in the stomach. Several subjects also reported sensations when the ELF frequency was between 6 and 7 Hertz. The verbatim responses in this range were "ringing" in the ears, "flushed" face, "fatigued", "tightening" in the chest and "increasing" pulse.

Lock-on occurred at lower frequencies more often when the transmitted frequencies were progressively lowered, rather than randomly presented. It would seem that the brain prefers a gradual lowering of frequency rather than
a sudden or abrupt change in frequency. This may have been due to the extremely short duration of each transmission (10 seconds). It may be that this effect would disappear if longer transmission times were used.

There was no significant correlation between subjects reported level of relaxation and the ELF frequency or the occurrence of lock-on. Again, this may have been due to the extremely short duration of each transmission.

**Summary**

It is clear from these experiments that brain waves do in fact lock on to artificially produced ELFs in the 6 - 10 Hertz range. It is equally clear that the 10 second transmission was not sufficient to alter subjects moods to any consistent degree.