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Persistent Improvements in the Quantitative Electroencephalographic (QEEG) Profile of a Patient Diagnosed With Toxic Encephalopathy by Weekly Application of Multifocal Magnetic Fields Generated by the QEEG of a Normal Person

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ABSTRACT

Quantitative electroencephalography is a primary measurement by which dysfunctional conditions can be inferred and characterized within the human cerebrum. There is an implicit assumption that anomalous spatial-temporal configurations over the surface of a patient's scalp are strongly correlated with altered cognitive behaviors or that both share a common source of variance. In this experiment a 30 year old male university student who had been diagnosed with toxic encephalopathy six years previously and who exhibited compromised concentration, focus and processing efficiency was exposed for 30 min once per week for 6 weeks to the magnetic field equivalents of another person's normal quantitative EEG patterns that had been recorded from each of 16 sensors. The specific magnetic field equivalents from each sensor had been reapplied through each of 16 solenoids placed in the same position over the patient's scalp. Within two sessions there was visually conspicuous normalization of the patient's EEG, marked reduction in the d.c. transients correlated with his distraction, and increased proficiency for scholastic performance. These results strongly suggest that applying precise spatially distributed magnetic field equivalents matched for each EEG sensor through solenoids with microTesla intensities may be able to normalize aberrant electrophysiological activity and to improve cognitive deficits. The positive changes were clearly evident according to the subject's subjective and objective performance. The calculated energy and secondary current induction from naturally patterned (EEG) magnetic fields to a global array of

solenoids were within the range that might optimally resonate with intrinsic electromagnetic properties of cerebral cortical tissue and its unifying field.

***Keywords*:** quantitative EEG; multisite cerebral magnetic field application; normalization; attention deficits; simulated consciousness; synthetic brain fields

INTRODUCTION

The electrodynamic activity of the human brain is primarily generated from the integrated potentials of approximately 25 billion neurons that constitute the cerebral cortices (Pakkenberg and Gundersen, 1997). Modern quantitative electroencephalographic (QEEG) measurements that have been traditionally derived from ~20 sensors distributed in specified positions over the scalp can be employed to describe and infer complex functions. These electrical potentials include levels of awareness, various domains of cognition, states of consciousness, and the affective (emotive) component of experiences. One critical question is can these electrical configurations be modified in a safe, positive and proficient manner when applied (to the same spatial locations as EEG sensors) as external magnetic fields that simulate normal electroencephalographic space-time patterns? Here we present evidence for the first time that weekly, 30 min exposures to the magnetic field equivalents of a normal QEEG applied to the respective 16 positions over the cerebrum of a person who exhibited QEEG-verified distracted cognition normalized his QEEG and improved his proficiency for scholastic challenges.

Several reviews have demonstrated the capacity for power frequency and symmetrical (e.g., 60 Hz sine-wave) magnetic fields within the microTesla to milliTesla range to shift the distribution of power densities within human electroencephalographic profiles (Cook et al, 2002; Carrubba and Marino, 2008). The capacity for experimentally generated, physiologically patterned magnetic fields within the 1 μT to 5 μT range applied across or over the brain to persistently modify the electrophysiological patterns of the person after two exposure sessions has also been shown experimentally. For example Baker-Price and Persinger (2003) demonstrated that ~60 min of weekly exposures for 6 weeks of patients who had sustained mild brain injuries exhibited improved (normalized) EEGs signatures. Following the 6 weekly one hour exposures there was also psychometric-verified decreases in indicators of electrical lability within the brain, diminished depression, and marked attenuation of numbers of reports of non-specific pain. Significant changes were noted after only one or two sessions.

Anninos and Tsagas (1989) had shown that extraction of the magnetoencephalographic profile of a cerebral focus associated with seizure activity in epileptic patients and shifting the phase such that a "cancellation wave" was applied as a weak magnetic field over the focus markedly diminished the incidence of seizures. The field strengths were in the order of a picoTesla (10^{-12} T). Later the remarkably innovative Sandyk (1992, 1995), employing a multiarray of custom-constructed point sources for pT magnetic fields that were applied over and around the head, reported attenuation of symptoms associated with multiple sclerosis and other EEG-evident medical disorders. Jacobson and Yamanashi (1994) provided a potential mechanism by which pT magnetic fields could be effective. There has also been a long history (see Persinger, 1988 for a review) within eastern

European countries to employ cerebral exposure to weak electromagnetic fields, pulsed within the electrophysiological (1 to 100 Hz) range through amplitude or frequency-modulated MHz or GHz fields, to treat a variety of multivariate and complex cognitive symptoms. Unfortunately these important and seminal experimental demonstrations appear to have been ignored or forgotten.

It is not likely that these effects are all "placebo" related. First the changes were persistent over several weeks and very conspicuous. Second, sham field-exposed groups did not demonstrate the effect. Third comparable effects have been measured for non-human animals. Martin et al (2004) verified that whole body exposure of rodents to physiologically patterned magnetic fields produced antinociceptive effects with a potency equivalent to 4 mg per kg of morphine. Rats in which brain damaged had been induced by lithium-pilocarpine precipitated seizures displayed abnormal nociceptive thresholds. Martin and Persinger (2005a,b) showed that permanent normalization of their flinch thresholds to heat stimuli occurred after only three, 30 min, daily whole body exposures to a physiologically patterned magnetic field that produced analgesia.

These experimental results strongly suggest that when the appropriate resonance components are contained within applied complex fields that match the target tissue, the "normalization" of disrupted tissue from damage or disease could occur relatively quickly. There is evidence that under optimal resonance-matched conditions loss of neurons from epileptic processes can be attenuated (Lagace et al, 2009) by whole body exposure to physiologically-patterned magnetic fields that simulated the conditions of long-term potentiation. The argument that microTesla fields cannot penetrate the human skull was refuted when Persinger and Saroka (2013) tested the hypothesis experimentally. There was no significant attenuation of the intensity of the magnetic fields applied across cerebral distances between skull-thickness boundaries even when they were filled with physiological saline.

Non-linear effects are not unusual in living systems. This property is well established in chemical systems. For a specific receptor sub-type only a specific concentration of the ligand or neurotransmitter produces the optimal effect. Concentrations that are either lower or higher either produce no effect or disruptive effects. Transcerebral magnetic fields (in contrast to Transcranial Magnetic Stimulations that utilize 1 Tesla strengths, a million times more intense) have been shown to be most effective when applied as physiologically-simulated temporal patterns within the microTesla range. From the perspective of energy, according to the equation:

$$J = B^2 2\mu^{-1} m^3 \qquad (1),$$

a 1 μT field would be associated with $\sim 1 \cdot 10^{-9}$ J within the human brain volume ($\sim 1.3 \cdot 10^{-3}$ m^3). Assuming about 10^{11} neurons and glial cells within the human cerebrum the energy would be equivalent to about 10^{-20} J per cell. This is the same unit of energy associated with a single action potential (Persinger, 2010). An average time constant of a neuronal axon is in the order of 100 ms (10 Hz). Assuming a random distribution of the occurrence of this time constant, approximately 10% of the neurons would be activated during any given 100 ms interval. This means that the energy equivalent of ~10 action potentials (10 Hz) would be available to functional microstates (Wackermann, 1999) by immersing the cerebrum within this magnitude of magnetic field. Because the cerebral cortices are ~440 cc or about one-third of the cerebral volume, a slightly stronger field could produce equivalences.

To be synchronous and congruent with the intrinsic strength of the magnetic fields that are correlated with cognition, the applied fields should generate an equivalent magnitude within the cerebral volume. Magnetoencephalographic measurements (Pantev, et al, 1991) indicate that a median value for the average magnetic field strength (tens to hundreds of femtoTesla per Hz) from the cerebrum during processing approaches 10^{-12} T when distributed across the typical frequency bands. From a different perspective Naeije et al (2016) measured about 50 fT per cm during somatosensory stimulation which would be equivalent across the averaged 11 cm of the three cerebral axes to be ~0.5 pT. Applying:

$$V = dB \cdot dt^{-1} m^2 \qquad (2)$$

for a 1 μT (dB) field with a median variation of dt as 20 Hz (the midlevel between the major power range of 1 to 40 Hz for most cerebral activities), the potential difference over the cross sectional area of the cerebrum (10^{-2} m^2) would be $5 \cdot 10^{-7}$ V. Divided by the resistivity of intracellular fluid, 2 Ω·m, the current would be $1 \cdot 10^{-5}$ $A \cdot m^{-1}$. Across the averaged depth (3 mm) of the cerebral cortices (the primary source of the EEG) this would be equivalent to a current (I) about $3 \cdot 10^{-8}$ A.

The secondary magnetic field associated with a current of this magnitude within the tissue might be described by:

$$B = I\mu (2\pi r)^{-1} \qquad (3),$$

where μ is magnetic permeability ($4\pi \cdot 10^{-7}$ $N \cdot A^{-2}$) . If the radial shell (the cortices) is 3 mm, then the resulting magnetic field strength would be in the order of 10^{-12} T. This means that the derivative secondary magnetic field generated within the cerebrum from the initially applied magnetic field that produces an electric field (potential difference) within that volume would converge with not only the natural field strength of the cerebrum but with the effective intensities reported by Anninos and Tsagas (1989) that produced normalization of electroencephalographic activity.

METHODS

Subject

The volunteer was a 30 year old man. He exhibited a gradual onset of a debilitating disorder that began when he was 16 years old. He was diagnosed with toxic encephalopathy at age 24 years that was a consequence of arsenic poisoning and organophosphate exposures. At the time of the experiment he was enrolled as a part-time university student. His cognitive impairments were diagnosed broadly as "frontal lobe-like syndrome" typified by difficulties with concentration, speed of processing, multitasking and memory. He was not fully ambulatory.

The EM-16 Device

The device was a collection of peripherals that allowed the simultaneous presentation of up to 16 unique patterns through 16 different channels. The device was modeled after a

commercial unit (the Shakti) originally designed by Professor Todd Murphy. Essentially 16x16-bit USB soundcards functioned as digital-to-analog devices that appropriately applied AC-coupled signals generated by computer software. More complex signals that employ DC components (such as square waves) were less accurately presented as spike trains. All 16 sound cards were connected to a 16-port USB hub that was powered by the 5V supply of the computer USB output as well as an external 5 volts supplied by the power mains to ensure enough power was delivered to all the soundcards. Instead of headphones, 16 separate pick-up coils (plugged individually into appropriate headphone input jacks on the soundcards) were used to generate the individual magnetic fields with intensities in the order of 1-7 microTesla depending upon the volume of the soundcard. The actual device and its arrangement are shown in Figure 1.

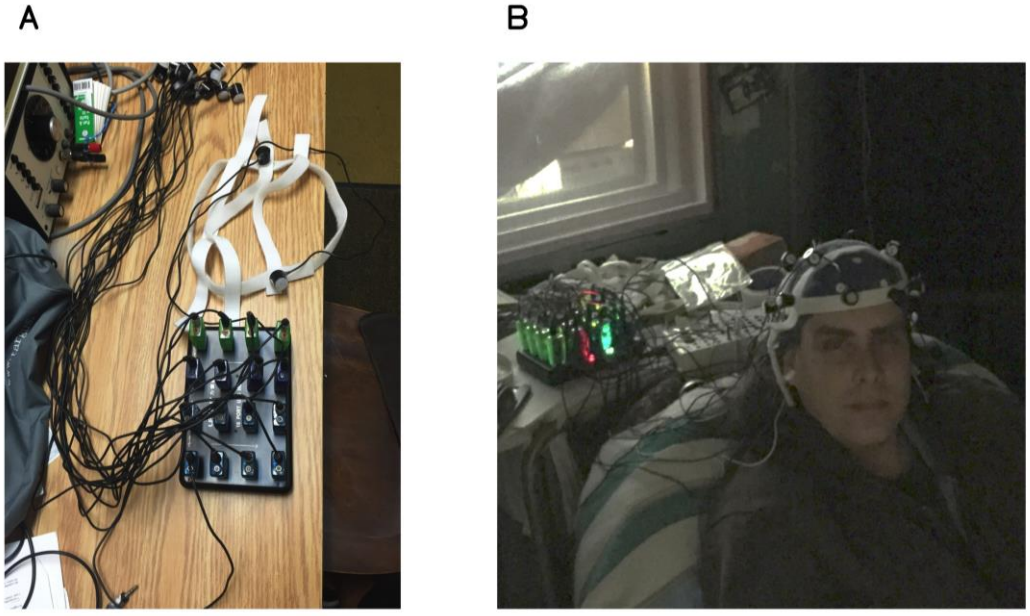

Figure 1. A) the basic circuitry and 16 source board for the magnetic field array. Each source generated the magnetic field equivalent of the EEG activity for the same specific sensor location on the scalp. This "magnetic field equivalent" of the electrical activity from each EEG sensor was applied to the volunteer (B).

Software

The device utilized commercial software (Combiwave), which was originally intended to function as a cueing platform for DJs. Instead, 16 separate channels were configured for simultaneous playback of patterns. Each channel was prescribed a soundcard device from the 16-port USB hub and all channels were cued simultaneously during EM field applications.

Patterns

Because each of the 16 soundcards were AC-coupled devices, electroencephalographic activity (which is a manifestation of the AC component of the electric field) was presented with a moderately high degree of fidelity and was comparable to

the original recordings obtained from the quantitative electroencephalograph. Figure 2a shows a comparison of the original pattern recorded with the QEEG (right occipital O2 sensor) and the equivalent pattern when delivered to a pick-up coil and measured with a separate pick-up coil connected to a separate soundcard.

The correlation (Pearson r) between the two signals, when lag-corrected for direct comparison, was about .68 (Figure 2b). However, this was only an approximation that may be a reflection of the frequency-responses of the output and input soundcards and/or the coils used for measurement rather than the actual induced magnetic field. For more detailed analysis, spectral analyses were completed on the two signals. Both are depicted in Figure 2c between 1.5 and 30 Hz (both datasets were filtered between 1.5 and 30 Hz). To best approximate the electric field landscape from scalp EEG recordings, 16 channels of approximately equal distance were employed. This included the following 10-20 locations: Fp1/Fp2, F7/F8, F3/F4, T3/T4, C3/C4, T5/T6, P3/P4 and O1/O2.

The original data, recorded with a Mitsar-201 EEG system (sample rate 250 Hz) and WinEEG software, were exported into MATLAB software. All voltages (with ranges between 5 μV and 50 μV) were rescaled between -.8 and .8; these amplitude ranges were chosen to eliminate clipping of the original recording and to preserve signal fidelity (if rescaling occurs such that |amplitude|>1, fidelity is lost. Each individual channel was then exported as its own *.WAV audio file from MATLAB software. These files were subsequently imported into Combiwave for simultaneous presentation.

Procedure

A simple 6-week experiment was designed for first-use and trial testing of the device. The experiment consisted of 1) a pre-experiment eyes closed baseline (5 minutes), 2) a 30-minute exposure to the electroencephalographic profile of another individual, and 3) a post-exposure eyes closed baseline (5-minutes). The experiment was repeated once per-week over the course of 6 weeks.

All brain activity from the exposed subject (the patient) was recorded with a Mitsar-201 EEG amplifier equipped with WinEEG software for data recording. A 45-75 Hz notch filter was applied to minimize 60-Hz power mains artifacts. Brain activity was measured from 19 sensors (Electro-Cap International) placed in accordance with the 10-20 International Standard of Electrode Placement. Each coil from the EM-16 device was placed over the homologous sensor for the 16 sensors stated above. Initial testing indicated that induction effects that might be produced by the coils interacting with the EEG sensors were not obvious. The absence of artifacts in QEEG power spectra during application of < 5 microTesla (μT) magnetic fields with complex temporal patterns has been shown by Saroka and Persinger (2013).

The original EEG from the source person is depicted in Figure 3. This is a normal profile as indicated by the synchronization of the caudal regions (occipital, temporal, parietal lobes) and alpha rhythms. There were no electrical transients. The source EEG was obtained from a healthy ~30 year old man who had obtained his Ph.D. in a science-related field and who is an accomplished musician. This record (Figure 3) is also typical of the “normal” EEG according to traditional criteria.

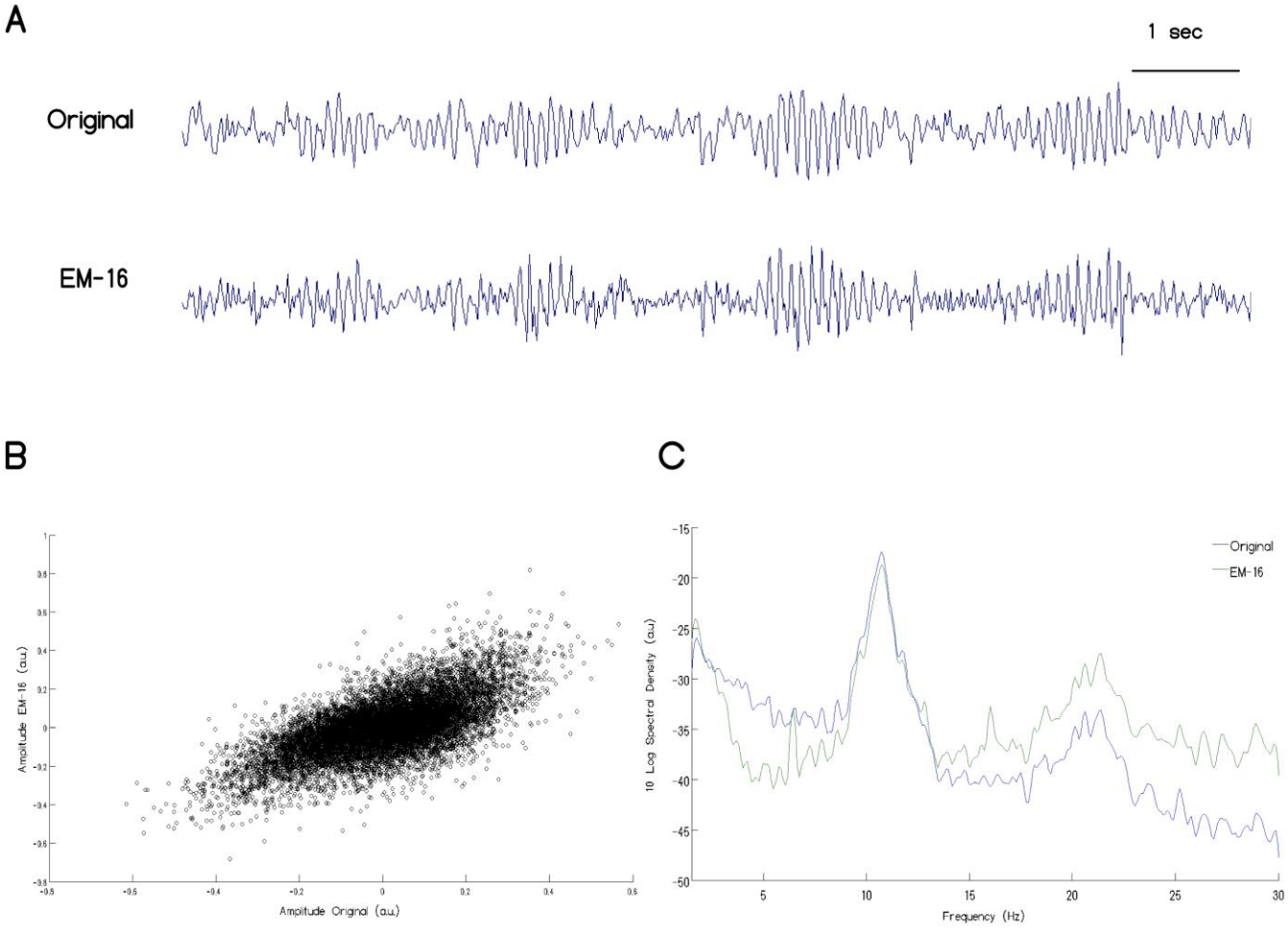

Figure 2. A) Sample fidelity between the original electroencephalographic pattern from one sensor and the magnetic field pattern that was measured when the original EEG was applied through the EM-16 solenoid apposed to the subject's scalp. B) The correlation between incremental power values between the original EEG and the applied EEG. C) Log base 10 of the spectral density for the original EEG and the magnetic field simulation (EM-16) in blue.

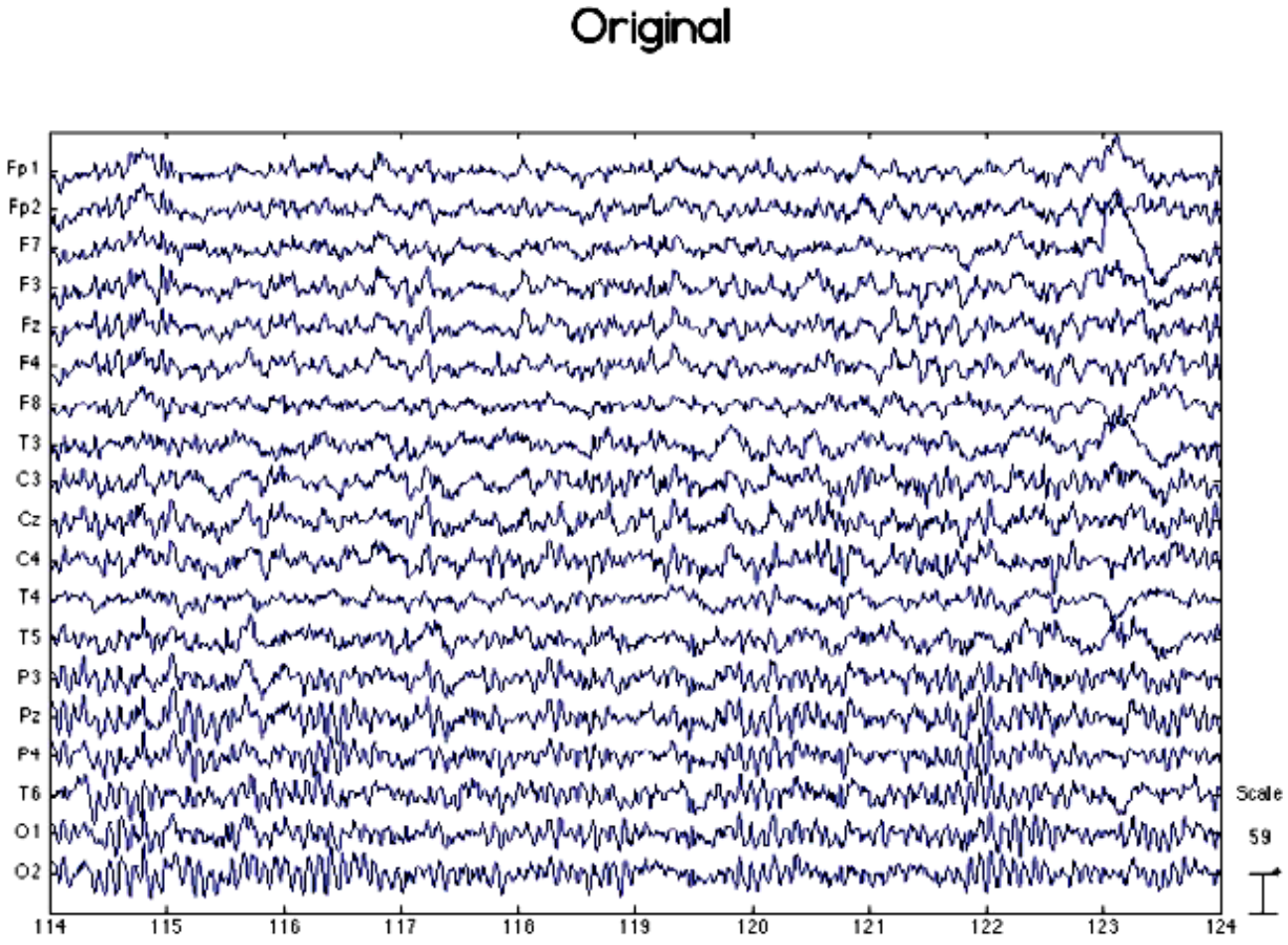

Figure 3. A component of the original QEEG from the source subject that was transformed to magnetic field stimuli and applied over the scalp of the patient such that pattern for each of the individual 16 solenoids matched the pattern of the specific sensor. Horizontal axis indicates 1 s increments. Vertical axis reflects the international positions of sensors. F (frontal), T (temporal), P (parietal), O (occipital), C (central). Odd numbers refer to the left hemisphere; even numbers refer to the right hemisphere.

RESULTS

Sample 10 s panels from the subject's real time EEG before, during and after the 30 min exposures to the source magnetic EEG pattern were extracted for each of the six weeks. Because the changes were evident over this period, only week 1, 3, and 5 are presented here. The ten second panels for baseline (no treatment initiated) for the first, third and firth weeks of exposure are shown in Figure 4. A cursory inspection of the data indicated a potentiation of synchronous alpha activity that was not observed in earlier recordings of the subject. In general, the potentiation increased as a function of time in weeks. Because one week elapsed since the previous exposure, the shift would be consistent with the property of persistence.

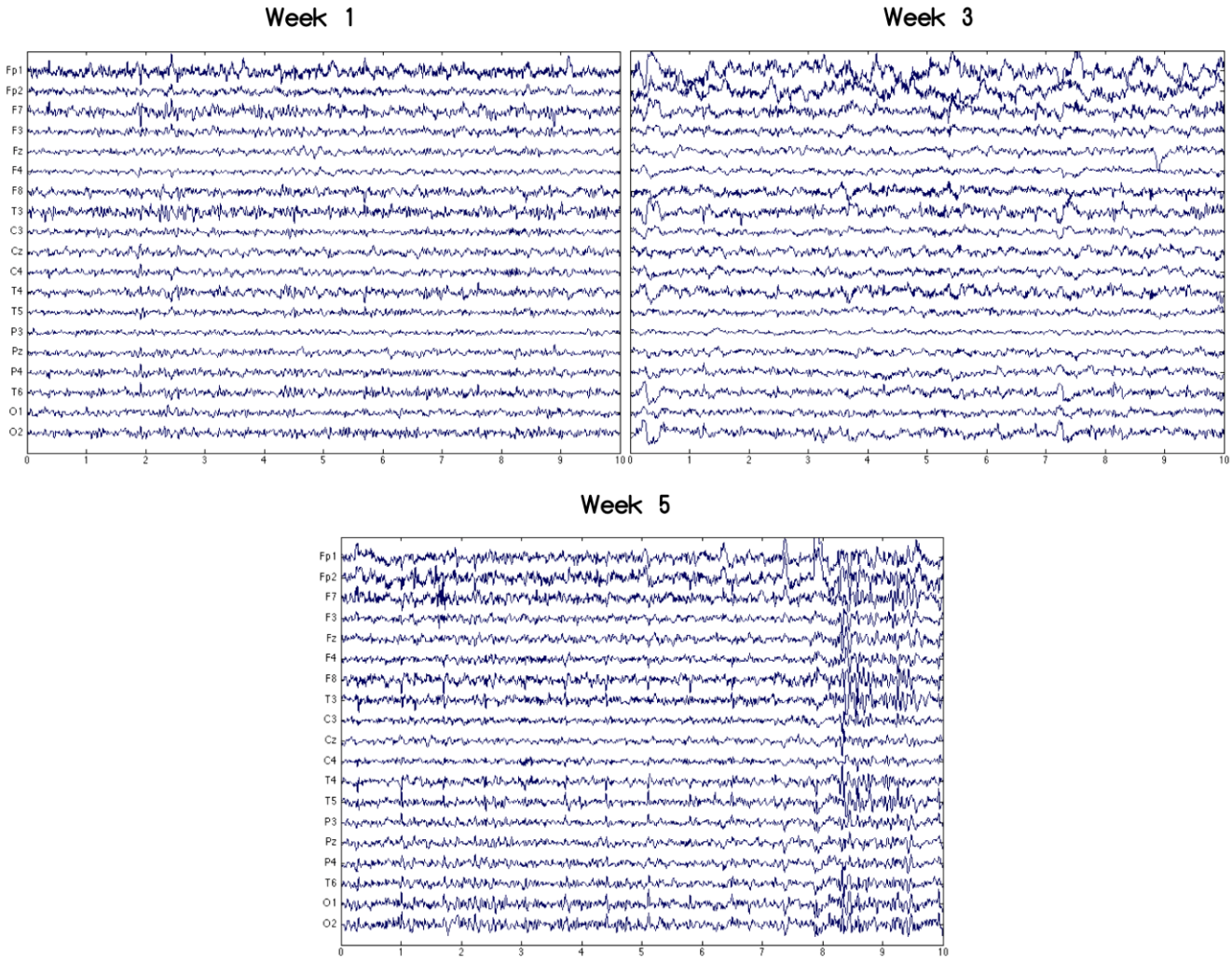

Figure 4. Pre-baseline for week 1 (before treatment) week 3 (two treatments) and weak 5 (four treatments). These pre-baselines reflect the residual effects of previous treatments.

Figure 5 shows 10 s panels of the subject's EEG activity during the exposure to the magnetic configuration of the source person's QEEG. The emergence of normalized bursts of alpha rhythm and alpha-power patterns is evident during the first treatment and increase visually over time.

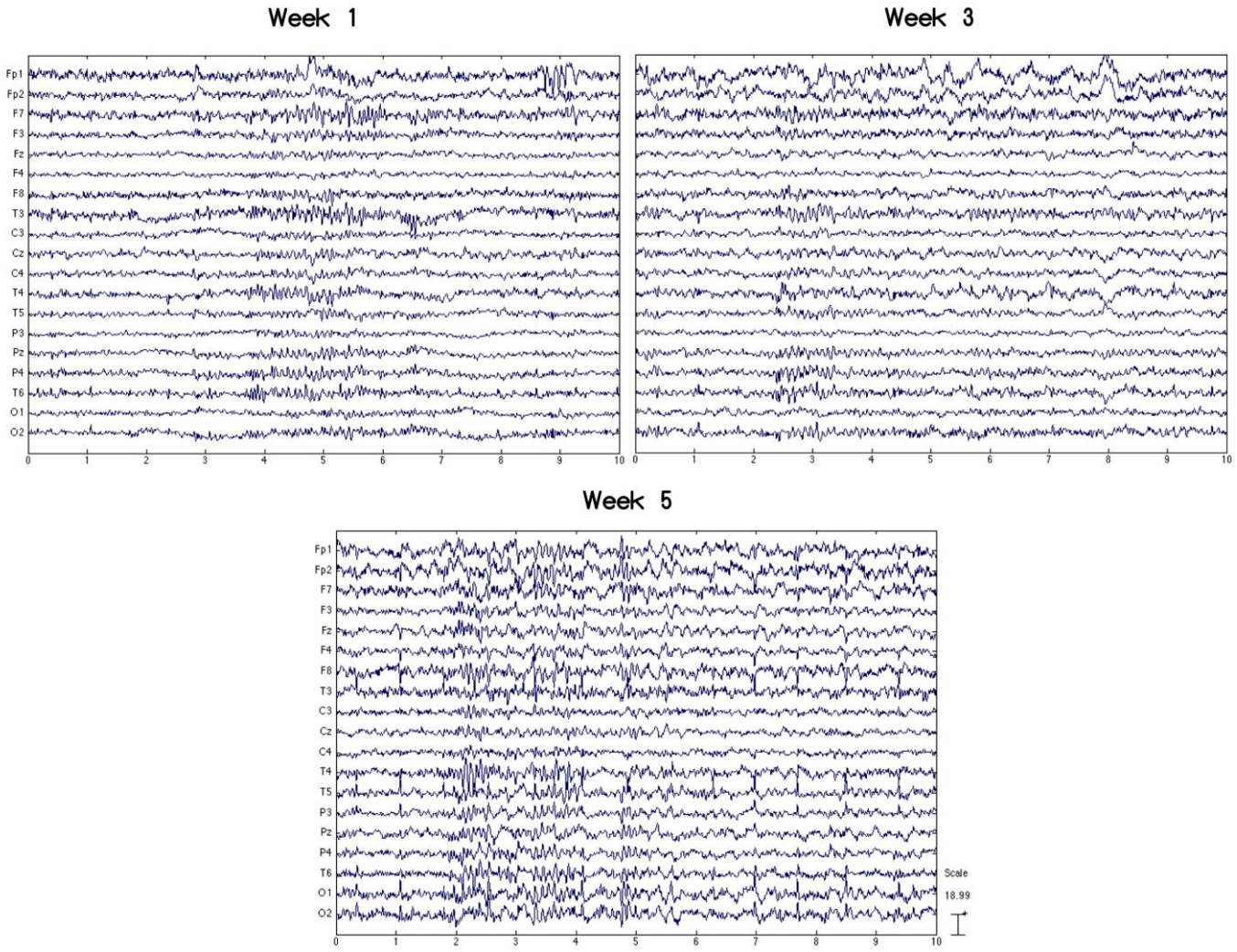

Figure 5. Activity across the 19 sensor placements during the exposure for the 1st, 3rd, and 5th weeks. Note the increased synchronization across channels by week 5.

The 10 s panels of EEG activity for the post-exposure period as a function of weeks of exposure to the magnetic field equivalents of the source brain's EEG are shown in Figure 6. The anomalous patterns noted after the first trial were not present during the 3rd and 5th weeks. Note that the increased normal synchronization across sensors was conspicuous following the field exposure during week 5.

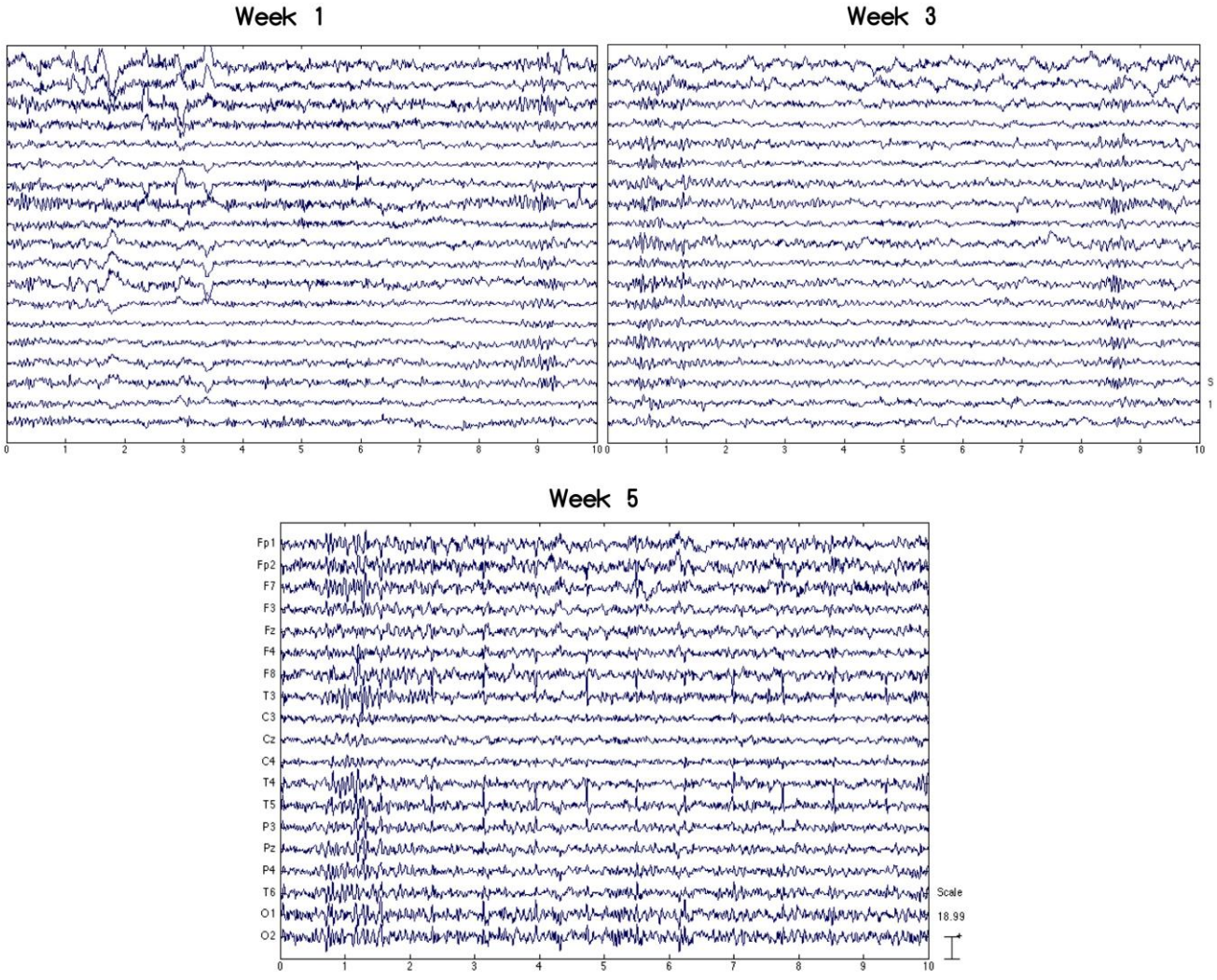

Figure 6. Post-baseline (immediately after the exposure) activity across all EEG channels after the first (week 1), third and fifth treatments. During the first week there was no conspicuous persistence following removal of the EEG magnetic field. On the other hand the continuance of the field pattern even after the applied EEG field was stopped became evident for the third week and was conspicous by week 5.

One of the most clear features of this subject's baseline EEG profile were the persistent but intermittent displays of "d.c." shifts or transients. These large excursions are sufficient to disrupt the necessary integration of the cerebral field that is optimal for comprehension, focus, and protracted concentration. Figure 7 shows three baselines for this patient obtained over two months before the treatment began. After the first 30 min of exposure to the configuration of magnetic field EEQ equivalents the transients were significantly reduced. The enhanced value for the baseline just before the experiment began coincided with a period of substantial cognitive distraction (compared to previous weeks) and may have been the contributing factor for his decision to volunteer for the experiment. In fact

after the mild overshoot (which is found in pharmacological treatments as well) during the second week, the numbers of disruptive "d.c." shifts were reduced and stable.

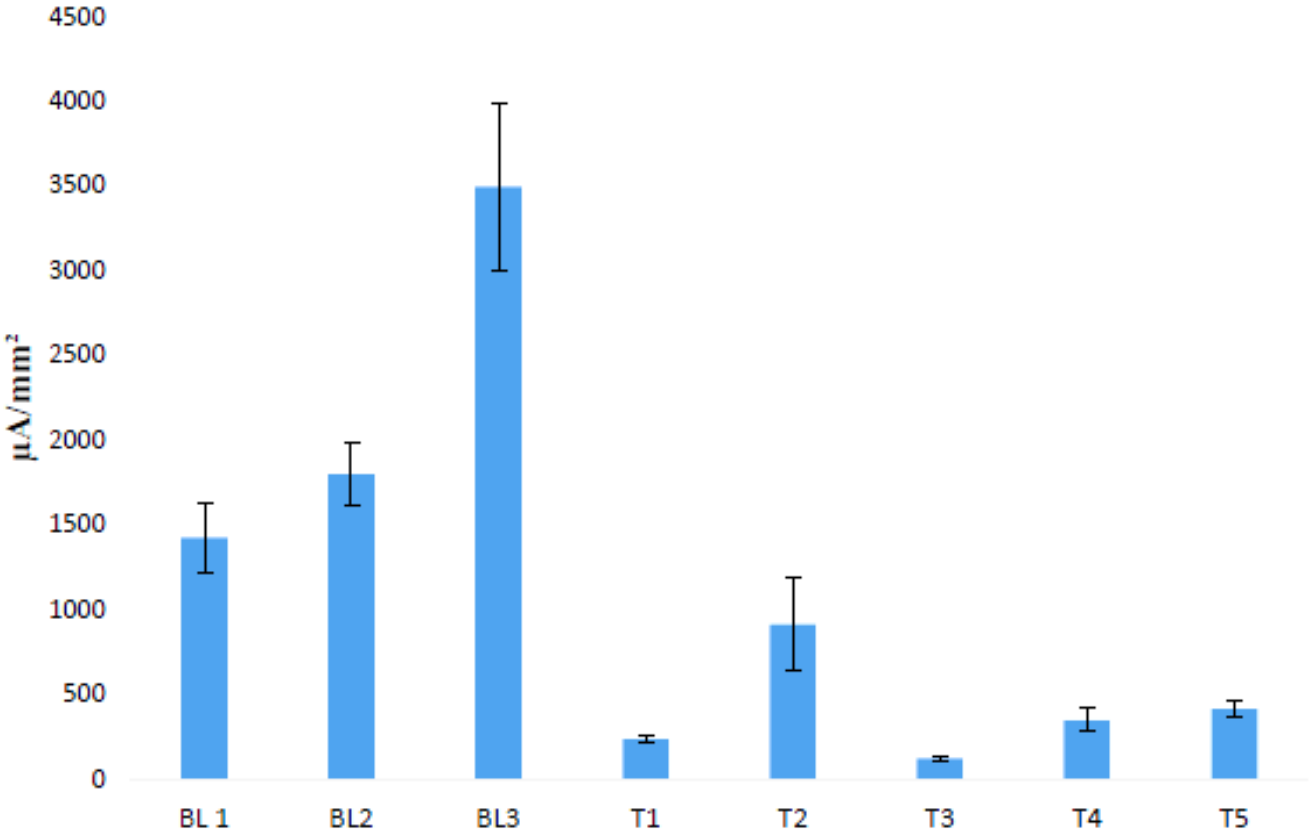

Figure 7. Current density from sLORETA images of the subject's cerebrum for sharp d.c. transients that were correlated with his disrupted concentration during reading. BL3 refers to the baseline when his distraction was particularly notable just before the first exposure to a normal person's "brain wave" patterns. BL2 and BL1 were previous baselines completed on two separate weeks. T refers to trial. Note that after only one 30 min exposure there was a significant diminishment of the current density associated with d.c. transients that did not return to baseline levels over 6 weeks of weekly exposures.

Subjective Experiences

Following each weekly 30 min exposure and during the subsequent week the subject recorded any novel experiences. During the first exposure (T1) the theme of the reported experiences was an increased sense of three-dimensional space, central focus, a sense of stillness, increased awareness, and a greater command over cognitive faculties. During the subsequent week (before the second exposure), he experienced a greater duration between being "asleep" and waking up from sleep. There was a sense of "increased processing". During the second exposure he reported "one of the most wonderful experiences I have had since the toxic exposure". There was a facilitation of the processing and thinking ability that he had been diminished since the injury.

During the third exposure deepened hypnogogic images were experienced. The dominant color was green. The images were lucid and strikingly clear. His response during the fourth exposure was a sense like "thought flowed in an extremely easy stream of consciousness". Visual experiences such as flowing colors, forms, lights and blobs appeared to display linguistic properties. The two central experiences during the fifth exposure were increased processing speed and the sensation that his inner world was no longer "paralyzed". Although potentially spurious it may be relevant that is mid-term examination grade score was 43% while his second examination given after the treatments was 90%.

DISCUSSION AND CONCLUSIONS

There are two methods to open a door. One can kick it open with destructive force or insert the correct key that involves very small quantities of rotational energy and produce the same results without breaking the mechanism. One of the most conspicuous principles that have emerged within the domain of interactions between applied magnetic fields and the responses of organisms to those fields is that resonance or temporal congruence is a significant variable. It may operate upon a single ion (such as Ca^{2+}), through a Liboff-type process or as a complex topographical point-to-point intercalation analogous to the resonance (e.g., Alfven waves) that can occur between the interplanetary magnetic fields and the geomagnetic dipole field. In a manner analogous to the "lock and key" specificity of interactions between ligands and receptors in chemical systems, the more similar the temporal configuration of the applied magnetic field is to the temporal configurations that define the organ or its constituents the less energy is required to produce the major effects.

During optimal coupling the energy between the applied and tissue fields might behave as a functional "homogenate" through which information as temporal or "spatial resonance" energies ($\sim 10^{-21}$ J per bit) can diffuse. This narrow band intercalation that includes both amplitude and temporal patterns should be most effective when the applied field's characteristics reflect the original stable state of the system before any aberrant deviations occurred. Our working model is that this "homogenate" condition determines the type and the direction of the physical molecular mechanism that reconstitutes the aggregate of the cells (the organ) to a previously genetically-determined normal state.

In general time-varying magnetic fields with sine-wave and symmetrical temporal structures require mT or higher intensities to be effective in most tissues. As the temporal configuration of the applied magnetic fields approach the characteristics of the natural electromagnetic variation within the tissue less intensity is required to be effective. We had reasoned that the most optimal physiologically-patterned magnetic fields would be the configurations that *are* the electroencephalographic configurations generated by the normal (default) human brain. The results of the present study demonstrated the generation of a normal EEG pattern as a complex, spatial-temporal magnetic field applied in specific locations over the scalp not only influenced the activity of the brain but began to normalize anomalous activity.

Previous experiments (Persinger et al 1997) had shown that a tandem sequence of different patterns of weak magnetic fields applied across the temporal lobes of subjects resulted in conspicuous "driving" of electroencephalographic activity. The serial complexity of the patterns was required to produce the congruence of the electrophysiological activity

with the applied fields. The redundant presentation of symmetrical patterns of a single magnetic field did not produce this effect unless the cerebral state simulated the electrical lability of complex partial epilepsy where myriads of neurons can be recruited into coherent activity (Dobson et al, 2000).

Coercive field strengths with homogeneous frequencies and patterns (such as 60 Hz) are not conducive to the types of interactions that would adjust cell activity unless the intensities were substantial. This would be more analogous to "kicking in the door". Tissue is more likely to habituate to their presence quickly. According to one general relationship: $T_H = IRT^2\ R_t^{-1}$, where IRT is the interresponse time and R_t is the duration of the response (Persinger, 1979). It is a first estimate of the inflection point for habituation (T_H) to a protracted and repeated stimulus. A 60 Hz sine wave would approach that value within less than 20 ms or within a duration that is less than the typical time constant of an average axonal membrane (~100 ms or 10 Hz) or a microstate (Wackermann, 1999). Consequently temporal integrations across the temporal units will be less likely to occur.

On the other hand an asymmetrically, physiologically-patterned frequency modulated pulse composed of 859 distinct frequency or phase modulated points that produced the analgesia in the Martin et al (2004) experiments when each point duration was 3 ms would only begin to exhibit habituation after about 30 min. The quantified EEG pattern could display a similar complex structure. This is within the duration required to produce changes within the electroencephalogram as well as analgesia. From our perspective the "signal source" with the greatest potential for non-habituation (and hence maximum effect) should be the natural spatial-temporal patterns of human brain activity. Our results support this assumption.

The gradual shift towards normalization of the subject's general EEG pattern across the cerebral surface progressed over the six weekly sessions. The diminishment of the d.c. shifts that were correlated with distraction and diminished cognitive concentration attenuated after only 30 min of exposure to the normalized magnetic field brain pattern. Although this is a brief duration the chemical consequences can be permanent. Su et al (2002) found that after the first electrical seizure following systemic injections of lithium and pilocarpine in rats there was a permanent shift in the proportion of T-type calcium channels within the plasma membrane of hippocampal cells. Goodman et al (1983) were one of the first research groups to demonstrate that pulsed (single or trains) magnetic fields increased the specific activity of messenger RNA within 15 to 45 min. Stated alternatively only about 30 min was required to induce cellular transcription.

There are two implications that a specific generation of magnetic field equivalents from 16 positions of electroencephalographic activity from a normal person's scalp to the same 16 positions over the patient's head shifted the latter's activity to be more similar to the applied field. First, the etiology that produced the aberrant EEG activity was attributed to a diffuse toxic incident that may have disrupted the integrity of the whole brain's function as a unified field. If this field is analogous to a hologram (Di Base, 2009) involving light, then the duration required to saturate that field might be derived from the average output of photons per cell. There are multiple experiments that indicate living cells emit photons with power densities in the order of 10^{-12} $W \cdot m^{-2}$ (Dotta et al, 2014) and that photons may mediate primary cell-cell interactions (Trushin, 2003; Fels, 2009) For a typical neuronal soma with a diameter of 10 μm the cross-sectional area is $\pi \cdot 10^{-12}$ m^2 which results in about $3 \cdot 10^{-22}$ J per second. A central value of the energy for photons within the visible range emitted from the

cell is $5 \cdot 10^{-19}$ J. When the former value is divided the duration required to saturate or to utilize this energy is about 30 min.

In other words about 30 min would be required for the light energy per s from each soma in the field to match the energy of the single photons that integrate the photonic field within which all of the cells are immersed. At this point, like a hologram, all the matter that constitutes neurons would be influenced by the properties of the photonic field (Di Base, 2009). Persinger (2016) has suggested that the evolution of living systems over the last ~3 billions years as particulate substrates of heredity (DNA) occurred in a parallel manner with the accumulation and transformation of solar photons into biomass. In fact the current estimated biomass on the earth is the same order of magnitude as the energy equivalent of the total accumulated flux density as inferred from the solar constant. The major consequence of this photonic source to biological matter is that each cell should emit a small quantity of those "stored" photons. A similar idea had been developed by Popp (1979). These "virtual photons" could reflect the stable structure and prototypical set point of the cellular system and serve as primary sources of intercellular communication.

Although synaptic patterns are considered the dominant, functional infrastructure of the web of patterns that are the complex geometries and spaces containing the emergent properties that allow concentration, memory, and general cognition, the "blue print" that maintains this structure may involve photons. In his original and brilliant ideas about this possibility, Bokkon (2005) and Bokkon et al (2010) suggested that "dreaming" (a state during which there is copious protein synthesis and memory consolidation) may involve the actual awareness of a photon field within the visual cortices. Other researchers have suggested that the photons emitted from cells contain information that controls the formation of the microstructural changes in synaptic patterns. They are considered by many neuroscientists to be the structural "pathway" by which memories are formed and maintained (Persinger et al, 2015).

Dotta et al (2012) demonstrated that when human volunteers sat within a hyper-dark (10^{-12} $W \cdot m^{-2}$) room and imagined white light there was a significant increase in photon flux densities emitted from their right hemispheres. Persinger et al (2013) showed experimentally that photons introduced into the caudal region of the heads of volunteers were associated with an incremental increase in photon flux density from the frontal region. The latency of this response (about 1 s) was consistent with a mechanism whereby photonic energy was transmitted through Grotthuss chains of proton-proton movements associated with the hydronium ions of the water within the cerebral volume. A similar latency for the detection of photons from one side of the head when light was applied to the other side of the head reflected the smaller distance of traversal. All of these results support the model that photonic energy traverses the neuronal networks within the cerebrum.

If the electrodynamics that create the integrated manifold of the cerebrum's cognitive field involve the transcerebrally-integrated states described by Lllinas and Pare (1991) and contribute to the unity of consciousness (Kahn et al, 1997) through an electromagnetic field (McFadden, 2007) then a holographic process might operate. Affecting the whole field should influence all of the components which would involve the billions of neurons and glial cells that comprise the synaptodendritic web within which the processes associated with conscious awareness have been hypothesized to occur (Pribram and Meade, 1999). Applications of spatial and temporal homogeneous magnetic fields would not be expected to affect the

qualitative properties of the holographic pattern and might be represented as a variant of "noise".

The effects of applications of one or two focal magnetic fields might be compensated by alterations in other regions of the holographic pattern thus producing small or negligible effects. However the simultaneous application of 16 different focal presentations around the cerebral volume from which the field is generated could, in principle, have the capacity to change the qualitative properties of the holographic field (Persinger et al, 2010) because the conditions for whole (cerebral) field resonance would be more probable. Like the interaction between the earth's magnetic field dipole and the dynamically interacting interplanetary magnetic field ("the solar wind") the consequences of the different magnetic fields from the array superimposed upon the patient's cerebral electromagnetic configurations would be more typical of a field-field interaction that promotes entanglement and connections between the two sources of flux lines.

The energy within the cerebral volume from the pervasive ~10^{-6} T magnetic fields from the 16 different patterns according to equation (1) would have been in the order of 10^{-9} Joules. The equivalence between energy ($kg \cdot m^2 \cdot s^{-2}$) and magnetic field strength ($kg \cdot A^{-1} \cdot s^{-2}$) requires the multiplication of the latter by $A \cdot m^2$ or magnetic moment. For the two to approach equality, the value for $A \cdot m^2$ should be ~10^{-3}. According to the calculations by Vares et al (2016) the magnetic dipole strength of the human cerebrum is ~$0.2 \cdot 10^{-3}$ $A \cdot m^2$. This suggests that the patterned magnetocephalographic applications of another person's position-specific "brain waves" over 16 different sensor locations might have interacted with the magnetic dipole field of the patient's brain to match the energy that was available through the cerebral volume.

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