Original Article

Enhanced Power within a Predicted Narrow Band of Theta Activity During Stimulation of Another By Circumcerebral Weak Magnetic Fields After Weekly Spatial Proximity: Evidence for Macroscopic Quantum Entanglement?

Michael A Persinger, Eric W Tsang, J Nicholas Booth, and Stanley A Koren

Abstract

We tested if "entanglement" could be demonstrated between two non-sibling brains with only a history of spatial proximity if one brain was exposed to a consciousness-structured, continuously accelerating, circumcerebral magnetic field to access this connection. Four pairs of strangers met and remained within one meter of each other for one hour, twice per week, for four weeks. After this period the brain of the stimulus person of the pair, who was seated in a closed chamber, was exposed successively to six (5 min each) different complex circumcerebral magnetic fields that were rotated counterclockwise. Quantitative monopolar electroencephalographic measurements over the frontal, temporal, parietal, and occipital lobes were collected by computer for the response person of the pair who was seated in another room. The predicted increase in electroencephalographic power within the 5.0 Hz to 5.9 Hz band over the temporal lobes (but none of the other lobes), similar to that observed previously for siblings, was noted for the response persons when the stimulus persons received frequency modulated, circumcerebral magnetic fields at 20 msec rates of change per solenoid. The response persons also reported unusually intense "sensed presences", anger, and sexual arousal during these periods.

Key Words: entanglement; magnetic field; consciousness; theta activity, quantum neuroscience

NeuroQuantology 2008; 1: 7-21

Introduction

Bokkon (2005), Eccles (1992), Jibu and Yasue (1995), Penrose (1994), and Persinger and Koren (2007) have suggested that consciousness may be a result of neuroquantum interactions, that is coupling between the classical and quantum worlds. These recent developments are continuities of the ideas of Schrodinger (1944), Jung and Pauli (1955), Bohm (1986), Eccles (1986) and Hameroff (1987). If this assumption is valid, then two important possibilities must be considered. First every particle (mass) within the brain is associated with a wave propagating through its space as described by de Broglie (1962). Secondly, the aggregate of particles that composes the brain exhibits a macroscopic wave function operating within a collective mode similar to that described by Schrodinger (1978) for

Corresponding author: M.A. Persinger
Address: Behavioral Neuroscience and Biomolecular Programs, Consciousness Research Laboratory, Laurentian University, Sudbury Ontario,Canada
Phone: 01-705-675-4824
e-mail: mpersinger@laurentian.ca

the propagation of a wave of the matter field.

The former, de Broglie's matter waves, are the phase waves of the matter field associated with the motions of quanta as they spread over the whole of space. The latter application, from Schrodinger, would indicate that the second derivative of location, that is acceleration, might allow access to space-time rather than simply space. From this perspective energy is related to the geometry (the angles of the infinite points of space) and the rate of change in time, that is the time derivative multiplied by Planck's constant (Jibu and Yasue, 1995). This assumption would predict that access to the extent of the continuum of space-time would require a very specific value for phase space that is related to the derivative of time or acceleration.

That a second derivative may be the pre-requisite to the emergent property of consciousness has been suggested by Edelman (1989) and has maintained the interest in the "40 Hz" coherence waves and the metaphor that consciousness is not continuous but quantal recreations within the 10 to 25 msec ranges. In fact Llinas and Pare (1991) and Llinas and Ribary (1993) have measured coherent 40 Hz oscillations that characterize dreams and waking periods as well as a phase-modulation that occurs over the cerebral cortical manifold. The occurrence of phase modulation as a reservoir of information allows inordinately large degrees of freedom.

Even the partial validity of quantum principles applied to brain space would allow the possibility of entanglement (Einstein, et al., 1935) between two brains because a system of particles requires the principle of superimposition. It indicates that a new state of a system may be composed from two or more states such that the new state shares some of the properties of each of the combined states (Aczel, 2002). One consequence of a system (two brains) interfering with itself is that a change in the state of one brain should be associated with a simultaneous change in the state of the other brain.

The first example of entanglement in particles involved the photons emitted from the conversion of the positronium atom (one positron and one electron) into two photons with identical energies but opposite polarities. The change in the polarity of one photon, even when separated from the other by a factor of a million wavelengths, resulted in a symmetrical change in the other member of the pair. Recently Xu et al (2005) demonstrated entanglement in a macroscopic superconducting circuit by coupling large Josephson junctions into resonance with the resonator. These junctions can be considered macroexamples of quantum phenomena and share similarities with the narrow approximately 0.6 nm of layer of charge adjacent to neuronal membranes that define their steady potential.

The existence of entanglement between brains would require the consideration of nonlocality. It has been described by Cramer (1997) as an enforced correlation between separated parts of a quantum system that are outside of the boundaries of light velocity across space and time to ensure the parts of the system maintain equilibrium. We hypothesized that for two brains (which might be considered large aggregates of particles that meet some of the requirements of two condensates) this connection begins with an initial spatial proximity such that a system is created. Despite the separation of distance over time resulting entanglement demands that a change in state in one brain would result in a change in the other.

Intuitively, the conditions under which two brains would access entanglement should be coupled to the fundamental derivatives of change from which consciousness emerges. These rates of rates of change have been hypothesized to be within the theta range (Persinger, 1999a), particularly between 5 Hz and 7 Hz. These values are within the range of the fundamental resonance of the cerebral volume, depending upon small variations in bulk velocity of action potentials (Nunez, 1995). "Second derivatives" from these calculations result in temporal intervals of between 10 msec and 20 msec which are the re-entrant values associated with the theoretical requirements for consciousness (Jeffreys et al., 1996). These values, as phase modulations, are also generated as cohesive waves in a rostral to caudal direction over the cerebral hemispheres during waking and dream sleep. We have shown the circumcerebral application of weak magnetic fields that might access these cohesive phase spaces (Pribram and Meade, 1999) is associated with changes in power spectra within the theta range.

In previous studies, we (Persinger et al., 2003) found that pairs of siblings showed evidence of entanglement when one of the pair's quantitative electroencephalograms was measured while the brain of the other member of the pair sitting in a closed, distant, acoustic chamber was stimulated with specific rates of circumcerebral magnetic fields. The circumcerebral magnetic fields were created by successively stimulating one of eight solenoids that were arranged in a circle (45 deg apart) around the person's head. We selected this circular geometry because a field moving in a circle is constantly accelerating. The most significant changes in the spectrum within the "response" sibling's brain occurred within the 5 to 5.9 Hz interval when the rate of change of the magnetic field around the "stimulus sibling's" brain was 20 msec.

We had selected quantitative electroencephalography as our measure because in the balance of probabilities "brain waves" are not generated by the propagation of neural impulses within neural networks. Instead, as suggested by Pribram (1971), they require cooperative physical phenomena in the cerebral cortical synaptodendritic web (Pribram and Meade, 1999) or dendritic network (Pedroarena and Llinas, 1997) which is composed of large numbers of spine heads that function as electric dipoles. A phase wave of the dendritic membrane and electric potential field controls the dynamics of charged elements within boundaries of the membrane, resulting in a collective mode or condensate and the macroscopic wave function of a quantum field (Jibu and Yasue, 1995). From this perspective a Bose field from quantum domains interacting with the cortical field would be the electromagnetic field measured by QEEG (Umezawa, 1993) and connected with consciousness (McFadden, 2002).

However this "action at a distance" could have been related to a confounding factor of genetics or reinforcement history. In subsequent unpublished studies involving the same protocols we explored the possibility of the Aharonov-Bohm (1959) effect where the potentials not the fields affect the adjacent brain. If this is applied then the exposure of one person of a pair to the appropriate derivative of circumcerebral rotation would be associated with discrete changes in power within the brain activity of a second stranger and the operation of entanglement would not be required (Persinger, 1985; Persinger et al., 2002; Puthoff and Targ, 1976; Radin, 1997; Tart, 1968). Instead the effect would be more similar to the response of an electron passing outside of a cylinder containing a magnetic field inside the cylinder. The "emission" of "qigong" by practitioners of To-ate (an ancient Japanese martial art involving remote action) has been shown to produce transient contiguous increased phase correlation of alpha waves over the frontal and occipital cortices of non-aware recipients (Kawano, et al., 2000). However when four pairs of strangers, who had never met (and did not know the other person was involved with the experiment), were tested within our procedure which has been shown to affect "remote" phenomena (Koren and Persinger, 2002; Persinger et al., 2002a,b), there were no significant changes in the electroencephalographic power spectra (unpublished data).

The present experiment was designed to test the possibility that macroscopic "entanglement" between pairs of people could be displayed experimentally within the quantitative electroencephalographic activity of one brain while another brain, that only shared a history of previous spatial proximity, was receiving circumcerebral stimulation while sitting in a closed acoustic chamber. If a brief history of spatial proximity was the necessary condition for "entanglement" to occur and this could be accessed by the 20 msec derivative of change from circumcerebral activity, then the same enhancement of power within the 5.0 to 5.9 Hz band over the temporal lobes that was shown by siblings should be evident in spatially-experienced, non-siblings.

Method

Subjects

A total of 8 volunteers (4 men, 4 women) between the ages 19 and 24 years of age volunteered as subjects from a total of approximately 80 students within a first year psychology class. They were asked to remain after lecture and were told they would receive a 2% bonus mark for participation even if they did not complete the requirements of the experiments and $50 (per pair) when they did.

Procedure

The subjects were told that the experiment was about the nature of space-time entanglement and the application of quantum concepts to everyday situations. The male-female pairs of subjects were then announced and were asked if they wish to continue. All agreed. The pairs were requested to meet twice per week, for one hour each, for four consecutive weeks during November, 2002. The only required procedure for the meeting was to remain within 2 m of each other. The meetings could occur anywhere and any time, depending upon mutual convenience for the pair of subjects and the subjects could engage in discussions or even ignore each other during this period if they wished. The primary variable was spatial proximity.

At the end of the "entanglement" period, the subject pairs were requested to call the laboratory to schedule a time for the actual experiment which would involve an electroencephalographic measure or a brief exposure to circumcerebral rotating magnetic fields. The participants were told the field intensities were comparable to the values emitted by computers and that there was no scientific evidence of adverse or long-term effects from brief exposures to either these fields or to routine recording of electroencephalographic activity.

One subject (the stimulus person) was exposed to the circumcerebral magnetic fields while the EEG of the other person was taken. For all test periods, the two subjects were first shown the acoustic chamber in which one would sit and the arm chair in an adjacent room in which their associate would sit during the experiment. Eight solenoids attached to a Velcro strap were placed around the head of the stimulus person, just above the ears. This person received the circumcerebral magnetic fields by a device described previously (Cook et al., 1999). The details can be found in U.S. Patent Number 6,312,376 (6 November, 2001). This procedure was performed by the first author. At the same time, the second or third author attached silver electrodes by EC2 electrode cream to the scalp over the left and right prefrontal (F7, F8), temporal (T3, T4), parietal (P3, P4) and occipital (O1, O2) lobes (Niedermeyer & de Silva, 1987) of the response person. Both procedures required about 10 min.

Both subjects sat in comfortable arm chairs that faced south according to the direct measurements of declination by a magnetometer. Both subjects were blind folded. The characteristics of the local geomagnetic field within both the acoustic chamber (which was also a Faraday cage) where the stimulus person was sitting and the adjacent room where the response person was sitting have been reported previously (Persinger et al., 2003a).

When the circumcerebral fields were operating, the peak to peak changes in the static field within the center of the circumference around which the eight solenoids was attached ranged between 100 and 250 nT. According to a Metex N380 power meter the maximum strength of the higher frequencies was 1.5 microT within 1 cm (inward) from the perimeter and a more homogeneous 500 nT at the center. The field strengths in the center perpendicular to the plane along which the solenoids were arranged varied between 200 and 800 nT. When the circumcerebral fields were not operating the background values were below 20 nT.

Before the experiment began, the stimulus person, to whom the fields were delivered, was told to imagine being in the other room with their partner and to imagine touching him or her. This procedure was identical to that given pairs of siblings in our previous study (Persinger et al., 2003). After verification that the magnetic field equipment was functioning by direct measurement of the presence of the fields around the stimulus person and the electroencephalographic measurements were determined to be artifact free from the response person, the experiment began.

Each stimulus person received the same six separate patterns of 5 min each that had been employed in other studies (Richards et al., 2002), in a counterclockwise direction around the head. We employed only the counterclockwise direction because in previous studies it had been shown to evoke the greatest effect on subjective time experience (Cook et al., 1999) and electroencephalographic activity (Richards et al., 2002). The specific parameters for these six patterns are shown again in Table 1. Half of the stimulus persons received the six patterns in the order from left to right; the other half of the stimulus persons received the six patterns in the reversed order. The activation of each pattern was controlled by a single batch file so that once the experiment had begun there was no further requirement to program the computer controlling the experiment.

Table 1. Field parameters employed during application of counter clockwise circumcerebral magnetic fields.

Pulse Type	Burst-Firing			Frequency-Modulated		
Phase	1	2	3	1	2	3
Point Duration	1	1	3	1	2	3
Interstimulus Interval	1	2	3000	1	1	3000
Duration Field	20	100	200	20	100	200
Change in field	+2	+20	-2	-2	+20	-2

During the experiment, the response person's electroencephalographic activity was continuously recorded on paper by a Grass Instruments Model 8-16C machine. The filter selections for each channel were set for the standard range between 0.5 Hz and 35 Hz. At exactly 2.5 min after the initiation of each (5 min) pattern, the first experimenter walked to the door of the adjacent room in which the response person (blindfolded with earplugs) was sitting and placed a sheet of paper on the table beside the computer connected to the electroencephalograph. The paper contained a number between 1 and 6 that the second experimenter, sitting beside the EEG, employed as a code for identifying the digital sample of the ongoing electroencephalographic activity of the response person.

At this time, a 20 sec sample of quantitative electroencephalographic activity was completed simultaneously from all eight leads. This Model 8-16C machine was interfaced via a custom shielded cable, a parallel analogue shielded interface cable (Nat. Inst. SH100100), and a shielded connector block (Nat. Inst. SCB-100) to a National Instruments PCI-607IE Multi I/O Board computer interface card. The data collection was extracted by a DELL Dimension 8100 Personal Computer on a Windows 2000 Professional Platform. A custom designed user interface or Virtual Instrument (VI) using National Instruments Labview (Version 6.0i-2000) allowed the multichannel sample to be manually recorded to fixed disk.

At the end of the experiment, the equipment was removed from the two subjects. Each completed an exit questionnaire. It contained 32 items requesting the incidence of common experiences reported during these episodes (Persinger, 2003a,b). They included rankings (0=never, 1=at least once, 2=several times) of the incidence of visual, vestibular, auditory, olfactory, gustatory, proprioceptive, tactile, intrusive (e.g., the sensed presence of "another" or Sentient Being), and emotional experiences (anger, fear). A final hedonistic rating for the total experience, ranging from -2 (very unpleasant) to +2 (very pleasant) with 0=neutral) was also given. The hard copies of the electroencephalographic records were shown to both subjects. The general characteristics and implications of the records were described by the first author for the benefit of the subjects.

When all of the data had been collected for the experiment, the digital electroencephalographic recordings were analyzed by the second author with a custom programmed software package for Fast Fourier Transforms. The software was compiled under Borland Pascal (version 5.5, 1986). The Fast Fourier Transform utilized three publicly available Pascal software libraries for standard mathematical functions that included the FMATH, FOURIER, and MATRICES sections from the IPMath 1998-2001 math library by Jean Debord.

The frequency spectral outputs from each lead from the four lobes of the two hemispheres for the six patterns were extracted into a single file for 1 Hz increments between 3.0 Hz to 3.9 Hz, 4.0 Hz to 4.9 Hz, 5.0 Hz to 5.9 Hz, 6.0 Hz to 6.9 Hz, 7.0 Hz to 7.9 Hz, and 8.0 Hz to 8.9 Hz in order to compare the results to the previous experiment involving siblings rather than people who had been randomly paired for eight episodes of spatial proximity. This file was then uploaded to a VAX System for analyses.

In order to accommodate individual differences, the means of the raw data for the measurements during the presentation of the six different magnetic field patterns to the stimulus person were calculated for each of the frequency increments for the electroencephalographic power recorded from the brains of the response person. The standard deviations for these six values were also calculated. Z-scores were computed with SPSS software for the standardized power values of the response person's digital electroencephalographic data when the stimulus person was being exposed to each of the six magnetic patterns. These values were calculated for each of the six, 1 Hz frequency bands, separately.

The primary experimental design for the statistical analyses was a four way, within subject factor, analyses of variance (MANOVA). The within subject factors were the four lobes, the two hemispheres, the types of pulse (burst firing vs. frequency-modulated) and the types of phase (the different configurations of time constants for both types of pulses). These four-way analyses of variance were completed separately for each of the six 1 Hz frequency bands. The simultaneous inclusion of all six frequency bands within the analyses was prevented by the limitations of SPSS software.

One way analyses of variance was employed to analyze the differences in frequency of various experiences recorded by the exit questionnaire during the experiment by the "stimulus" person and "response" person. All analysis involved a VAX computer. *Post hoc* analysis involved correlated t-tests, as well as combinations of correlated t-tests ($p<.05$). Because F and probability values do not reliably indicate how much variance was explained, it was decided to report the effect-sizes as defined by eta-squared values. F values that were significant at the $p<.05$ and $p<.01$ level were indicated by asterisks.

Table 2. Means and standard deviations for the ratings of the statistically significant ($p<.01$) differences in subjective experiences between the stimulus persons (S-Persons) who were exposed to the circumcerebral fields and the response persons (R-persons) whose QEEGs were recorded. M:mean, SD: starndart deviation. Ω^2 %

Variable	S-Persons		R-Persons		Ω^2
	M	SD	M	SD	
Presence	.3	.5	1.5	.5	64
Anger	.3	.5	1.8	.5	75
Fear	.8	.5	0	0	65
Emotional	0	0	.8	.5	60
Sexual Arousal	0	0	.8	.5	60
Overall Rating	1.5	.6	.3	.5	64

Results

Only the statistically significant differences for the subjective experiences between the stimulus persons and the response persons are shown in Table 2. The omega-squared estimates for the amount of variance in these measures accommodated by being either a stimulus or response person are also shown. The response persons (while the stimulus persons were imagining walking into the room and touching the response person along the left side) displayed significantly greater incidence of a sensed presence, anger, and sexual arousal. On the other hand the stimulus persons reported significant more pleasantness but more episodes of fear.

The partial eta² values for the four way analyses of variance for the relative measures of change in power relative to baseline (before the fields were activated for the stimulus persons) are shown in Table 3. The primary statistically significant effects involved interactions between lobe and hemisphere and occurred within the delta, theta, and low alpha ranges. *Post hoc* analyses indicated that the primary source of these interactions were the enhanced power (by about 20%) within the right temporal lobe compared to any of the other five positions (left temporal and right and left frontal, parietal and occipital lobes).

The eta² values for the four way analyses of variance for the relative measures of change in power relative to the baseline for the response persons for each of the six, 1-Hz increments of power within the peritheta range are shown in Table 4. The interactions between lobes and hemispheres were significant statistically within the 3.0-3.9 Hz, 5.0-5.9 Hz, 7.0-7.9 Hz and 8.0-8.9 Hz increments. *Post hoc* analyses indicated that the primary source of this interaction was the increased relative power within the right temporal lobe within all of these bands. The remaining statistically significant interaction, between pulse and phase, within the 8.0 Hz-8.9 Hz increment, was due clearly to the decreased power (factor of 2) for the response persons while the burst firing magnetic field was being presented every 3 sec or the frequency-modulated pulse was presented every 20 msec (+2) around the heads of the stimulus person compared to the other four combinations that did not differ significantly from each other.

However, by far the most revealing interactions occurred with analyses of the z-scores. For the wide bands, as shown in Table 5, there was a statistically significant interaction between lobe, pulse and phase within the theta band that explained about half (48%) of the variance. *Post hoc* analyses indicated that the primary source of this interaction was due to the increased power within the frontal (z=1.06) and occipital (z=0.74) lobes but decreased power within the temporal (z=-0.41) and parietal (z=-0.41) lobes of the response persons when the burst-firing 100 msec (+20 msec) configuration was being applied around the heads of the stimulus persons but the marked increase in power over the temporal lobes only (z=0.55) compared to the other lobes (all zs=-.02 to +.05) when the frequency modulation field at 20 msec (+2 msec) was applied. The minor source of variance for this interaction was the markedly congruent increased power (z=0.75) over the frontal lobes during the 100 msec (+20 msec) configuration regardless of the pulse-form compared to the consistently decreased power within the temporal and parietal lobes (all zs=0.03 to -0.32) during these presentations.

Table 3. Percentage of explained variance (partial eta-squared) values for main effects and interactions for relative power changes within the delta, theta, low-alpha, high alpha, low beta and gamma bands during presentation of circumcerebral fields with different pulse and phase characteristics. *P<.05

Source	Theta	Delta	Low Alpha	High Alpha	Beta	Gamma
Lobe (L)	21	23	40*	23	30	21
Hemisphere(H)	28	32	47*	29	28	40
Pulse (Pu)	0	3	17	4	0	9
Phase (Ph)	12	13	11	24	28	9
LxH	36*	35*	34*	17	26	17
LxPu	4	4	5	20	2	12
LxPh	20	24	13	14	20	23
HxPu	5	0	12	20	12	36
HxPh	8	15	4	2	25	5
Pux h	3	13	11	19	12	21
LxHxPu	4	12	22	20	21	2
LxHxPh	10	7	2	18	9	5
LxPuxPh	14	17	8	15	22	17
HxPuxPh	6	11	11	15	17	1
LxHxPuxPh	11	14	6	5	18	2

The significant interaction between lobe, hemisphere and phase for the z-score of the power within the delta band again reflected the hemispheric asymmetry of the changes within the temporal and parietal lobes. *Post hoc* analyses indicated that while the stimulus persons' brains were exposed to the 20 msec (+2 msec) accelerations (regardless of pulse) the response persons' power increased over the right parietal lobe (z=+.42) and over the left temporal lobe (z=+.30) while during the exposure to the 100 msec (+20 msec) changes the power decreased over the right parietal lobe (z=-.35) and over the left temporal lobe (z=-.30).

The statistically significant interaction between lobe, hemisphere, phase and pulse for the power within the high alpha range was due primarily to the increased power in the left temporal lobe compared to the right temporal lobe during the frequency modulated field's presentations at 20 msec (+2 msec). The interaction between lobe, hemisphere, and phase within the delta, high alpha and beta bands again was due to the increased activity within the right temporal lobe during the 20 msec (+2 msec) circumcerebral rotations of the frequency modulated pulse.

Table 4. Percentage of explained variance (partial eta-squared) values for main effects and interactions for relative power changes within the peritheta, 1 Hz bands during presentation of circumcerebral fields with different pulse and phase characteristics.
*P<.05 and **p<.01

Source (Hz)	3-Hz	4-Hz	5-Hz	6-Hz	7-Hz	8-Hz
Lobe(L)	29	23	19	33*	18	34*
Hemisphere(H)	20	12	47*	38	15	43
Pulse (Pu)	0	1	1	8	8	10
Phase (Ph)	5	1	8	10	23	5
L x H	32*	24	40**	29	32*	47**
L x Pu	3	2	7	2	3	6
L x Ph	17	25	19	15	19	19
H x Pu	17	1	3	1	0	21
H x Ph	10	32	5	3	1	11
Pu x Ph	7	3	16	21	23	45**
L x H x Pu	15	8	8	11	16	18
L x H x Ph	15	14	3	6	15	2
L x Pu x Ph	15	10	18	14	21	15
H x Pu x Ph	5	4	3	19	18	17
LxHxPuxPh	13	17	17	9	12	6

The eta^2 values for the z-scored (standardized) data for each of the separate 1 Hz increments within the peritheta range are shown in Table 6. The statistically significant interaction between lobe, pulse and phase within the 5.0 to 5.9 Hz increment, which explained 53% of the unadjusted variance, was conspicuous. *Post hoc* analyses showed that the primary source of the interaction was the enhanced power over the frontal and occipital lobes of the response persons during the 100 msec (+20 msec) presentation of the burst-firing pattern around the stimulus persons' heads while only the temporal lobe showed enhanced power of the response persons' heads during the 20 msec (+2 msec) presentation of frequency modulation. A similar, statistically significant pattern was noted for the 7.0 Hz-7.9 Hz band.

Table 5. Eta-squared values (percents) or effect size for the various factors for the six, wide bands of standardized measurements of electroencephalographic power for six subjects.
*p<.05; **p<.01; ***P<.001

Variable	Theta	Delta	Alpha-1	Alpha-2	Beta	Gamma
pulse(Pu)	52	15	03	28	34	34
Phase (Ph)	10	24	45	29	18	15
Lobe(L) x Pu	15	11	22	26	09	49*
L x Ph	14	08	05	15	11	10
Hemisphere(H)xPu	28	17	04	06	41	01
H x Ph	06	07	07	25	18	05
P x Ph	22	35	49	64**	27	20
L x H x P	40	14	01	29	28	14
L x H x Ph	48**	37	18	43*	49*	11
L x P x Ph	39	42*	35	29	20	11
H x P x Ph	11	26	06	23	07	04
L x H x P x Ph	13	28	06	55***	37	19

The interaction between lobe, hemisphere and phase within the 6.0 -6.9 Hz band was found by *post hoc* analyses to be due to the enhanced power over the left frontal (z=+.81) and right frontal (z=+.78) whereas only the left occipital (z=+0.64) but not the right occipital (z=0.30) displayed this enhancement while the left and right temporal (zs=-.49,-.08) and parietal (zs=-.14,-.18)) lobes were diminished over the response persons' brains when circumcerebral presentations of 100 msec (+20 msec) regardless of the type of pulse were presented around the stimulus persons' brains. These combinations over the lobes for the other two phases did not differ significantly.

Table 6. Eta-squared values (percents) or effect size for the various factors for the six, 1 Hz bands of standardized measurements of electroencephalographic power for six subjects. *p<.05; **p<.01; ***P<.001

Variable	3-Hz	4-Hz	5-Hz	6-Hz	7-Hz	8-Hz
pulse(Pu)	44	65***	44	09	31	05
Phase (Ph)	10	01	17	41	37	06
Lobe(L) x Pu	21	01	18	21	30	05
L x Ph	17	12	24	46*	54***	24
Hemisphere(H)xPu	10	22	24	27	02	04
H x Ph	20	48	01	06	33	04
Pu x Ph	24	03	41	39	46	60*
L x H x Pu	28	13	24	24	07	07
L x H x Ph	31	33	32	52**	22	15
L x Pu x Ph	47*	20	53**	28	44*	38
H x Pu x Ph	18	06	16	60*	49	02
L x H x P x Ph	20	32	21	33	40	19

Discussion

We have been investigating the conditions that create the sensed presence within the laboratory for about 20 years. The present experiment is the first time we have observed a powerfully experienced sensed presence in people (response persons) who were not being exposed to weak, rotating circumcerebral magnetic fields although another person's (the stimulus person) brain was exposed to these fields and this person was "imagining" walking to and being near the response person. As shown in Table 2, the response persons also reported elevated scores for anger, sexual arousal, and emotional significance of their subjective experiences while the stimulus persons were receiving the circumcerebral stimulation and imaging being proximal to them.

The actual value for the sensed presence in the response persons was not only significantly more frequent than the stimulus persons but about twice the value of experiments where different magnetic fields were designed to induce these experiences (St-Pierre and Persinger, 2006). This marked elevation of the subjective experience of a sensed presence by the response persons would support the concept of entanglement because a change in the state of the stimulus persons (receiving the circumcerebral fields and imagining being near the response person) resulted in a complimentary change in state of the response person (the frequent experience of someone standing nearby). The differences in scores between the stimulus persons and the response persons explained more than 50% of the variance for each of these measures. Such enhancements of subjective experience in people not exposed directly to complex weak magnetic fields (St-Pierre and Persinger, 2006) or these effect sizes were not observed in our unpublished reference studies where pairs of strangers randomly selected to be the response or stimulus person on the day of the experiment were exposed to this protocol.

In the present study there was a relative enhancement of electroencephalographic power over the temporal lobes within the delta, theta, and low-alpha range in the response persons while the stimulus persons were exposed to the circumcerebral magnetic fields. Within the theta range, this interaction between hemisphere and lobe, due primarily to the changes within the right temporal lobe, were evident across the 3.0 Hz to 3.9 Hz, 5.0 to 5.9 Hz, 7.0 Hz to 7.9 Hz and 8.0 Hz to 8.9 Hz increments. These increases were based upon the relative changes compared to the baseline when no field was being presented to the stimulus persons. Although these general increases could be argued to be "non-specific" responses to the presentation of counterclockwise circumcerebral fields to the stimulus persons, these changes might always be explained by the cumulative effects of sitting, blind-folded in a comfortable chair for 30 min.

A more rigorous test of an enhancement of the effects of one person's brain upon another's electroencephalographic activity would require the enhancement only during specific temporal changes in the field. This would be manifested as an interaction between phase or pulse and phase and particular regions of the brain within specific electroencephalographic bands whose information carrying capacity has been either empirically or theoretically demonstrated. The theta band in particular has been suggested as the substrate for this capacity. In the present study statistically significant interactions were observed between phase (the duration and change of duration of the field at each solenoid as the field rotates around the stimulus person's head) and either the pulse or the cerebral regions.

The results were congruent with the concept that the intentions or ideas of one person can affect another person's subjective experiences if they share a history of space-time proximity and one of the pairs is exposed to circumcerebral magnetic fields whose rates of change involve 20 msec increments. In our previous study where brothers and sisters were the stimulus and response persons there was a marked enhancement of power over the frontal and occipital regions within the 5.0 Hz to 5.9 Hz interval relative to the temporal and parietal lobes of the sibling whose electroencephalographic activity was being recorded while the stimulus person was exposed to the frequency modulated field whose initial duration over the first (left prefrontal) solenoid was 100 msec and then decreased at 20 msec increments over the left posterior frontal, left temporal, left occipital and right occipital regions until it accelerated faster than gravity between the right temporal and right prefrontal regions. This interaction between lobe, phase, and pulse accommodated 37% of the variance (Persinger et al., 2003).

In the present study the stimulus and response persons were initially strangers who were randomly assigned to be in close spatial proximity twice a week for one hour for four weeks. When one of these individuals per pair was exposed to the circumcerebral magnetic fields there was also an increased power within the other member of the pair's EEG within the 5.0 Hz to 5.9 Hz range. The effect size explained 53% of the variance and was again due primarily to the enhanced power over the frontal and occipital lobes relative to the temporal and parietal lobes of the response persons *specifically* during the presentation of the frequency-modulated pulse whose duration changed at the same rate as the most effective pattern that produced these effects in our previous sibling study. However there were differences in the minor contributions to the interaction. In the study involving siblings there was a relative increase in power within the parietal lobe compared to the other three lobes when the frequency-modulated pulse was presented for 20 msec and accelerated at each solenoid by 2 msec. In the present study this increase occurred only over the temporal lobes of the response persons when this specific pulse and specific acceleration were being applied around the heads of the stimulus persons. The reason for this discrepancy is unclear. That spatial awareness is a function of the temporal lobe, not the posterior parietal lobe when confounding factors are removed has been shown in clinical contexts (Karnath et al., 2001).

The patterns of our electroencephalographic shifts in power are compatible with those reported by Silberstein et al (2003) who found that fronto-parietal evoked potential synchronization increased during tasks that required "mental rotation". This intrinsic "spatial" task might be considered analogous to the instructions to the stimulus persons to "imagine" transporting to the other room and touching the response person's left side. These researchers also found anisotropic interhemispheric coherence between the left frontal and right parietal sites. However our results also suggest that when the appropriate spatial history and circumcerebral magnetic fields are applied to the stimulus persons the response persons' electroencephalogram display this configuration even though they were told to relax and were not informed about instructions given to the stimulus persons.

We have hypothesized that this particular increment of theta activity contains derivatives that would satisfy the re-entrant conditions required for consciousness because the 20 msec increments would occur as solutions for the second, third, and fourth order rates of change. We have suggested that consciousness eludes simpler models and is complex because the temporal component over large increments of time must be accommodated. The approximately 20 msec rate of change would allow access to this longer period of time.

The hypothesis that the total existence of an object is represented within a four-dimensional, space-time coordinate system has been suggested for non-living and living matter (Reichenbach, 1958). Such continuity of the same "matter" or space occupied by that matter over time would create the conditions for interactions between different time-lines due to incidental spatial proximity during discrete intervals of time of the matter's history. Interactions between time-lines because of spatial proximity in the past for different objects or organisms would constitute a type of entanglement such that under the appropriate conditions a change in one living system would result in the systematic change in the other.

We had assumed that any entanglement between two brains would be reflected in electroencephalographic activity because it is effectively electromagnetic phenomena (McFadden, 2002). Although researchers have often considered the physical bases of thought to be related to the same processes that generate the EEG, definitive verification has been difficult. We must always consider the possibility that a third factor, as yet not described by physical mechanisms, is responsible for both thought and electroencephalographic patterns. In this study there was evidence that, in addition to specific EEG power, the response person's thoughts may have been affected by the stimulus person's thoughts or that a third factor produced changes in both members of the pair.

That small amounts of energy involved with quantum phenomena might determine the essential features of "thinking" was suggested by Neils Bohr (1958). His concept of the magneton, of an electron rotating in an orbit with a radius of approximately 58 picometers with a fine structure velocity (1/137 the speed of light), can be transformed into the value of Planck's constant of 6.63×10^{-34} J s, the fundamental constant of quantum phenomena. This transformation emerges when the energy equivalence (4.33×10^{-18} J) of the classical mass of an electron moving at this speed is multiplied by the time required for the completion of one orbit (1.53×10^{-16} s).

The magnetic moment of the electron in Bohr's model, when immersed within a cohesive low frequency magnetic field requires a field strength of within the range (picoTesla) predicted as the operating mode of the human brain to be coherent with this magnetic moment. If one assumed that the median time derivative was in the theta range, for example 7 Hz, then the "threshold" energy would be the product of 7 Hz and 6.63×10^{-34} J s or 4.6×10^{-33} J. We selected this frequency not only because of its solution as a higher order derivative for a major correlate of consciousness but because of its occurrence as the peak in the band of intrinsic (Schumann) resonance solutions (Konig et al., 1981) for the earth-ionospheric cavity within which life evolved (Cole and Graf, 1974).

According to the wave mechanics of Dirac the magnetic moment associated with the spin of an electron closely approaches the magnetic moment of the Bohr magneton of 9.27×10^{-24} Am^2 or J/T (Illingworth, 1991). This means that for the threshold value of energy of 4.6×10^{-33} J to be achieved, the applied field must be about 2×10^{-10} T which is within the range Anninos et al (1991) have suggested is the operating intensity of the brain. Such energies would be expected to affect the rotational symmetry of the electron in either its spin or rotation.

Within the context of quantum field theory, the Nambu-Goldstone theorem (Jibu and Yasue, 1995) asserts that the result of spontaneous breakdown of any compact and continuous symmetry, such as rotational symmetry, results in the manifestation of the massless quanta or Goldstone bosons. Their eigenvalues change continuously from zero to any positive value of energy. In principle an infinitesimal amount of energy is sufficient to create a Goldstone boson. For coherence lengths with macroscopic order vacuum states to be maintained an extremely low energy eigenvalue of the common elementary energy eigenstate would be required. These values are within the 10 Hz region. If this process is valid quantum phenomena can be manifested within the macroscopic range of brain space.

Consequently, the operation intensity of the magnetic fields within the 7 Hz range within the brain would be able to generate energy that would be equivalent to that associated with the magnetic moment of an electron. If we assume that thought is either caused by or correlated with a unit of matter that has been shown to display both wave and particle qualities, then the electron would be an optimal point through which information from one brain could be shared with another. We suggest that the point-to-point transforms of information between electrons within different brains would be limited to fundamental subjective patterns, ideas, and emotions shared by all members of our species or by subgroups who shared similar genetics (Nowak and Marczynski, 1981) that in turn determine the organization of matter (molecular patterns) within the brain. Jung and Pauli (1955) had pursued this possibility in order to understand the connection between quantum, synchronicity, and the collective unconscious.

The candidacy of the electron as a wave/particle that could mediate the effects of "thought" through entanglement has quantitative support. There is a marked discrepancy between the width of an electron (2.82×10^{-15} m) as a particle and length of an electron derived from solving for (the Compton) wavelength from the relationship $mc^2=hf$ where m=mass, c=the speed of light, h=Planck's constant and f=frequency (which is c/wavelength). This value is 2.43×10^{-12} m. In other words there is an approximately 1000 fold difference between width of an electron based upon a solution as a particle or as a wave.

The discrepancy can be accommodated by the differences in relative velocity between the proton and electron in the frame of reference. If we assume the observed radius of an electron has been affected (reduced) by a velocity approaching c (the speed of light), then according to the modified Lorenz transformation $l_o=l_a$ times $\mathrm{sqrt}(1-v^2/c^2)$ the velocity of the electron would be .999999326c to generate a quotient of .001161 that when multiplied by the expected Compton wavelength would result in the smaller empirical radius of an electron. From this perspective the apparent small radius of the electron would be a relativistic length. We appreciate this inference would be not be acceptable to some theorists. However, we suggest a reconsideration of previously forbidden "boundaries" where relativistic equations are technically undefined.

The interesting consequence of this value is the amount of energy-equivalence of matter with changes in velocity between .999999326c and c. The energy equivalence, employing mv^2 at values approaching c, would be in the order of 10^{-15} J. However, the *discrepancy* between the energy equivalence for the mass of an electron moving at .999999326c and c is about 10^{-20} J. This value is equivalent to the amount of energy imparted to a dipole by an action potential of a neuron which displays a net difference of about 120 mV (1.2×10^{-1} V) when acting on a particle with a single charge of 1.6×10^{-19} C (Persinger and Koren, 2007). As indicated by Fong (1968) and Wei (1969) the value 10^{-20} J is within the range of the stacking energy of one base of RNA and suggests that information obtained from quantum sources could affect experience as well as its stages of consolidation into memory.

The conspicuous congruence between the energy associated with the action potential, the most likely candidate that either mediates or is the primary correlate of thought, and the energy difference between an electron moving at c or the value required to accommodate the discrepancy between the Compton wavelength and the classical radius would suggest that fundamental brain activity is coupled to quantum mechanisms. Such a connection would support the concept that thought, as mediated by the observer, could change the probability of distal events by being correlated with whether the electron behaves as a particle or a wavelength. Such "excess correlation", another name for entanglement (Arnesen et al., 2001) then becomes an important resource in quantum information processing that would allow the interconnectiveness of the other dimensions of Kaluza-Klein space. Because the smallest spaces, those approaching Planck's length (10^{-35} m) have the maximum interconnectiveness within the extent of space for the smallest amount of time (Persinger, 1999b; Persinger and Koren, 2007) "instantaneous" interaction over extraordinary long distances would be possible.

The involvement of distance, within brain space, would favour a greater contribution of right hemispheric processes (Persinger & Lalonde, 2000; 2002a). Right hemispheric anomalies, discernable by electroencephalographic, Magnetic Resonance Imaging, or Single Photon Emission Computerized Tomography (SPECT) have been shown in exceptional individuals whose behaviors suggest entanglement (Persinger et al., 2002b; Roll et al., 2002). Many of these experiences involve "the intrusion" of experiences and a sensed presence into awareness, a process that has been hypothesized to be the person's experience of the right hemispheric equivalent to the left hemispheric sense of self (Persinger, 2003b).

A right hemispheric origin would allow information obtained without left hemispheric awareness (Persinger, 1985) to affect or create specific types of memories that could be represented within the constraints of the left hemispheric processing (Healey and Persinger, 2000). The particular involvement of specific right hemispheric processes, particularly those related to the limbic system (Vinogradova, 1975) may be relevant because of their apparent enhanced sensitivity to very subtle changes in activity of the earth's magnetic field within which human beings are immersed and potentially interconnected (Persinger, 1983). The amount of magnetic energy that can be "stored" within the earth's magnetic field, even within a conservative estimate of a volume twice that of the lithosphere (about 10^{22} m^3), can be estimated from (B^2/2 mu) multiplied by the volume, where B is the strength of the magnetic field and mu is magnetic permeability (4pi x 10^{-7} N/A^2).

For an average geomagnetic field strength of 5 x 10^{-5} T (0.5 gauss), the magnetic energy that could be stored is about 10^{19} J. Assuming 10^{-20} J per action potential and an average of 10^1 of these quantum per sec (10 Hz) from each of 10^{10} neurons in the right hemisphere of an average human being who lives for about 2 x 10^9 sec, a total of about 1 J of "neuroelectromagnetic energy" would be available to be represented in a lifetime. Consequently, there would be more than sufficient energy stored within the earth's magnetic field to represent the configurations of every person who has ever lived.

Although the isolation of the mechanisms by which human cognition is generated and the precise description of these consequences have not been completed, there is strong evidence that consciousness and thoughts are correlated with discrete but complex changes in quantitative electroencephalographic activity. Our results suggest that if entanglement has occurred between the processes that generate consciousness or a type of consciousness within two separate brains (Booth et al., 2005), the induction of a compatible state at some later date within one brain should affect specific changes in the other brain as if the two brains were within their original spatially and temporally proximal locality.

The ontogeny of human consciousness has been the focus of human thought for millennia (Rose, 2006). There have been myriad approaches and solutions to the apparent intrinsic duality of brain (or matter) and mind (or consciousness). Explanations occupy positions along a continuum from the extreme idealism that consciousness creates matter to extreme materialism that matter (the brain) creates consciousness. However all of these arguments are still dependent upon the fact the relationship between brain and consciousness is a correlation and that causality, like in all correlational relationships, cannot be definitively attributed. There is always the possibility of a third factor by which the two correlated entities are associated. A solution might be isolated by exploring the role of entanglement as the third factor that contributes to or creates both.

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