

Non-Locality changes in intercerebral theta band coherence between practitioners and subjects during distant Reiki procedures

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Abstract. This study investigated if changes in interbrain coherence as measured by quantitative electroencephalography occur during distant (non-local) Reiki procedures where the stimulus and response person who never met were separated by 50 m. Compared to sham-procedure pairs, Reiki pairs displayed increased shared transcerebral coherence within the theta band particularly within the left temporal lobes. There was evidence of maximum changes in strength of inter-brain coherence in the Reiki pairs after three minutes of the procedure that was not evident in sham procedure pairs. The magnitude of the increased coherence, although small, would be within the quantitative range associated with the changes in information when operations converge in neuronal systems. Although the potential access of Schumann resonances and the “cerebral field” generated within all human brains due to their immersion within the geomagnetic field offer potential solutions, the Pitkanen Topological Geometrodynamics (TGD) theory of consciousness allows a more palatable and potentially testable explanation for the apparent violations of space-time contiguity and causality.

Keywords: Distant Reiki, quantitative EEG, interbrain coherence, theta band, Landauer limits; Topological Geometrodynamics (TGD) theory

1. Introduction

The concept of action at a distance has defined the natural world and involves locality embedded with the mechanisms that mediate the cause-and-effect between two objects or processes. The classic example within the brain is the mechanism of effect, that is axons and their time-limited potentials, between two neurons. However, the concept of non-locality when two events separated by non-traditional distances show excess correlation in their occurrence has been usually relegated to the microcosmic domains of quantum physics. One example would be quantitative changes in one person's brain that are temporally correlated with the same or similar quantitative changes in another person's brain at distances beyond the expected connections of typical sensation. In the experiments reported here, we applied the quantitative electroencephalography (QEEG) to pairs of individuals to test the contention that "distant" or remote "Reiki" could be supported by modern techniques for dynamic cerebral measurements.

Reiki is a putative "energy field" healing process that was described in the *sutra* or ancient writings from Tibet. The procedure allegedly activates and directs universal life energy, which is presumed to be pervasive (everywhere) to facilitate healing through returning the dysfunctional body to its optimal homeostatic set point. There are multiple reviews of its history [1]. Essentially the current form was popularized by an early 20th century Japanese practitioner who had studied the ancient texts and following a period of prolonged fasting and concentration experienced a series of symbols and forms that were interpreted to reflect the access to this universal force. The concept is similar, in terms of alleged stimulus operations and fundamental characteristics, to Leibnitz' 18th century "monads", von Reichenbach's odyl 19th century force, and Reich's 20th century orgone energies.

There are two distinct classes of Reiki claims. The first involves proximal effects when the practitioner is within sensory (touch or body radiation) distance. Like many forms of "touch therapies" application of Reiki procedures, usually as multiple trials, each with durations of about 20 to 30 min once or twice per week for five to eight weeks, has been reported to produce significant improvements in depression and anxiety [2], elevation of specific immunoglobulins (IgA) without affecting cortisol [3], reduction in blood urea nitrogen, enhancement of vagotonic indicators [3] normalization of heart rate variability [4] and small increases in hemoglobin levels compared to control or placebo conditions [5]. Although the effect sizes are relatively small, explaining about 20% of the variance, they are considered impressive because the primary intervention is the practitioner "thinking" about the specific sequence of symbols and placing his or her hands over specific areas of the body for about 5 min.

The second class of Reiki claims is more conceptually challenging. It assumes the universal forces can be directed to individuals at some distance from the practitioner. Although not intuitively obvious to classical neuroscience, there is now evidence that "excess correlation" of measurements between two individuals separated by a distance can be experimentally produced and replicated if they share similar circumcerebral magnetic field configurations [6,7]. Persinger et al [8] showed that if the heads of pairs of volunteers were exposed to circular arrays of solenoids from which magnetic fields with changing angular velocities were generated light stimulation in one of the pair was associated with discrete alterations in QEEG power in the other. Later Dotta et al [9] found that when pairs of subjects were exposed to these angular accelerating or decelerating fields generated within these circular arrays the presentation of light flashes to one person was associated simultaneously with the emission of photons, in the order of 10^{-11} Wm^{-2} , from the head of the other person who was sitting in the dark in another room. Subsequent experiments [10] indicated that cerebral photon emission in general was temporally coupled to changes in power within the QEEG profiles.

This excess correlation between photon emissions from one person's brain that was exposed to the same temporal pattern of rotating magnetic fields as the brain of another person exposed to dim flashing lights in another room was considered potentially significant for accommodating the "non-locality" claims of various therapies and practices. The time required for a photon to traverse a plasma cell membrane is within the same order of magnitude (10^{-16} s) as the time required for one orbit of a single electron (the Bohr magneton) around a proton [11], a time which is intricately related to the quantity: Planck's constant, upon which quantum relationships are strongly based [12]. Given the similarities of magnitude of the average energy density of the universe ($\sim 10^{69}$ J per $\sim 10^{78}$ m³) and the energy (about 10^{-9} J·m⁻³) associated with the summed action potentials [13,14] correlated with cognition within human cerebrum and the quantitative solutions for gravitational and electromagnetic energy [15,16], the involvement of photons was considered a possible means by which both non-locality and action at a distance could be rationalized. Although not directly pursued in the present experiments the mechanism could at least be testable if there was evidence of this excess correlation with magnitudes sufficient to be manipulated experimentally.

We reasoned that the Reiki procedure would be an optimal test to discern if coherence between two brains could be discerned by modern QEEG data and correlative analytical software. vanderVaart et al [17], who employed a double blind procedure, reported lower heart rate and blood pressure in women after elective Caesarean sections (but no effect upon subjective nociceptive levels) associated with a practitioner 100 km away who engaged in the Reiki intervention for 20 min per patient. If heart rate, a remarkably crude measure, could be affected, we hypothesized that conspicuous and more powerful associations should occur between Reiki practitioners and their "targets" compared to sham pairs of subjects when modern measurements of quantitative coherence were employed.

Instead of applying QEEG to interhemispheric activity we applied it to *interbrain* activity with the ultimate goal of applying the approaches of Wackermann [18]. We also reasoned that with the appropriate measurement a procedure claimed to have clinical significance, which usually involves effect sizes of around 50%, should be statistically significant and evident even with a small sample size that employs repeated or within subject pair analyses. In various scientific disciplines when small samples reveal strong effects at statistically significant levels the stimulus-response variables are more likely to be more temporally contiguous rather than interfaced with multiple intervening variables (i.e., "noise"). We report here evidence for this association.

2. Methodology

2.1 Participants

Following approval of the university's research ethics board, a total of 8 pairs (n=16) subjects were tested over a six week period (only 1 pair per day). There were 4 Reiki pairs and 4 Sham pairs. The Reiki pairs involved 2 experienced female Reiki practitioners, 25 and 30 years of age. The ages of the subjects ranged from 25 to 35 years. One of the Reiki participants had been a subject in an experiment where discernable photon emissions from the right side of her brain had been measured reliably when she thought about white light vs periods when she thought about black or other mundane events.

2.2 Design and procedure

Each pair was tested singly in the following manner. For convenience the practitioners (sham or Reiki) were designated as senders while the patients or subjects were designated as receivers. The senders were brought to the basement Consciousness Research Laboratory after having been met by one of the experimenters. Each sender sat in a comfortable chair within a closed industrial acoustic chamber that was also a Faraday room. A standard 19 channel EEG cap (Electro-Cap International) was placed on the head and the impedance of the sensors was verified according to procedures routinely employed in our laboratory [19]. At about the same time each receiver was met at a distant location by other experimenters and taken to a quiet room about 50 m away from the chamber on the second floor of another building. The same type of EEG cap was placed on the receiver's head and the sensors were checked to ensure impedance criteria. The receiver and the sender of any pair never met or had direct physical proximity with each other during the experiment.

Both senders and receivers were told to relax and to follow instructions. This involved: eyes opened for 90 s during a baseline, 10 min eyes closed during the procedure, and another 90 s at the end of the procedure with eyes opened. They were also instructed to try to remember any images because they would be asked to draw them or write them down at the end of the experiment.

According to the standardized protocol, the experimenter assigned to the receiver called (via internal university phone in each room) the experimenter assigned to the sender. Within 1 s both experimenters started recording WinEEG 19 channel montage window on two very similar laptops with the same software. Immediately the receiver was told to close eyes and the sender was told (by in chamber speaker) to start the procedure (sham or Reiki). At second 595 (clearly indicated by software) of recording by the computers, the experimenter monitoring the sender called the other experimenter to ensure the timing of the two computers was still synchronized. Recording was stopped at 610 s. During the 10 min period the EEG was recorded simultaneously from the receiver and the sender while the latter engaged in the practiced Reiki procedure (experimental) or imagined the symbols (sham) regarding sending the information to the patient who they had never met or would meet.

2. 21. Reiki and Sham Methods

At the beginning of the session the sender was only told the first name and the gender of the putative receiver. Before the treatment (and 10 min measurements) began each Reiki practitioner meditated for approximately 5 minutes. After the instruction "start the task" each practitioner "imagined" the first symbol, a spiral with a straight line and its word (*Choku rei*) that was repeated three times. The second symbol (face-like pattern) with its associated word (*Sei he ki*) was repeated three times and "imagined" towards the specific gender and name. The third symbol looks like a Japanese Christmas tree and the word (*Hon Sha Ze Sho nen*) was repeated three times. This cycle was about 1 min and repeated throughout the measurement period. The practitioners also imaged specific colours associated with symbols.

The sham senders were given the three symbols and the words just before the procedure started. They were instructed to remember the symbols and the associated words and that when they heard the sentence "start the task" they would "send" the words and the symbols. They were

informed to repeat this procedure until they were told to stop. Post experiment verification indicated they engaged in this activity throughout the 10 min period. At the end of this period both participants listed the words that described their experiences and images.

2.3. QEEG Spectral analysis

A total of 300, 2 s samples were extracted for each person's QEEG for each pair of subjects. The segments were imported into MATLAB for computation of spectral power within the delta (1.4 to 4 Hz), theta (4 to 7.5 Hz), low-alpha (7.5 to 10 Hz), high-alpha (10 to 13 Hz), low beta (13 to 20 Hz), high beta (20 to 30 Hz) and gamma (30 to 40 Hz) frequency bands. The values for each of the 300 second samples for each person were then loaded into SPSS for statistical analyses.

Global power measures for each frequency band were completed by taking the sum of the power within each of the 19 channels. Spearman rank order correlations were completed between any given sensor for the "sender" in each pair of subjects with the homologous sensor in the "receiver" of each pair for each of the frequency bands. Correlations were completed for each of the three, 3.3 min blocks of time that constituted the 10 min of treatment between the global power for the sender and receiver in any given frequency band. Consequently there were 400 values (100 x 4 pairs) for the sham group and 400 values for the Reiki group.

2.4. QEEG: Interbrain Coherence Analyses

A total of 150 4-second time-locked samples were extracted from the raw record and imported into MATLAB. Within MATLAB coherence was calculated using a specialized script freely available within the EEGlab package. Coherence was computed between each sensor from the sender and the same sensor for the receiver for each of the classical frequency bands. For example the coherence was computed between the Fp1 channel in the sender and the Fp1 in the receiver. The coherence values were then averaged according to each of the three time blocks representing the beginning (first 3.3 min), middle (second 3.3 min), and end (third 3.3 min) of the Reiki or sham treatment.

2.5. Specific Correlations for Areas of Interest

The most rigorous test of action at a distance would be an increase in coherence of activity between pairs of brains that are receiving Reiki compared to Shams but only after a discrete amount of time. In other words, like recruitment of randomly firing neurons into an ensemble or "reverberating circuit" time would be required for sufficient numbers of neurons to be synchronous and reach the quantitative threshold to be measured by as far field electrical potentials by scalp QEEG. This would minimize the likelihood of confounding variables from unspecified but shared external variables present in both loci, particularly if the Reiki pairs showed the effect while the sham pairs did not. Based upon inspection of the data from sLORETA (Low Resolution Electromagnetic Tomography) in our related studies that conspicuously changed in power during Reiki treatments the power of low-alpha activity from the right and left superior frontal regions (RSF, LSF) of the sender was correlated with the low-alpha power from the right and left precuneus (RP, LP) of the receiver for each of the 4 pairs of Reiki and 4 pairs of Shams participants for each of the three, 3.3 min time intervals. The Spearman correlation coefficients (4, i.e., RSF-RP, RSF-LF, LSF-RP, LSF-LP, per time interval for the three time intervals) were employed as the data for analyses.

2.6. Emotional Word Meanings of Images of Receivers

Every word reported by each of the 8 pairs (4 sham, 4 Reiki) to describe their experiences during the 10 min of the treatments was transcribed and scored automatically for emotional meaning by the Whissell Dictionary [20]. The mean values per narrative along the pleasantness-unpleasantness, inactive-active, and concrete-abstract scales (1 through 7) were obtained. For each pair the mean value for the receiver was subtracted from the mean value of the sender for each of the three categories. The working hypothesis was that the affective or emotional loadings of the words employed at a distance by a sender-receiver pair receiving the Reiki treatment should be less discrepant; this is more congruent, as defined by a very low subtracted value, than for the sham pairs.

2.7 Statistics and Analyses

For the QEEG data seven, 4 way analyses of variance within one between subject factor (treatment) and three within subject factors (time, lobe, hemisphere) were completed for the coherence values for each of the frequency bands. Similar analyses were employed for the other data. SPSS-16 software was utilized.

3. Results

3.1. Quantitative EEG

The mean interbrain correlation coefficients for the average power within the traditional electroencephalographic frequency bands from all 19 sensors between the pairs of senders (sham) and receivers for the comparison group and between the pairs of senders (Reiki practitioners) and the individuals of their focus (receivers) as a function of the three successive 3.3 min increments of the 10 minute session are shown in Figure 1. The value for each point was the mean of 400 samples for each pair.

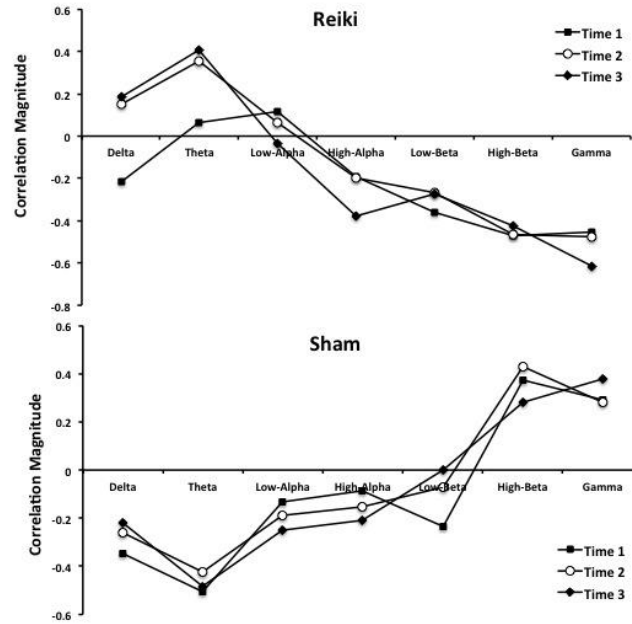


Figure 1. Mean interbrain correlation coefficients between pairs of senders and receivers for the Sham condition and between senders and receivers for the Reiki condition within all the frequency bands (Delta, Theta, Low-Alpha, High-Alpha, Low-Beta, High-Beta and Gamma).

Although the inverse relationship between the Reiki and sham pairs over the frequency bands was qualitatively conspicuous, the more critical result for supporting the involvement of treatment-dependent “coupling” between the pairs of brains occurred only in the Reiki pairs for the theta and delta bands. There was a clear and significant increase in the strength of the serial sample interbrain correlations between the first 3.3 min and the subsequent two 3.3 min intervals during the Reiki treatment *only*. The sham pairs displayed no significant change in the correlations between raw power values for the different frequency bands over time.

3.2. Coherence Between Brains Analyses

A more revealing relationship was found for the coherence measures, which are the correlations (or point to point overlaps) between successive changes in power between the brains of the pairs of participants for each of 4-second Δ s for the 150 samples over the 10 min period of the experiment. As shown in Figure 2, there was a significant [$F(1,9)=7.91$, $p < .05$; $\eta^2=.47$] increase in whole brain coherence between the sender-receiver pairs within the theta band for the Reiki group compared to the sham groups.

The most specific region that differentiated Reiki and sham pairs within the theta band was T5 (left temporal). There was a significant [$F(6,54)=3.39$, $p < .05$; partial $\eta^2=.27$] interaction between EEG band and condition for the theta and low-alpha band over T5 only. As noted in Figure 3, the Reiki-receiver pairs showed more coherence in the theta band but less in the adjacent alpha band compared to the Sham-receiver comparison pairs.

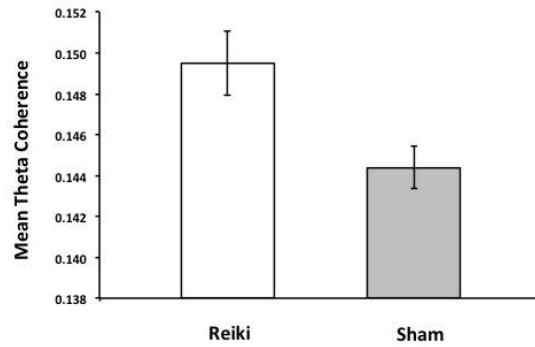


Figure 2. Increased theta power in whole brain coherence between Reiki senders and receivers compared to the Sham group senders and receivers.

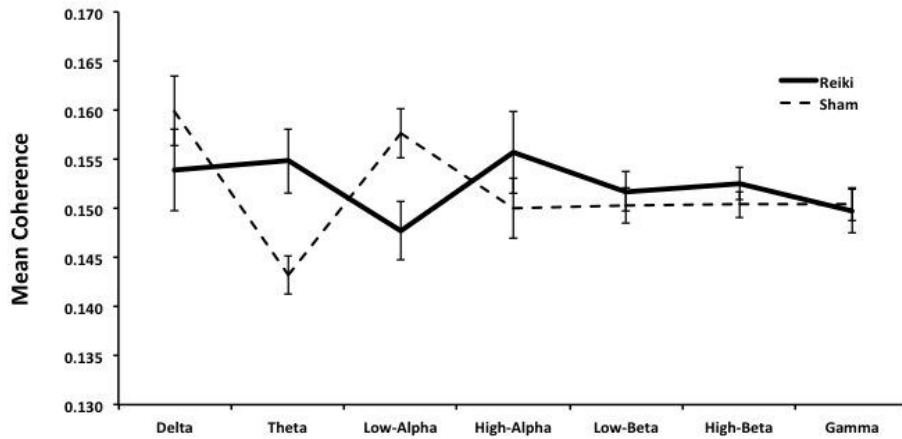


Figure 3. The pattern of significant difference found between Reiki and Sham groups over the left temporal (T5) in theta and low-alpha bands.

Comprehensive analyses of each of the seven frequency bands indicated that only the delta band displayed a statistically significant $[F(7,63)=2.21, p < .05; \text{partial } \eta^2=.20]$ interaction

between condition, lobe and hemisphere. In addition to the general *lower* coherence between pairs in the delta band over the temporal, parietal, and central regions, *post hoc* analyses, as reflected in Figure 4, indicated that the source of the interaction was primarily due to the lower coherence between the Reiki-receiver pairs for C4 and P3 compared to the Sham-receiver pairs whereas the coherence values for all other areas did not differ significantly.

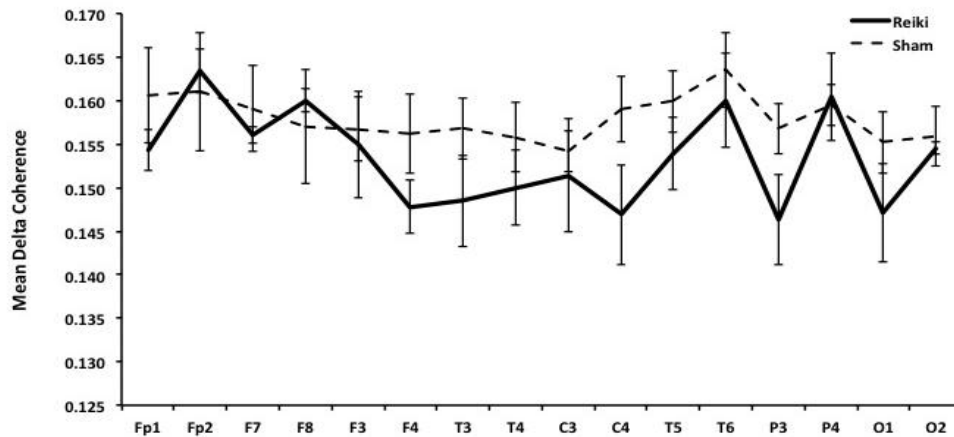


Figure 4. Coherence between the brains of Reiki senders and receivers compared to Sham senders and receivers within the delta range. Note the lower coherence in particular for the Reiki pairs for C4 and P3 compared to the Sham pairs.

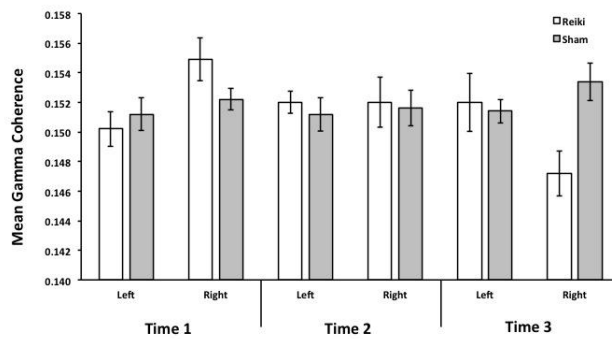


Figure 5. Significant interbrain coherence in the gamma band over the right hemisphere during the successive 3.3 minutes of treatment for the Reiki compared to Sham pairs. Note the increased coherence in interbrain gamma activity over the right hemisphere for Reiki pairs during the first part of the procedure but marked reduction during the last part of the procedure compared to Sham pairs.

The major time-dependent change for coherence between pairs of brains for the Reiki vs Sham (comparison) groups occurred for the gamma band [$F(2,18)=4.46, p >.05; \text{partial } \eta^2=.33$]. As shown in Figure 5, there was no significant change over time for the sham comparison pairs for the left or right hemispheres. However the Reiki pairs displayed significantly more interbrain coherence in the gamma band over the *right* hemisphere during the first 3.3 min and significantly less interbrain coherence over the right hemisphere during the last 3.3 minutes. Detailed visualization of the data indicated an inflection point for this diminishment to be around 8 minutes.

Table 3.1 Spearman correlation coefficients between global activity in the frontal regions of the senders and precuneus of the receivers for the 4 pairs of Reiki and sham subjects for the first, second, and third sequential 3.3 min intervals of the 10 min interval.

Reiki

Time	Pair 1	Pair 2	Pair 3	Pair 4
1	-.11	.25	-.66	.78
2	.47	.43	.26	-.40
3	-.46	.27	.52	.40

Sham

Time	Pair 1	Pair 2	Pair 3	Pair 4
1	.46	.74	-.13	.01
2	.46	.35	-.20	.05
3	.17	-.35	.27	.52

Time-coupled Brain-Brain Intercorrelations

Three way analyses of variance as a function of treatment, time, the four combinations of correlations (left and right superior frontal region for the senders and left and right precuneus region for the receivers) of the Spearman correlation coefficient values for the (sender-receiver) shared low-alpha power demonstrated no statistically significant differences between treatments or levels. The means for the strength of the four interbrain correlations per pair that received the Reiki or Sham treatment for the three intervals are shown in Table 1. It is evident that 3 of the 4 Reiki pairs showed relative increased brain-to-brain correlation for the selected areas (frontal for sender, precuneus for receiver) during the second time increment compared to the first while this pattern was not obvious for the sham-treatment pairs. As a *post hoc* examination, the absolute values for the change in correlation coefficients between the second and first time increments were analyzed. There was significantly more mean absolute change in interbrain correlations for the Reiki pairs than for the Sham pairs. This was not apparent for the absolute differences between the third and first time interval.

3.3. Emotional Scores of Words to Describe Experiences

The results of one-way analyses of variance demonstrated no statistically significant differences ($t(1,6) < 1.92$, $p > .05$) between the Reiki and Sham groups with respect to the discrepancy between pairs for the emotional scores for pleasantness, activity or imagery of the words employed to describe their experiences. The mean of means and standard deviations for the raw scores for the words employed by the senders and receivers were pleasantness $M=1.90$, $SD=.06$, activity $M=1.70$, $SD=.09$, and imagery $M=1.65$, $SD=.22$.

4. Discussion

The possibility that the brain activity of a person sitting in one room can be causally connected with the change in activity of a second person sitting in room at distances beyond conventional sensory contact has significant philosophical [21], theoretical [22; 23] and practical implications [13]. Such connectivity would not necessarily require simultaneous awareness of both members of the pair that the process is occurring. In addition the non-locality does not necessarily imply that any information must be exchanged or extracted. Although intuitively difficult from the current perspective of causality in Neuroscience, the difficulty might be analogous to attempting to rationalize how a visually compromised flying mammal (a bat) in complete darkness avoids collisions with objects before the understanding of ultrasound.

In the present experiments the only “shared” component was the knowledge both participants were involved with a relaxation experiment. The experiment was designed to minimize subtle cues. In addition the fact that both Reiki and sham receivers were exposed to the same procedures in the same distal room and only the Reiki pairs demonstrated the strongest within-pair *changes* in raw EEG power and general coherence over time suggests that the possibility of artifacts was minimal. That individuals’ EEG can be affected without their awareness by a practitioner has been shown previously for To-Hate [24], another Eastern method of intention or influence at a distance. Interestingly, this effect occurred when the practitioner “concentrated upon the receiver (who was not told this process was occurring) but only if the receiver’s brain was in a particular state as defined by the electroencephalographic signature.

The most robust and perhaps most important difference between the groups during the entire 10 min sessions was the bands in which the greatest strength of interbrain correlations for overall power were measured. The sham pairs displayed most interbrain correlations in general raw power within the high beta and gamma range, which would be expected considering the nature of human cognition. On the other hand the Reiki pairs displayed the strongest interbrain correlations in general raw power within the theta range. If one assumes the sham pairs reflect the “normal” condition then the fact that both the senders and receivers engaging in the Reiki procedure shifted to the theta band would support the hypothesis that: 1) the process produced a specific effect between the senders and receivers, and/or, 2) the sender affected the receiver’s cerebral activity to occur within the theta region.

Like many other studies the interbrain correlations and coherences within the *theta* electroencephalographic band displayed the most consistent significant differences between our Reiki and sham pairs. The only time-dependent statistically significant increase in the strength of interbrain correlations, as would be expected if the two cerebrums were “interacting” over time, occurred for the Reiki pairs after the initial 3.3 min. This theta effect was reflected in the greater transcerebral coherence within the theta band between the pairs of cerebrums engaged in the Reiki process compared to sham pairs.

Coherence measurements refer to the proportion of temporal association of power within a band between the two sources, the brain of the sender and the brain of the receiver. There was a general increase in overall transcerebral coherence between the two brains for the serial temporal increments (4 s) for Reiki pairs compared to sham pairs. The only local region within the cerebrum where the group differences were significant statistically occurred over the left temporal lobe (T5). The Reiki pairs displayed more coherence than the sham pairs within the theta band. That the sham pairs displayed more coherence within the low alpha (alpha 1) range over this same region compared to the Reiki group would be consistent with the assumption that the symbols have some effect even with novices but the total effect requires some experiential component.

The general increased coherence in the theta band for the Reiki process would be consistent with the Landauer phenomena or limit that states that when operations converge or when a bit of information is lost the energy release into entropy can be quantified by $\ln 2 \cdot kT$ where k is the Boltzmann constant and T is temperature. The increases in degrees of freedom represent the shift from information to “non-information”. For brain temperatures the quantum lost would be $\sim 3 \cdot 10^{-21}$ J. This has significant potential application to mechanisms involved with neuro-nonlocality. Within Layer II of the medial entorhinal cortices, which mediates the bi-directional interconnections between the hippocampal formation (a primary source of limbic theta waves upon which “40 Hz” ripples are superimposed) and the cerebral cortices, stellate and pyramidal-like cells display persistent sub-threshold oscillations of ~ 8 Hz with mean amplitudes of $2.6 (\pm 0.5)$ mV. Assuming 8 of these amplitudes per s with each quantum equivalent to $2.6 \cdot 10^{-3}$ V the total effect upon unit charges ($1.6 \cdot 10^{-19}$ A·s) would be $\sim 3 \cdot 10^{-21}$ J per s [25]. This begins to approach the $\sim 10^{-20}$ J quantum which has been considered a fundamental operational unit within the brain [13].

From the perspective of “universal energies”, which to be studied from traditional neuroscientific paradigms requires a quantitative equivalent, 10^{-20} J is the range of energies that emerge when the averaged energy of the universe is distributed across the wavelength of neutral hydrogen, the most abundant element in the universe [14, 15]. This value is also the solution for the energy lost to entropy when the Schwarzschild radius for the DNA content of the numbers of neurons within the human hippocampus is applied to the traditional equation for entropy and information [26].

The change in coherence measures between the pairs of brains for the theta band averaged around .14 for the comparison group and about 0.15 for the Reiki pairs. On average, a correlation coefficient of this magnitude reflects a shared variance of about 2.5% and the difference in coherence coefficients would reflect a shared effect equivalent to about 0.3%. If there are a maximum of 7 peaks (4 to 7 Hz for the theta band) per second over 600 s there would be a total number of peaks of 4,200 for which 2.5% would be 101 coincidence events. That would mean the Reiki pairs would have had .3% of this proportion or about 12 (assuming equal distribution over time) more coincidence events or “convergences” in Landauer operations. Similar small, near-zero mean correlations in cortical circuits have been found during asynchronous states coupled to specific stimuli [18, 27].

Although the duration of a single cycle in a 7 Hz sequence (143 ms) is sufficient to accommodate the duration of a percept, 80 to 120 ms [7], the peak power would occur for about 20 to 25 ms. If we assume the typical peak-to-peak change in voltage within the theta range (4-7 Hz) pattern is about $10 \mu\text{V}^2/\text{Hz}$ the global loss of coherent energy within the components contributing to the potential could be estimated from the square root of $V^2 \cdot B \cdot (A \cdot s)^2$ where V is voltage, B is band width, and $A \cdot s$ is Coulombs per charge [11,16] Assuming $10 \mu\text{V}^2 \cdot \text{Hz}^{-1}$, 4 Hz for the band width (theta) and $2.56 \cdot 10^{-38} \text{ A}^2 \cdot \text{s}^2$ for squared charge, the energy is about 10^{-21} J. This

is the same magnitude of energy entering entropy when a bit of information is lost or two computational pathways converge [28].

The involvements of energies within the theta band have been encountered in other experiments where non-locality is suspected. For example there was a conspicuous peak in 7 Hz power over the right temporal lobes in subjects who were near Sean Harribance who is well known for his capacity to infer the internal cognitive states and memories of others [29]. We suggest it is not spurious that the primary resonance frequency for both the earth itself within the biosphere and the human cerebrum (circumference about 60 cm) is 7-8 Hz [30]. The magnetic components (picoTesla range) and electrical components (mV range) for terrestrial and cerebral resonances in the 7-8 Hz range are effectively identical. The concept of accessing representations of other cerebrums through these shared frequencies has quantitative support but still requires experimental verification.

There were two other major measurements in this study that are salient. First the diminished coherence during the Reiki process within the delta range occurred primarily within the caudal regions of both hemispheres. There were no group differences within the prefrontal regions. This discrepancy is consistent with the passive or receptive rather than the active and organization (prefrontal) feature of Reiki claims. The apparent congruence between the general location of the changes within cerebral spaces of the sender-receiver pairs for the Reiki condition and the neural correlates of sympathy [31] may be more than coincidence.

The second result is the different coherence in gamma activity between the sham and Reiki pairs over time only in the *right* hemisphere. During the first third of the treatment duration there was more interbrain coherence for the Reiki pairs over the right hemisphere compared to sham pairs; however the effect was reversed during the last third of the duration with no group differences for the middle third. The well known intercorrelation between gamma and theta activity for the theta-dominated hippocampal region and the “40 Hz”-dominated cerebral cortices [32] as well as the classic observation of gamma activity superimposed upon the intrinsic theta waves measured directly from the hippocampus [33] would predict that any time-dependence in one band would be reflected in the other [34,35].

We had assumed that the likely greater right hemispheric involvement with distal Reiki, which was supported by QEEG data, would be reflected in greater emotional imagery in general and less discrepancy between senders and receivers. This was not supported. However there are many phenomena, such as cerebral detection of changes in syntax while reading that are clearly discerned by fMRI without the participant’s awareness, as reflected in verbal behaviour, even though the change has occurred.

The potential involvement of the right hemisphere within the gamma range in the initial “coupling” and interaction during Reiki procedures relative to sham procedures and the marked changes in correlation strength between the spectral powers of Reiki practitioners’ frontal regions with the receivers’ precuneus regions is consistent with the role of the right hemisphere in immunological processes [36]. We suggest it is important that the right hemisphere of the human brain is also more sensitive to increases in natural geomagnetic activity [37]. This is relevant because all human brains are immersed within the earth’s magnetic field that may serve as a medium of interbrain connection [23]. The geomagnetic field is also an optimal environment to support the conditions for macroscopic non-locality [11, 38].

Clearly the most difficult component to logically reason is why concentrating on three or four symbols differentially affected other people’s brains even though the two people never met and the Reiki practitioner did not know the identify of the person in a room 50 m away. One

could argue that the symbols, which “appeared” to the person who first popularized the Reiki method after he had been fasting for several days could be a hallucinatory pattern representing some intrinsic property of the right temporoparietal region. However this does not accommodate the effect upon the single person at a distance.

This challenge could be accommodated by Pitkanen’s [39-41] Topological GeometroDynamics (TGD) theory of consciousness and biosystems. According to this approach space-time is regarded as 4-faced surface in an 8 dimensional space which includes a complex projective space of two complex dimensions. It could be considered a more developed concept of hyperspace which is usually conceived as a four-dimensional composite of 8, three dimensional cubes. The many-sheeted space time or “topological condensate” is intricately connected to each other by wormhole contacts at discrete points along the boundaries. Unlike other considerations of space-time as an abstract manifold endowed with pseudo-Riemannian structures, the TGD assumes discrete and potentially quantifiable properties. There are two concepts that emerge from the TGD theory that are applicable to our results.

First, the self is approached as a system that remains *unentangled* during quantum jumps. According to Pitkanen, the maintenance of the self requires p-adic numbers to allow the non-determinism of imagination which is an essential element of cognition. Intention-to-actions occur in quantum jumps in which a region of p-adic space-time is replaced with a real geometric coordinate. Thus the contents of imagination, such as the four symbols visualized and ideated by the Reiki practitioners, could be manifested within mindlike space-time sheets that serve as correlates for conscious selves.

The coherence between the Reiki pairs (“sender” and “receiver”) shifted to the theta band, the one potentially associated with the Schumann resonance and within which all brains are immersed [23] whereas the inexperienced (sham) pairs displayed relative increases within the adjacent (8 to 10 Hz) low alpha band. Thus both types of paired-brains (involving either an experienced or inexperienced practitioner) showed greater interbrain sender-receiver coherence in the left temporal lobe only. This is the primary cerebral region associated with the linguistic labels associated with ideation and imagination. Metaphorically one may conceive the two cognitive processes as “interacting” within the space-time of imagination (“imaginal space”) which would be consistent with apposition of the boundaries of two “mind-sheets” in the TGD model.

From this perspective the only difference was the degree to which the shift occurred towards the intrinsic Schumann-ionospheric band that could potentially allow contact between the fields associated with all brains immersed within the earth’s magnetic field. According to Pitkanen the “sensory canvas” is outside of the brain and could exhibit a size that approximates the earth. The cerebral processes associated with “the self” serve as projectors and frequency-place coding induces magnetic quantum phase transition at some distance along magnetic flux tubes. In this manner simple qualia and more complex features are assigned to a point in the perceptual field through the 40 Hz frequency band. We found the specific enhanced coherence of this “40 Hz band”, the gamma frequency, over the right prefrontal regions of the Reiki pairs.

Pitkanen’s postulate that magnetic flux tubes, which are the elementary field quanta of magnetic fields, exhibit spatial dimensions in the order of a few microns, supports a modern principle of neuroscience that the synapse (with a width in the order of 0.5 to 2 μm) is the domain in which consciousness emerges. In fact the Casimir force when applied over the functional area separated by the distance between the pre- and post-synaptic membrane, that is 10 nm, results in a value whose energy solves for 1.42 GHz. In other words, the convergence of magnetic tubes to

within the range of the synapse would allow access to the universal hydrogen line. As predicted by Pitkanen, this value is coupled to Bohr orbits and the properties of the Bohr magneton.

The prevention of entanglement through serial quantum jumps is an intricate component of the role of p-adic numbers. If this did not occur, selves would be entangled presumably indefinitely. The Reiki pairs exhibited marked increase in interbrain coherence over the right prefrontal region for activity only in the gamma frequency (40 Hz) band. The effect was transient and dissipated within about 8 min. This is the duration of the “entanglement”, which was clearly transient [22] for photon emissions between non-local reactions of light emitting chemical reactions that were exposed to the same circularly rotating magnetic fields with changing angular velocities where the phase and group values had been dissociated.

The second application of the TGD involves the differentiation between subjective time and geometric time. Because of the non-determinism of serial quantum jumps associated with consciousness and the sense of self the contents of the conscious experience can be localized to a finite time interval. Although the space-time sheets associated with consciousness are non-determined they drift towards determinism if their boundaries begin to appose the sheets associated with geometric time. This physical effect would require some entanglement between the self and spaces such that there must be quantum communication between the brain of the geometric past and geometric now. If this “space-time” is dominated by the physical correlates of imagination, then Reiki practitioners would have been more effective within it because of their experience with this form of mentation.

The two spaces (separated by 50 m) that were employed in our study were always the same even though the people within them never met the people in the other space directly. However the brains of both members of the pairs were measured at the same time by almost identical equipment. Assuming an average EEG output over the 19 sensors to be $\sim 3 \mu\text{V}$ and that a weak electromagnetic field from this array of punctate voltages collected by the sensors was distributed over each of the two brains separated by 50 m, then the condition may have simulated the “double circularly rotating magnetic fields” [22] that produced the excess correlations in the photon emission studies. In this instance the source of the circular rotating electromagnetic fields would be the continuous “recreation” every 20 to 25 ms (“40 Hz” band) of the rostral-to-caudal coherent waves integrated over large cortical areas.

We have assumed the “circle” is completed through the structures of the Default Mode Network [42] of the human brain that primarily occupy the medial regions deep within the cerebrum (the cingulate areas). We would not expect this “angular velocity” to be constant but to display occasional changes in value that would allow occasional discrepancies between group and phase velocities. Thus the act of measurement simultaneously in two different locations could have produced the subtle energies required for the non-locality. The chronological age and the state of the two participants in a pair may be instrumental in the facilitation of this effect. Recently Lee et al (43) found that global power in QEEG activity decreases during wakefulness across age, especially in the lower frequency (0.5 Hz to 7.5 Hz) range. This is exactly the range that showed the greatest difference between Reiki pairs and inexperienced (“sham”) pairs as shown in Figure 1.

It may be relevant that assuming a cerebral field (which could produce a Pitkanen boundary) of $3 \mu\text{V}$ and a resistivity of $2 \Omega \cdot \text{m}$, the current (I) across the $\sim 10 \text{ cm}$ length of the cerebrum would be $\sim 10^{-7} \text{ A}$. Applying this to the simplest of application geometries, $I \cdot \mu \cdot r^{-1}$ would result in $10^{-7} \text{ A} \cdot (4\pi \cdot 10^{-7} \text{ kg} \cdot \text{m} \cdot \text{s}^{-2} \cdot \text{A}^{-1}) \cdot (10^{-1} \text{ m}^{-1})$ or $\sim 10^{-12} \text{ T}$ (pT). This is the order of magnitude of the operational intensity for action potentials within the cerebral volume as measured empirically by SQUID technology. The magnitude also defines the typical intensity for

the magnetic component of the Schumann resonance. When 10^{-12} T is multiplied by the magnetic moment of the Bohr magneton ($\sim 10^{-24}$ A·m²), the energy is within the range of 10^{-36} J whose mass equivalence is $\sim 10^{-52}$ kg. This is considered to be the upper limit for the rest mass of a photon.

The procedures (and subjective states) displayed by both sets of experimenters located at each of these two space-time points over many days of testing pairs of Reiki and Sham pairs could have strengthened the point-contacts or “wormholes” between the many sheeted space-time. A component of Pitkanen’s principles predicts that repeated quantum jumps of many consciousnesses within the same 4-faced, 8 dimensional sheets could enhance both connectivity and identity between the loci through space-time contiguity. It may be relevant that we noted that the strength of the effect in separate Reiki pairs increased as the experiment progressed.

The TGD inspired theory of consciousness requires attention to the most counter-intuitive feature of time, the parity and equilibrium of cause-effect. In other words, there may be periods or space-time intervals where the effect precedes the cause. In quantum jump sequences predicted by the TGD the geometric past, that is the classic physical temporal history, changes. From this perspective (which would alter the manner in which human kind perceives and interprets history and the nature of predisposing factors for health and well being), the specific coherence of gamma activity in Reiki pairs over the right prefrontal region could have been a necessary condition. It is this region that is most correlated with the “reconstruction” of experience, that is the past, and is the fundamental determinant of episodic and autobiographical memory. The TGD theory suggests that geometric time was actually changed and that the coherence occurred because of events that emerged after the measurements. From this perspective the increased theta coherence in the last portions of the measurement (Figure 1) for the Reiki pairs would have caused the increased gamma coherence between the each pair over the right prefrontal region (Figure 5) and hence would have produced the potential to have modified any associated autobiographical memory.

Acknowledgements

We thank Dr. Cynthia Whissell and Dr. Sandra Dorman for the constructive criticisms and help with the analyses. A special thanks to the Neuroscience Research Group, particularly Professor Stanley Koren, Ms. Mandy Scott, and Mr. Mark Collins, for supplying the equipment and assistance.

Addendum / Open Peer Review Comments

Selected Comments, initial submission

Reviewer 1 [...] To remedy the degrees of freedom problem with all the frequency bands available for the effect, I would suggest the authors perform a pattern classification analysis to determine if a pattern classifier can predict whether brain activity is from the reiki or sham condition.

Another approach is to apply Bonferroni-type corrections.

Reviewer 2 [R 1] suggests using a pattern classifier, a nice idea but one which is only a part solution (what exactly were all the variables (frequency bands, electrode etc)/analyses tried out). The experimental investment is minimal here, 8 pairs for 10min data collection each: allowing for overhead maybe 8 hrs total experimental time. Why not just do the experiment again; but this time with all the analysis variables set at the values of the first experiment? This would probably take less time than doing a pattern classification.

Reviewer 1 That would work too. This is an exploratory experiment, and they should perform a confirmatory one.

Reviewer 4 I agree with both R1 and R2, and I think the recommendation for a pre-specified repeat is good.

Reviewer 5 [...] I see a clear description of the procedure and a sufficient methodology. The problem of post-hoc analyses and the correction of multiple comparisons should be reduced if authors clarify better the exploratory vs. the confirmatory hypotheses.

From: Dr. Michael Persinger, March 6th, 2014

We wish to thank the referees for their comments. They are excellent suggestions but not directly applicable to the method of data collection employed in this study. The Reviewers suggestions for pattern classification analyses or some variant are interesting but our sampling sizes are not sufficient for such procedures. In addition, the large effect sizes of the differences between two groups with such small sizes but whose single measurements were obtained over several weeks (now indicated in the Method Section) is typical of clinically robust phenomena as we have seen many times in our practice involving more mundane measurements.

In addition, the degrees of freedom are not particularly an issue when one considers these are repeated measure, mixed designs. Again, we reiterate that even with the perceptually impressive degrees of freedom, what are more critical are the effect sizes. They are independent, in large part, from sample size while statistical significance is influenced by sample size. The group differences we observed explained 25% to 50% of the variance in the QEEG data. In our opinion, that is the major strength of the study and the phenomena. The fact that the specific frequency bands that were differentiated between the two groups are those associated with previous experiments by other researchers and are precisely the increment that would be required to access large transsurface locations over the earth strengthens (but obviously does not prove) the argument.

Yes of course we agree that replications are preferable, especially Sidman-type replications where in order to discern a predicted effect one must intrinsically replicate a previous effect upon which the prediction is based. Considering the inexpensive nature of QEEG and sLORETA equipment and now the clear demonstration of how large the effect between two brains can be if one simply

substitutes the two whole brains of two people separated at distances for two hemispheres of one brain in the same space, replications by other groups should be forthcoming.

Thank you,

Dr. M. A. Persinger
Full Professor
Behavioural Neuroscience and Biomolecular Sciences Programs

From: Dr. Michael Persinger, March 13th, 2014

Dear Colleagues,

As an integrative scientist I appreciate that phenomena emerge at different levels of discourse and that some phenomena are reflected at different levels of discourse. One of the reasons I have studied electromagnetic fields for the last 50 years with such dedication and commitment is that, when applied appropriately, they affect social behaviour, individual behaviour, organs, cells, plasma cell membranes, chemical reactions, physical (quantal) changes, and photon emissions.

Instead of employing only a reductionist approach, which can be informative, the applications of magnetic fields and the measurement of changes at each level of scientific discourse reveal the configuration (temporal or spatial) by which the “same” magnetic stimulus is revealed at each level. In other words there is no requirement for a reduction or trivialization but an opportunity to view the equivalence or the “unique” application geometry.

From this perspective I offer a possibility for which I cannot accept credit, for Spinoza explored this to the limits of verbal behaviour with greater exactitude. If we assume the validity of the basic functional units of matter as the proton and electron and the potential salience of the resurrection of Eddington’s number reflecting the fixed number of fundamental units in the universe, a property of relevance to consciousness researchers emerges too.

The induced magnetic moment corresponding to the change in angular velocity (opposite to B) can be described as:

$\Delta m = -(e^2 \cdot r^2) \cdot (4m)^{-1} \cdot B$ where B is the magnetic field intensity, e is the unit charge, r is the Bohr radius and m is the mass of an electron. If we apply the typical strength of the intracerebral magnetic field that we have inferred and measured associated with cognitive activity coupled to consciousness, that is about a pT (10^{-12} T), the induced magnetic moment is about 10^{-41} A·m² or 10^{-41} J per T. If this magnetic moment is immersed within a second magnetic field, in the order found within galactic magnetic fields, 10^{-10} T, the energy is within the range of 10^{-51} J, more specifically about $1.8 \cdot 10^{-51}$ J.

Although this increment seems very small when divided into the central reference for quantum phenomena, Planck’s constant, $6.626 \cdot 10^{-34}$ J·s, the solution is between $3 \cdot$ and $4 \cdot 10^{17}$ s, effectively the current age of the universe. Obviously the coefficients that determine the exactness of solutions will be critical in a more objective assessment of the approach. However I bring this to the attention of my Colleagues because if the essence of what we attribute to consciousness is a physical property contained within the space occupied by the cerebrum that is based upon proton-

electron processes (and the photons coupled to them), the consternation concerning the duration of consciousness may be less critical than previously assumed.

The second relevant feature is the energy volume density within the universe and the human cerebrum. The estimated “total” energy of $2.2 \cdot 10^{69}$ J of the universe with a volume (assuming a sphere) of $8.4 \cdot 10^{78} \text{ m}^3$ from an age of $4.2 \cdot 10^{17}$ s, results in an energy density of $\sim 0.3 \cdot 10^{-9} \text{ J} \cdot \text{m}^{-3}$. Within a human cerebrum with a volume of 1300 cc ($1.3 \cdot 10^{-3} \text{ m}^3$), this is equivalent to $\sim 10^{-12}$ J. The energy associated with the action potential ($\Delta V = 1.2 \cdot 10^{-1}$ V multiplied by a unit charge of $1.6 \cdot 10^{-19} \text{ A} \cdot \text{s}$) is $\sim 2 \cdot 10^{-20}$ J. That would be equivalent to between 10^7 to 10^8 action potentials per s or for between 10^6 and 10^7 cortical neurons each discharging around 10 Hz. This is precisely the number of neurons associated with specific types of experiences and percepts often attributed to consciousness.

Finally the temporal coupling between the physical processes associated with consciousness and cerebral function may have been apparent for at least two decades. The recursive rostral-caudal movement of bulk velocity potentials over large coherent regions of the cerebral cortices at $\sim 4.5 \text{ m} \cdot \text{s}^{-1}$ is associated with a repetition rate as well as a phase modulation in the order of 20 to 25 ms, that is 40 to 45 Hz or the gamma range typically associated with “consciousness”. The typical stacking time for a base nucleotide on a DNA fork during synthesis is in the order of 20 to 25 ms.

A similar electromagnetic-nucleotide connection was noted for RNA. The energy associated with the stacking of one base on a RNA ribbon is about $2 \cdot 10^{-20}$ J and requires about 1 ms. This is the same order of energy associated with a single action potential of an axon and as well as the duration of the classic “spike”. The correlative shift in the absence or presence of a base due to this energy potentially alters the constituency of the base pair sequence and hence the type of protein that is ultimately synthesized. In this manner the transformation from the “electromagnetic” transients of short-term memory (the representation of experience) to the protein-structure-specific bases for intermediate and long-term memory can occur.

For consciousness durations, of about 20 to 25 ms, the congruence between the “refresh rate” of consciousness and the stacking time for a base nucleotide on the DNA sequence sets the potential condition that not only does the DNA structure affect the electromagnetic fields that may define consciousness but that these fields could affect or even modify particular aspects of the DNA “record” within neurons and glial cells. If 10^{-20} J is a universal quantum then the intercalation between both DNA patterns (during synthesis) and the electromagnetic manifold associated with consciousness could have a very broad space-time boundary.

Thank you for reading this suggestion.

Michael Persinger

From: Dr. Matti Pitkanen, March 15th, 2014

1. About the experimental and statistical procedures and feasibility of the results.

a) The representation of the experimental side looks quite clear. Personally I find it difficult to conclude how significant the reported larger changes of EEG power and mutual coherence of EEG power in left hemisphere theta and right-hemisphere gamma are. From elementary particle physics I know how little one can trust on the outcomes of statistical procedures.

b) Contrary to naive expectations, in some bands also sham pairs demonstrate increase of EEG power. Increases in correlations and EEG power present in higher bands were interpreted in terms of similar cognition processes, which looks natural since the symbols were not familiar for the sham pairs, unlike for the Reiki healers.

c) Also unexpected increase in low alpha for both members of sham pairs was reported. This is more difficult to understand and could be used to argue against the proposed interpretation.

2. About results

a) The increase in gamma power for Reiki pairs in the first third of experiment time brought to my mind Revonsuo's finding that increase in gamma power might relate to the generation of new percept (<http://www.phil.vt.edu/ASSC/engel/revonsuo1.html>). Maybe this might be of some interest concerning interpretation. Maybe increase in gamma power might serve as an indicator for transfer of conscious or sub-conscious information in remote mental interactions.

b) The time scale of about 2 minutes appearing in data is interesting.

3. Some Comments concerning theoretical interpretation

I have added in these comments reference to TGD because discussion section refers to TGD.

First, a proposal for a correction. The statement "spacetime is regarded as 4-laced surface in an 8-dimensional space" is misleading and might lead to wrong impressions about TGD; "space-time is regarded as 4-dimensional surface in an 8-dimensional space" is the correct term. I also often mention the analogy with string models where "space-time" is 2-dimensional surface in a 10-dimensional space. Later the statement "4-faced, 8-dimensional sheets" occurs and should be replaced with "4-dimensional space-time sheets in 8-dimensional imbedding space" (say) to avoid wrong associations.

Next comments relate to the theoretical interpretation and here I cannot avoid mentioning TGD.

a) In the discussion the authors talk about universal energy quantum of $10^{(-20)}$ J and propose an interpretation involving cosmology and Schwarzschild radius. In my opinion a much more conservative interpretation is possible.

The resting potential of the neuronal membrane is around .063 V (last decimal is 3 just for convenience!): electron and proton get the energy 63 meV in this potential when moving through this potential without friction this corresponds precisely to the "universal energy quantum" $10^{(-20)}$ J.

The TGD interpretation of the energetic quantum as Josephson energy $ZeV = 2eV$ of Cooper pair with $Z=2$ ($126 \text{ meV} = 2 \cdot 10^{(-20)} \text{ J}$) is attractive and involves only basic facts about membrane plus superconductivity hypothesis. At microscopic level cell membrane as Josephson junction would be replaced with microscopic Josephson junction which would be naturally ionic channels and pumps.

The photon energy at the maximum of the black body radiation energy density dE/df as function of frequency energy is about $E_{\text{max}} = 3 \cdot kT = \text{about } .1 \text{ meV}$ at temperature 310 K /37 C). This is slightly below the energy $2eV = .12 \text{ meV}$ of Cooper pair so that Josephson radiation should not be masked by thermal radiation. Also the local temperature might be reduced by some kind of adiabatic mechanism.

b) Since theta band is around 8 Hz as also Schumann resonance, the obvious idea is that Schumann resonance possibly assignable to collective levels of consciousness is involved. If the flux tubes of the personal magnetic bodies are within flux tubes or flux sheets of Earth's magnetic field, this interpretation is natural. I do not believe that particular symbols thought by Reiki healer are important as such - they might be analogous to the letters of written language making communication between healer and magnetic body of Earth seen as intelligent entity. Some convention is necessary but what this is convention is, does not matter. Religious symbols would define similar language.

c) There is a comment about cyclotron energy of charged particle in magnetic field of intensity $10^{(-12)}$ Tesla defining the order of magnitude for Schumann resonance amplitude. The corresponding cyclotron energy heB/m for proton is extremely small for ordinary value of Planck constant h , and happens to be of the order of upper bound for photon mass - to my opinions this is just coincidence.

In TGD framework the key idea is however the hierarchy of Planck constants $h_{\text{eff}} = n \cdot h$ inspired originally by the findings of Blackman et al. about effects of ELF em fields on vertebrate brain and frequencies, which are harmonics of Ca^{++} in magnetic field $B = (2/5) \cdot B_E = .2 \text{ Gauss}$ identifiable as endogenous magnetic field. What is important that for high enough value of h_{eff} allows to have cyclotron energies above thermal threshold.

d) TGD suggests following approach to the understanding of the claimed effect - assuming it is real. Earth's magnetic body could serve as a "relay station" containing the flux tubes of both Reiki healer and patient inside its flux quanta. Sender and receiver would be like two neurons of brain whose activities are correlated by macroscopic quantum coherence. This would allow both

classical communications by theta waves and negentropic quantum entanglement, which is maximal in the sense that density matrix is proportional to $n \times n$ unit matrix. This entanglement carries (maximal) information assignable to the pair (for instance, pairs in the superposition could be interpreted as instances of a rule defining the information). The measure for this information is p-adic variant of Shannon entropy. The p-adic prime p which gives rise to largest prime power dividing the number n of the maximally entangled states: for instance for $n = 26 = 2 \cdot 13$ the prime would be 13. Unitary entanglement matrix encountered in quantum computations defines an example of this kind of entanglement.

From Dr. Persinger, 21 March 2014

We concur with Dr. Pitkanen's interpretations and suggestions. We are designing a series of experiments that might allow us to produce reliable macroentanglement. I (Dr. Persinger) appreciate the convergence of cognitive operations between Dr. Pitkanen's approach and our neuroquantum-quantitative approach. In my opinion the similarity is greater than it appears at present.

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