

Cerebral Activity and Source Profiles Accompanying the Process of Non-Locality

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ABSTRACT

The independently rated congruence of subjects' drawings and descriptions with the content of affective pictures hidden ~50 m away were correlated with cerebral quantitative electroencephalography (QEEG) and LORTEA (Low Resolution Electromagnetic Tomography) over three weekly trials. A shift over time from left prefrontal gamma activity to right caudal hemispheric delta activity was associated with increased accuracy. Increased accuracies for the details for the non-local stimuli during sessions were associated with greater congruence within the 25-30 Hz and theta (4-7 Hz) range between the parahippocampal regions. Increased theta power also occurred in the left anterior cingulate, fusiform gyrus and midtemporal regions. We suggest that experiences of non-locality involve confluence within the right parahippocampal region and are translated for their personal and linguistic equivalents within specific left hemispheric structures.

Key Words: QEEG, s_LORETA, detection of distance stimuli, non-locality, temporal lobes, parahippocampal gyrus, theta activity

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1. Introduction

Human perceptions are cerebral phenomena that involve the combined processes of sensation and memory. Sensation is defined as the responses to stimuli which are defined as environmental events that elicit, through transductions of energies, more or less consistent changes in the occurrence or probabilities of those responses. Memory is the representation of experiences within cerebral space. For most phenomena and for most explanations there is the assumption of locality. Locality indicates that any relationship between a stimulus and response

occurs because there is some mediating process in the proximity that allows the stimulus to elicit the response (Persinger and Lavallee, 2010; 2012; Stepp, 2009). In this study we investigated the possible involvement of non-locality for the acquisition of distant information within hidden pictures by examining rated accuracies for these details with measurements of quantitative electroencephalography (QEEG) and one method of source localization, s_LORETA (Low Resolution Electromagnetic Tomography).

The effect of event A upon event B, or stimulus and response, is the basis of behavioral approaches to living systems. In general instances the causal connection between A and B is assumed to be mediated by a factor they both share such electromagnetic or mechanical energies. However, the *a priori* understanding for a mechanism that involves locality, that is some process that mediates the effect of the stimulus upon the response, is not essential to study or to measure the phenomenon.

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Over the long history of rational inquiry there has been a subset of phenomena attributed to conditions of non-locality. In this setting a stimulus occurs in one setting and a response occurs elsewhere without the apparent direct causal connection from a mediating source at the time. The occurrences of these “excess correlations” did not mean that the mechanisms were not ultimately understandable. For example in the 19th century the avoidance (response) of objects (stimuli) in the dark by bats was attributed to “psychic detection”, the contemporary description for non-locality. The measurement and quantification of ultrasound supplied the missing mediating process.

The most singular development that revealed the mechanisms involved with operations of natural and physical phenomena has been technology. The rapid development of quantitative electroencephalography (QEEG) and the algorithms to discern three-dimensional activity within the cerebral volume such as s_LORETA (low resolution electromagnetic tomography), like fMRI technology, have shown that proximal stimuli can produce changes in focal brain activity without awareness (Berns *et al.*, 1997). These measurements are consistent with the fact that consciousness may require a critical mass of neuronal patterns or numbers (Fendrich *et al.*, 1992; Huang *et al.*, 2007).

Considering the more sophisticated tools now available to brain research historically eccentric phenomena can be re-examined with the possibility of meaningful discovery. The first involves the acquisition of information from a distance about an object, for example a picture unknown to the percipient hidden in an envelope at a significant distance. During the last 100 years there has been intermittent focus on this challenging philosophical problem that included the “psychic” research studies of the late 19th century (Harrington, 1995), the exploration of “extrasensory perception” by Rhine and Pratt (1957) during the first half of the 20th century, the remarkably reliable Maimonides “dream telepathy” research during the 1960s by Krippner and his colleagues (Ullman *et al.*, 1989), and more recently the Stanford Research Institute’s “remote viewing” paradigm developed by Puthoff and Targ with the help of Ingo Swann (Puthoff and Targ, 1976).

The persistence of these effects suggests the presence of a yet to be discerned physical process that may reveal the boundaries of the human brain’s capacity to access information from space-time. In the present experiments we combined three approaches in a novel manner. First the potential role of entanglement was employed by insuring that the experiencers had been in the same space where the stimulus would be located. Such shared space has been shown experimentally to facilitate excess correlations consistent with one definition of entanglement (Dotta *et al.*, 2009; 2011a, b; Dotta and Persinger, 2012). Second QEEG and s_LORETA measurements were obtained while the subjects were engaging in cognition about the details of hidden pictures and then compared to the accuracies of descriptions.

Experimental Procedures

Subjects

A total of 14 male (n=2) and female (n=12) subjects volunteered for the experiment in response to advertisements in a local newspaper for people interested in psychic research. Their ages ranged between 26 and 78 years.

Procedure: Non-Local Experiences (NLE)

Each subject engaged in three separate Non Local Experience (NLE) episodes, once per week, for three consecutive weeks in November and December 2011. On each day of the experiment the subject was first escorted to the area where a picture was to be located and then escorted back to a room (about 50 m away) where the QEEG was measured.

For each day of the experiment the subject wore a 19 channel sensor cap (Mitsar EEG-201). Three samples were collected during the 3 min baseline followed by a single sample during visualization while the subjects imagined walking from the test room to the room where the picture was sequestered. During the subsequent 10 min the subject engaged in attempts to perceive the picture that had been placed in the room a few minutes previously. There were three samples of QEEG measurements when the eyes were closed and three samples when the eyes were opened. During this period each subject focused upon receiving information about the picture. At the end of this period a post session



QEEG sample (eyes closed) was completed. Consequently there were a total of 11, 30 s EEG samples per week. During the NLE of the hidden pictures the subject recorded and wrote down all of his or her images or impressions that occurred when focusing on the place where the picture was located.

There were a total of 3 hidden pictures (1 per week) for each subject (n=42) that had been obtained from a collection of photographs provided by Professor Don Hill, an artist and journalist from the University of Edmonton. The 8 x 11 pictures printed in color on typing paper had been selected for their emotive, colorful, and striking characteristics. Each picture had been placed in an 8 x 11 sealed manila envelope with the face up by another person. These envelopes were then given to the experimenter. The experimenter did not see the photographs until after the sessions were completed.

Quantitative EEG data

The data from each of the 19 channels were analyzed by WINEEG software to obtain the $\mu V^2/Hz$ values for six classic EEG intervals: delta (1-4 Hz), theta (4-7 Hz) alpha (8-13 Hz) low beta (13-20 Hz), high beta (20-30 Hz) and gamma (30-40 Hz for each of the 11 samples of EEG measurements for each of the three weeks. The power for each frequency band was extracted and exported into SPSS Windows PC.

Narrative-Drawing-Picture Scoring

A total of 10 individuals not involved with the experiment volunteered as judges. One group of 5 judges assessed the narratives for each of 21 pictures while another 5 judges assessed the narratives for the other 21 pictures. The judges were all graduate students who were familiar with the concepts of consciousness and NLE but who did not know the subjects. For judging of accuracy each judge was tested singly. Each original picture was presented with 3 other pictures on a table in front of the judge. The judge read the narrative and then ranked the pictures according to which one was most (rank=1) to least (rank=4) like the descriptions or drawings. Then the four pictures were removed and another 4 pictures (1 being the original picture) was assessed according to the narrative that was recorded for the subject during NLE for that picture. All judges were

told that both perceptual and emotive themes should be emphasized.

Consequently for each narrative for each subject a rank of 1 to 4 was obtained for each of the three weeks. The mean of the five rankings for each narrative for congruence with the "target" picture was calculated for each subject for each of the three weeks. As a result there were a total of 42 scores with ranks between 1 and 4.

The most appropriate method to assess the potential field or matrix nature of the relationship between congruence between narratives and picture information and EEG activity was multiple regression. These analyses were completed for the average accuracy scores for each of the three weeks. This means that there were a total of 11 multiple regressions for each EEG sample for a given week. All measures from the 19 channels and 6 frequency bands were allowed potentially to enter. Because there were only 14 subjects, the criteria set for maximum numbers of variables to enter the equation was 3.

One method to control for such large numbers of variables is to discern temporal congruency. To assess this feature the EEG data for a given week was analyzed not only for the accuracy scores for the same week but also in independent analyses the accuracy scores for the other two weeks. We assumed that random or spurious relationships associated with employing such large numbers of independent variables could be differentiated. One would predict that the greatest numbers of significant variables to enter an equation for predicting the congruency scores between narratives and pictures according to judges' ratings should occur for the same week.

The outputs for the 11 (6 NLE, 5 baselines or visualizations) multiple regressions of EEG data for each week for accuracy for each week (33 x 3=99) employing the above criterion were obtained. The numbers of EEG variables that entered (of the possible 0 to 3) were extracted. To discern if there were differences in the entry of EEG variables from different lobes, hemispheres, or frequency bands, this information was extracted as well. These data were then analyzed by SPSS PC software. Chi-squared analyses, where appropriate, were calculated manually.



For each NLE session (N=42) a total of 18 segments from each condition (baseline, remote viewing) were exported into s_LORETA where raw data was first transformed to obtain the $\mu V^2/Hz$ values for eight classic EEG intervals: delta (1.5-4 Hz), theta (4.5-7 Hz), alpha1 (7.5-10 Hz), alpha2 (10.5-13 Hz), beta1 (13.5-20 Hz) beta2 (20.5-25 Hz), beta3 (25.5-30 Hz), and gamma (30.5-35 Hz). These cross spectral data files were then transformed into .slor files and analyzed within the s_LORETA software.

To examine differences in brain activity during NLE the transcripts of the NLE were rated as highly accurate (n=14; mean accuracy range = 1 to 1.5) as opposed to when NLEs were rated as highly inaccurate (n=12; mean accuracy range = 2.6 to 4), sLORETA t-test pairs were used to localize the source of the changes observed in QEEG activity between baseline and NLE interval. For each of the 26 comparisons the sources displaying the greatest change (areas with the largest t-score) were scored as either 0=no change, 1=increase from baseline, or 2=decrease from baseline, regardless of frequency band (delta to gamma). These scores (0 to 2) were entered into a database and analyzed in SPSS Windows PC along with variables for group, time (weeks 1 to 3), and accuracy (ratings 1=hit to 4=miss).

High rankings of accuracy were achieved throughout all three testing weeks by subjects in each of the three groups. To discover the source of the changes in brain activation over time during highly accurate non-local experiences at the beginning and end of the treatment period, 8 of the most accurate NLE sessions were entered into s_LORETA where independent t-test pairs were used to compare the QEEG data obtained during high accuracy in week 1 (NLE1, n=4) to week 3 (NLE3, n=4). Mean accuracy for both groups was equal (1.25).

2. Results

2.1 Increased congruency scores with time and practice

Over three successive weeks during approximately two months more than a dozen subjects who volunteered for the experiment in response to a local newspaper advertisement were tested singly. Each subject had been escorted to the space in which a picture would be hidden for that week and then taken to one of several rooms about 50 m

away in a different building. About 5 min after the subject left the stimulus space a sealed envelope containing a picture was placed in that space by another experimenter.

Then, during a 15 min period 30 s samples of QEEG (Hunter *et al.*, 2010) during 3 baseline, a visualization period where the subject imagined walking down to the locus and walking back, 6 imagining (3 eyes opened, 3 eyes closed) and 1 post-baseline periods were recorded. During the imagining periods the subject drew and wrote what was “experienced” or perceived. At the end of the recordings the subject was escorted down to the stimulus space, opened the envelope and saw the picture while the experimenter was present.

This procedure was repeated for 3 successive weeks for a total of 42 different pictures that had been printed on 8 x 11 paper and contained within envelopes that the experimenter who placed each one during a session in the location could not see. The envelopes had been prepared and sealed by another person. The pictures had been selected by an artist from an extraordinarily large pool of photographs that emphasized emotion and color of objects or events. After the experiment was completed groups of 5 judges, each assessing singly in a single sitting, were given the actual picture and three other pictures (not related to the experiment) and asked to rank the similarity (1 most to 4 least) of the subject’s drawings and comments. The mean of the rankings of the five judges for congruency between the picture and the descriptions/drawings was used as the score for accuracy.

Two examples of maximum congruence between the picture and the drawings and descriptions and two examples of minimum congruence between the picture and the drawings and descriptions are shown in Figures 1 through 4. The visually conspicuous accuracy of the drawings/descriptions given the greatest congruence scores with the actual photograph were similar qualitatively to the fidelity first reported by Puthoff and Targ (1976) but less detailed than those produced by the exceptional subject Ingo Swann (Persinger *et al.*, 2002).

Over the three weeks (trials) there was a significant [$F(2,26)=2.57, p <.05$; one-tailed]



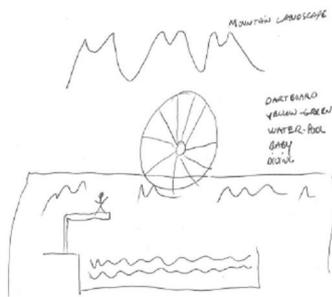
increase in the mean accuracy of the experiences. The means and standard deviations (in parentheses) for the mean rankings for subjects' drawing and descriptions and the hidden pictures for the three weeks were 2.3 (0.9), 2.1 (0.8) and 1.7 (0.5), respectively (lower mean scores more accurate).

ID09rv3 (Acc 1.0)

Target



RV Data



[Transcript]

Mountain landscape
 Dartboard
 Yellow-green
 Water-pool
 Baby
 Diving

Viewer Comments:
 "I got the sense of round, and somebody diving. There was also some movement, it felt like."

Figure 1. Example 1 of a picture stimulus and the responses that were ranked as most congruent.

ID09rv1 (Acc 1.0)

Target



RV Data



[Transcript]

Building
 Flowers
 Cloudy

Viewer Comments:
 "I also got an impression of a car in the foreground, was going to put it in but I didn't."

Figure 2. Example 2 of a picture stimulus and the responses that were considered as most congruent. Note automobile in the far background.

ID14rv1 (Acc 4.0)

Target



RV Data

Summer -
 picnic
 blanket on grass
 teddy bear - brown
 hot air balloon bright colors blue & red
 wavy pattern on top left side of picture
 = funny/comical
 - air

a white horse

Kids
 a toy train yellow/red/blue/large
 bright colours

[Transcript]

Summer
 Picnic
 Blanket on grass
 Teddy bear - brown
 Hot air balloon bright colours blue and red
 Funny/comical
 Air
 A white horse
 Kids
 A toy train yellow/red/blue/large
 Bright colours

Viewer Comments:
 "The picture was coming to me in landscape orientation vs portrait"

Figure 3. Example 1 of a picture stimulus and the responses that were ranked as least congruent.

ID08rv2 (Acc 3.8)

Target



RV Data

Cool-air
 Grey
 Clouds - misty
 Water
 Sparkle
 Wood
 Grass
 Glisten
 misty



[Transcript]

Cool air
 Grey
 Clouds - misty
 Water
 Sparkle
 Wood
 Grass
 Glisten
 misty

Figure 4. Example 2 of a picture stimulus and the responses that were considered as least congruent.



Post hoc analyses indicated that the major difference occurred between the second and third week [$t(13)=2.17$, $p < .05$]. When net changes in scores were computed for the second and third week compared to the first week the consequences of repeated experiences and reinforcement, that is, seeing the picture that was the stimulus after the drawings and written descriptions were apparent. The improvement between the second and third week accommodated 27% of the variance [$F(1,13)=4.71$, $p < .05$].

2.2 QEEG Correlates with Accuracy Scores

Our approach to the cerebral bases to reified constructs such as “consciousness” and “perception” is that their closest physical equivalent would display field-like or matrix-like characteristics (Bokkon, 2005; De and Pal, 2005; McFadden, 2002; Persinger and Lavalley, 2012; Pribram and Meade, 1999). A given value for a matrix could be the resultant from a large number of combinations of different values in each of the cells that compose the matrix. We reasoned that the closest quantitative method to assess the potential field or matrix nature of the relationship between (congruence) narratives and picture information and EEG activity was multiple regression analyses. All measures from the 19 channels and 6 classical frequency bands (delta, theta, alpha1, alpha2, beta1, beta2, and gamma) for the 11 samples per week were allowed potentially to enter the equation to predict accuracy scores. For a given week there were 11 (the samples) equations.

Two approaches were employed to minimize artifacts. First, only three variables were set to enter each equation. Second, the regressions were completed for the accuracy scores for the same week but also in independent analyses with the accuracy scores for each of the other two weeks. We assumed that random or spurious relationships associated with employing such large numbers of independent variables could be differentiated. We predicted that the greatest numbers of significant variables to enter an equation that predicted the congruency scores between narratives and pictures according to judges’ ratings should occur for the same week.

The results of the multiple regression equations for accuracy for NLE for the same day (indicated by *) and the other two days (separated by a week or two weeks) are shown in **Table 1**. What is qualitatively clear is that the numbers of brain activity variables that entered equations that predicted accuracy was greater than other weeks for the second and third weeks of the subject’s testing. This would be consistent with a learning-like process.

Chi-squared analysis for the total numbers of brain activity for the different trials (weeks) that entered the equations for accuracy scores for the different weeks indicated a statistically significant ($p < .05$) discordance. In other words, as a function of experience and time, the numbers of variables from contemporary brain activity correlated with accuracy increased after the first week.

The origins of the EEG activity over the different lobes, hemispheres, and frequency bands that entered the equations that predicted accuracy are shown in **Table 2**. For this analysis correlations with the central leads were included under the parietal lobes. The most conspicuous observation was the greater number of frontal origins during the second week and more temporal origins during the third week.

With respect to hemisphere, the change over time was also apparent. The major origin of variables contributing to equations that predicted accuracy of NLE originated disproportionately more from the left hemisphere during the second session and from the right hemisphere during the final session. Small discrepancies in the totals shown in Table 3 are due to the entry of the occasional z (midline) position that was not allocated to either hemisphere. For the frequency bands (that contributed to the equations that predicted accuracy) the major discordance occurred during the third week with disproportionately more predictor variables originating from the delta band. This was not apparent during the second week and first week, when gamma activity was weakly prominent.



Table 1. Numbers of EEG variables entering multiple regression equations (max=3) during the non-local experiences for each session and the congruency scores for that session (*) and for congruency scores of the other two sessions.

Sample	First Session			Second Session			Third Session		
	A1*	A2	A3	A1	A2*	A3	A1	A2	A3*
<i>RV C1</i>	0	2	0	0	3	3	0	3	3
<i>RV C2</i>	3	1	0	1	2	3	1	3	3
<i>RV C3</i>	1	3	0	1	1	3	3	0	2
<i>RV O1</i>	0	0	1	1	3	1	1	2	2
<i>RV O2</i>	0	0	1	2	3	1	3	0	2
<i>RV O3</i>	2	1	1	3	3	3	1	1	3
<i>Base1</i>	2	1	3	3	3	1	0	2	3
<i>Base2</i>	2	1	3	1	3	0	0	1	3
<i>Base3</i>	2	0	1	3	2	2	0	3	3
<i>Visual</i>	0	3	1	3	3	1	0	3	3
<i>PBase</i>	1	0	3	0	3	0	3	1	3
Total	13	12	14	18	29	18	10	19	30

Table 2. Numbers of EEG variables from different lobes entering (max=3) during the non-local experiences for each session and the congruency scores for that session (*) and for congruency scores of the other two sessions.

	First Session			Second Session			Third Session		
	A1*	A2	A3	A1	A2*	A3	A1	A2	A3*
<i>Frontal</i>	4	1	2	8	13	7	5	8	8
<i>Temporal</i>	9	8	6	7	6	3	4	9	12
<i>Parietal</i>	0	3	5	2	8	8	2	1	5
<i>Occipital</i>	0	0	1	1	2	0	0	2	5

Table 3. Numbers of EEG variables from the two hemispheres entering multiple regression equations (max=3) during the non-local experiences for each session and the congruency scores for that session (*) and for congruency scores of the other two sessions.

	First Session			Second Session			Third Session		
	A1*	A2	A3	A1	A2*	A3	A1	A2	A3*
<i>Left</i>	9	9	6	10	15	8	5	12	7
<i>Right</i>	3	3	6	8	8	9	5	8	20

Table 4. Numbers of EEG variables from the different frequency bands entering multiple regression equations (max=3) during the non-local experiences for each session and the congruency scores for that session (*) and for congruency scores of the other two sessions.

	First Session			Second Session			Third Session		
	A1*	A2	A3	A1	A2*	A3	A1	A2	A3*
<i>Delta</i>	3	4	3	4	9	2	2	8	11
<i>Theta</i>	0	0	0	1	2	7	2	2	5
<i>Alpha</i>	1	6	5	4	6	3	2	4	2
<i>Beta1</i>	2	0	4	4	5	4	3	3	6
<i>Beta2</i>	0	1	2	5	4	0	1	1	3
<i>Gamma</i>	6	1	0	3	3	2	0	1	3



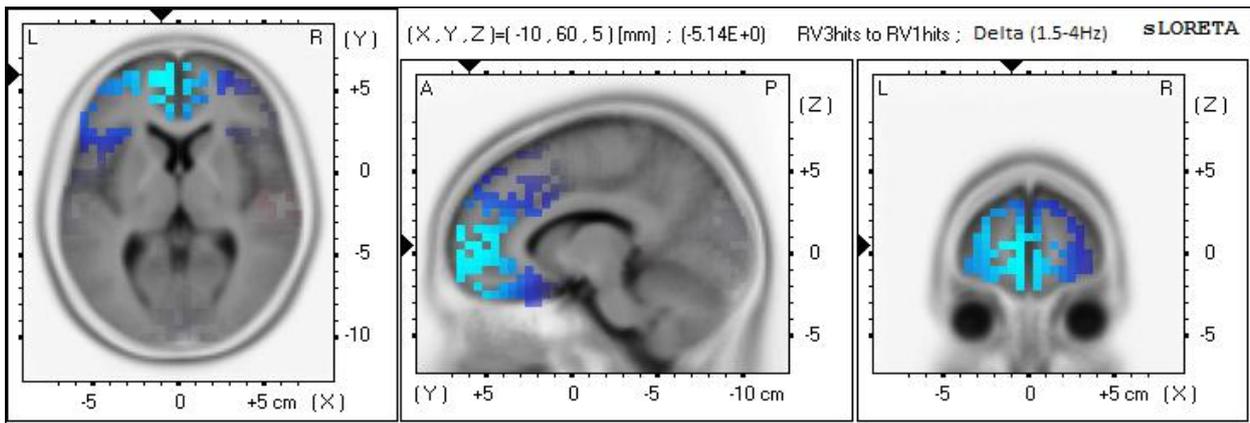


Figure 5. s_LORETA profiles during non-local experiences. Blue indicates areas of decreased power within the delta (1-4 Hz band) primarily in the left medial frontal lobe (BA10) in the third week compared to the first week.

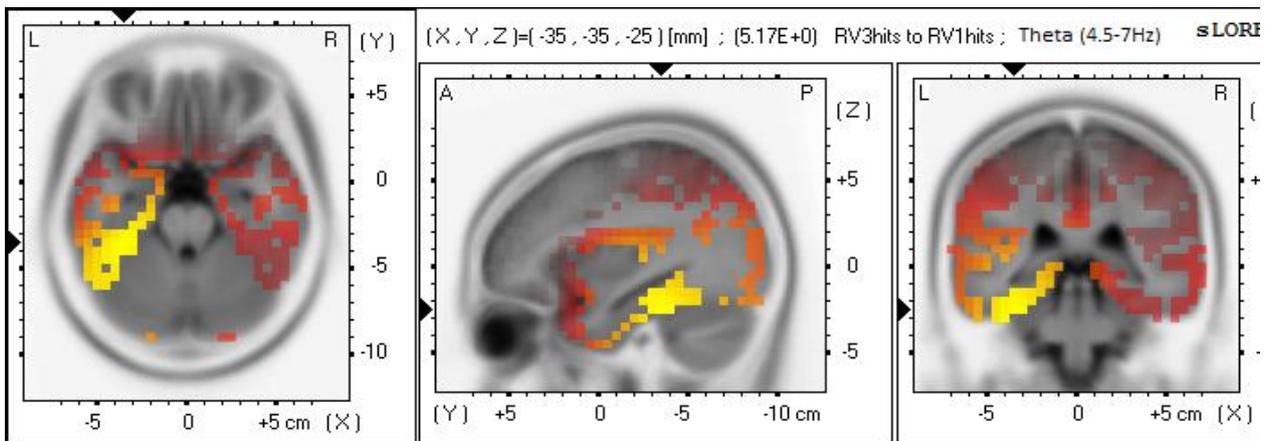


Figure 6. s_LORETA during non-local experiences. Yellow-Red gradient indicates increased power within the theta band in left fusiform gyrus (BA20) during the third week of testing compared to the first week.

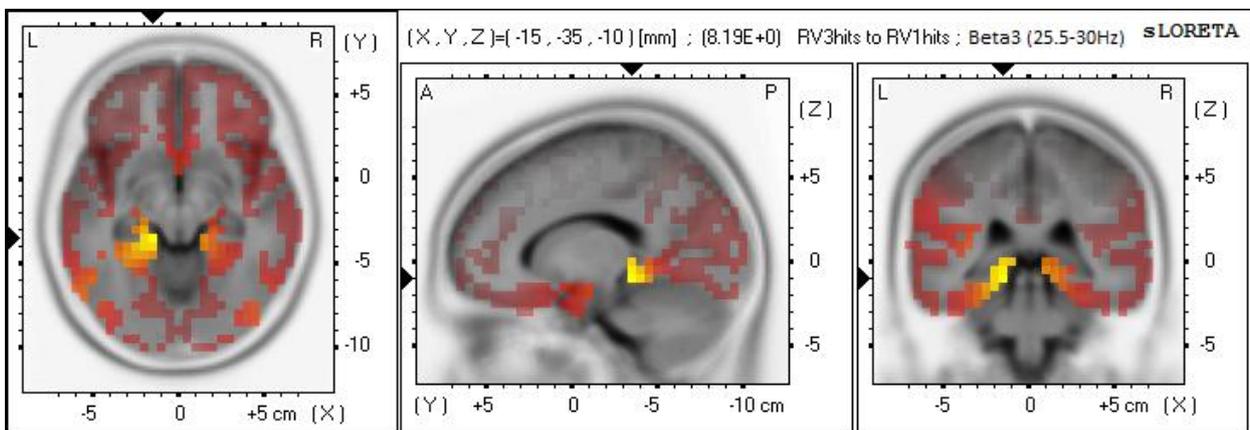


Figure 7. s_LORETA during non-local experiences. Yellow-red gradient indicates increased power within the beta3 (25.5 to 30 Hz) band in the left parahippocampal gyrus for the third versus the first week of testing.

2.3 Results of S-LORETA

The data from each of the 19 channels were exported from WINEEG software to s_LORETA in 5 s segments sampled once every 10 s during baseline (with eyes closed) and during NLE with eyes closed. In order to discern which regions of the cerebrum were most activated within specific frequency bands of electroencephalographic activity s_LORETA

profiles were obtained for subjects who displayed the greatest and least congruence between their imaginings and the actual stimuli according to independent judges. Enhanced congruency scores between the third week and first week involved beta activity within the 25 to 30 Hz range within the parahippocampal gyrus. This is the same electroencephalographic band and cerebral



locality that was markedly activated and associated with the greatest accuracy for reporting distal information by the exceptional subject Sean Harribance (Persinger and Saroka, 2012).

Increased theta activity occurred within the left fusiform gyrus, insula, and middle temporal gyrus and within both the left and right parahippocampal gyrus. Higher (alpha) frequencies were evident within anterior cingulate gyrus and the superior and middle temporal lobes for both hemispheres for those subjects whose scores for congruency between drawings and descriptions and the hidden pictures were most accurate. Examples of the most robust and reliable change in s_LORETA profiles between the first and third sessions are shown in Figures 5 through 7. These data suggest that accuracy of experiences about a distant stimulus are related to brain regions whose functions involve spatial localization, emotional attachment and bonding, and visuospatial memory and processing.

Discussion

The concept of non-locality whereby information from *A* affects *B* (and vice versa) challenges causality because the usual physical process of electromagnetic or mechanical waves does not appear to be involved (Persinger *et al.*, 2003). This dilemma may be less intellectually restrictive when there is a quantitative demonstration that the accuracy of the information about a hidden, distance object is systematically related to increased numbers or characteristics of cerebral regions of the subject reporting this information.

If there is stimulus (information within the picture) and response (activity within the brain) coupling one would expect that the greater the involvement of different cerebral areas or patterns of activity the greater the accuracy of the congruence. This contention was supported by the results of the present experiment. After the first week, accuracy of congruence for a given week involved more brain activity variables for that week than for the other weeks. The fact that the more brain variables from the same week as the experiment were correlated with the accuracy for that week indicates that the effect was not likely to be spurious. If it were spurious, the probability would have been more or less equal

that numbers of EEG variables from the other weeks would have been comparable.

This method of analysis had been selected because the working model is that consciousness and the process associated with access of distant information involves a field-like or matrix-like process. Consequently individual cerebral locations or EEG frequencies are less important and substitutions of which components are most "active" at any given time are expected to occur routinely. As a comparison in a 5 x 5 matrix there are inordinate numbers of combinations that can yield the same sum even though the individual values within each of the cells of the matrix could vary markedly at each temporal increment of operation.

However there was a dynamic shift over the weeks of experience and feedback for the hidden drawings that were noted in this population. During the second week more variables associated with frontal and left hemispheric activity predicted accuracy of the experiences about the pictures. During the third week more variables associated with the temporal lobe and right hemisphere predicted accuracy.

This pattern supports other studies that suggest the right temporal lobe is associated with access of distant information through mechanisms not known to date. Right temporal functions and activity have been associated with mystical states in the 20th century (Kurup and Kurup, 2003) and 19th century (Harrington, 1995). The quality and pattern of the experiences are similar to those originating from right hemispheric paroxysmal processes (Bancaud *et al.*, 1994; Gloor *et al.*, 1982). Activity in this region recently has been coupled to accuracy of experiencing distant information. Both Venkatasubramanian *et al* (2008) and Persinger and Saroka (2012) showed that exceptional subjects from different cultures who routinely accurately discern information from a distance displayed marked increased activity within the right parahippocampal gyrus (the ventral region of the temporal lobe) when they were engaging in the accurate experiences.

Source localization (s_LORETA), which has been shown to reflect functionally accurate correlates of behavior and are strongly congruent with the results of fMRI studies indicated that over the three weeks



greater congruency between the stimulus picture and the experiences was associated with changes in activity primarily within the left prefrontal, parahippocampal, anterior cingulate and superior and middle temporal regions. The bilateral changes in the parahippocampal structures would be consistent with the concept that information from the right hemisphere is transformed or translated into information within the left hemisphere. Considering the direct interconnection between these two regions by the dorsal hippocampal commissure (Gloor *et al.*, 1993) in the human being this process can occur with minimal participation of cognitive processes mediated through the corpus callosum.

Like other neurocognitive processes associated with consolidation of memories, the configuration of brain function contributing to overt behavior changed over time (practice). There are multiple studies that during the subsequent days to weeks following the acquisition of new experiences, the regions of the brain that become active or are involved with the representation and reconstruction (memory) of these experiences changes (Shadmehr and Holcomb, 1997; Zola-Morgan and Squire, 1990). If the results of the present experiment can be generalized than either 3 trials or 3 weeks (because there was only 1 trial per week) are required before the cerebral configuration approaches the pattern more frequently associated with accuracy of information within a distant locus.

When compared to the objective measure of accuracy, as discerned by independent judges, the scores for the NLE were significantly more accurate on the third compared to the first week with an effect size of 15%. If we assume that the average configurations associated with the entire group reflect the micro-configurations of the individual's cerebral activity for briefer periods of time, then this suggests that even minor alterations of increased accuracy of distal information are associated with quite prominent increases in involvement of right hemispheric and temporal lobe function.

The major challenge to the experimental evaluation of non-locality in general has been the identification and experimental replication of the mechanisms and processes (Persinger *et al.*, 2008). Considering the very likely overinclusive

nature of the label, there is no reason, except by parsimony, to assume a singular process. We have assumed the incremental or basic unit of energy involved with these phenomena is very similar to that involved with the more conventional concept of information. One bit (0, 1) is associated with Landauer's limit of $kT \ln 2$ (k =the Boltzman constant and T =temperature of the system) when it is lost to entropy or converges with another computation. For the normal brain with an average temperature of 310°K, the threshold energy is $2.95 \cdot 10^{-21}$ J. This value is within an order of magnitude of the quantum of energy associated with action potentials, ionic sources of the resting membrane potentials and the increments required for sequestering of ligands to receptors (Persinger, 2010).

If a text word is about 10^2 bits, a simple drawing is $\sim 10^3$ bits and a low resolution photograph is about 10^6 bits, the matched energy from changes in the magnetic energy available within the brain can be estimated. The amount of energy from a magnetic field intensity represented within cerebral space is related to the product of the volume and $B^2 \cdot (2\pi\mu \cdot 10^{-7})^{-1}$. For a change in ~ 5 nT, the range in geomagnetic activity associated with the maximum effect in other studies (Persinger and Krippner, 1989; Spottiswood, 1990), the energy available in 10^{-3} m³ (the approximate volume of the cerebrum) is 10^{-14} J. When divided by the Landauer limit ($2.95 \cdot 10^{-21}$ J bit⁻¹) the potential numbers of bits are $\sim 3 \cdot 10^6$. This is sufficient, if fully utilized, to represent the essential components of a photograph.

Scott and Persinger (2013) recently evaluated the data collected in the present study and found that on the third week the correlation between accuracy for the NLEs and geomagnetic activity (as measured by 3-hr K_p indices) was $\rho = -0.64$ ($p < .01$) for the interval of the NLE but 0.28 and 0.10 (not significant statistically) for the 3-hr interval before or after the time of measurement. The most accurate NLEs occurred when the K_p values were 0, which is equivalent in general to global geomagnetic activity of 5 nT or less. This magnitude is very similar to what has been observed for "spontaneous cases" and for the Maimonides dream studies (Persinger and Krippner, 1989).

The challenge is the observation in this experimental study and previous analyses of



putative spontaneous reports NLEs that they occur more frequently or more intensely during geomagnetic activity within the ~1 to 10 nT range. Greater geomagnetic variations attenuate these phenomena as inferred by both greater inaccuracies and the fewer spontaneous occurrences. In a manner similar to high and low affinity receptors for different concentrations of ligands, there must be “narrow band” limits or boundary conditions for the information to be accessed. “Channel” capacities and limits are frequent features of many media through which information is conveyed, including the +/- 5 V range for many personal computer systems.

We suggest that the induced electrical potentials from the changes in the geomagnetic field intensity must overlap the limits with the thermal limitations of brain activity. According to Adey (1980, 1981), the thermal limitation for V^2 (voltage-squared) is $4kTb\Omega$ where b is the band width and Ω is the resistance of the extracellular fluid. If we assume a 10 Hz band width, which would accommodate the centroid of transitions between theta, alpha, and low beta activity in the QEEG range, and a resistance 300 Ω -cm, the threshold voltage would be in the order of 10^{-9} V. In comparison, the electric field, according to the product of (dB \cdot dt $^{-1}$ \cdot area), assuming a 10 cm length of the cerebrum, is $\sim 10^{-9}$ V. This value is within the same order of magnitude as the thermal limit to discern an applied magnetic field (Adey, 1981).

The final potential impedance that might be accommodated through application of classical concepts from physics is the latency for the information (bits) to be acquired. The electrical transients, usually within the μ V \cdot s $^{-1}$, are derived as minute fluctuations within the “steady state” potentials (Koenig *et al.*, 2002) of the cerebral cortices within the mV range. Assuming the magnitude of $\sim 5 \cdot 10^{-3}$ V for the averaged shifts in cerebral steady state potential and $5 \cdot 10^{-9}$ T for the mean change in the surrounding (and penetrating) geomagnetic field, the diffusivity is 10^6 m 2 \cdot s $^{-1}$. This value is within the range of measurement and biological variability for the magnetic diffusivity (Ryskin, 2009) constant ($\mu^{-1}\sigma$) where σ is the conductance for physiological saline ($\sigma=2.1$ S m $^{-1}$) and μ is $4\pi \cdot 10^{-7}$ N \cdot A $^{-2}$. The value is $1.7 \cdot 10^6$ m 2 \cdot s $^{-1}$.

Although experiments must still be completed to verify the following calculations,

the time required to involve or “diffuse” through every human brain can be estimated. With the assumption of the velocity of c for light or electromagnetic waves and effectively the topologically continuity of all human brains with a total surface area of $9 \cdot 10^7$ m 2 , the time required to “diffuse” through the entire surface would be only a few (~5) minutes (Persinger and Lavalée, 2010). This value is within the range required in our experimental studies to produce the effect and the latency of the power changes within the QEEG.

The medium within which the NLE occur appears to involve immersion within the geomagnetic field and very small changes in fluctuation intensity. The ~5 nT is within the range of the magnetic field embedded within the solar wind within which the earth-moon system is immersed. Theoretically, and in context of future applications, the effect could still be evident at larger than lunar distances within the solar system (Campbell, 1997). Within this medium photons emitted from cerebral tissue (Dotta *et al.*, 2011a; Dotta *et al.*, 2012; Salari *et al.*, 2011) would have the potential to be major correlates of information bits as well as “signals” from inter-neuronal communication (Sun *et al.*, 2010).

Although the range of intensities vary depending upon technology and experimental paradigm, the typical strength of the neuromagnetic field associated with neuronal activity within functional distances (~cc) and cognition is in the order of pT (Wikswa *et al.*, 1980). Assuming an average empirical value of about 30 pT, the energy within cerebral space would be $[(9 \cdot 10^{-22} \text{ T}^2) \cdot (2.5 \cdot 10^{-6} \text{ N} \cdot \text{A}^{-2}) \cdot 10^{-3} \text{ m}^3]$ or $\sim 3 \cdot 10^{-19}$ J. When divided by Planck’s constant the frequency is within the range of 550 nm, the central tendency for the visible wavelength. The involvement of light frequencies has potential significance for information distribution over very large spaces (Persinger, 2012).

Dotta and his colleagues (2011b) have shown that pairs of brains (or cell cultures) that are separated by non-traditional distances but share the same configuration of changing magnetic fields display the properties of “entanglement”. Light flashes to one brain results in photon emissions from the other brain if they share the same field. We suspect a recondite relationship between minute steady-state changes in the geomagnetic field adjacent to the subject’s brain and the very weak



neurogenic emission of photons (“biophotons”). For example the total energy associated with the increased photon emission ($\sim 1 \cdot 10^{-11} \text{ W} \cdot \text{m}^{-2}$) during imagining white light (Dotta *et al.*, 2012) while sitting in complete darkness is equal to the decrease in magnetic energy from the geomagnetic field within the volume around the brain as measured by both precision photomultiplier tubes and magnetometers (Hunter *et al.*, 2010).

The recent convergence between the operations of neuronal function and concepts related to quantum phenomena (Jibu and Yasue, 1995), particularly non-locality, suggests that phenomena previously attributed to “non-physical” or spurious causes can be explained by physical principles that reflect brain function and be reliably replicated within the laboratory. In the present study the accuracy of impressions, as recorded by drawings and verbal descriptors, about distant hidden pictures to which the subjects had not been exposed previously and judged for accuracy in blind settings by several judges,

were associated with specific activations and locations within the cerebrum that are consistent with our contemporary understanding of neurocognitive functions.

Increased accuracy over trials and with feedback for a group of normal (non-exceptional) volunteers indicates that the capacity can be trained and is subject to classic principles of reinforcement. The relatively strong relationship between quiet, global geomagnetic activity within a specific band of intensities and increased congruence (“accuracy”) between the experiences and the hidden stimuli are consistent with multiple correlational and experimental studies. The modulating factor from a medium within which all human beings are normally exposed suggests that information from distant sources can be accessed by brain function through non-traditional transduction and the interaction between the processes generating electroencephalographic activity and the cerebrum itself may be the interface.

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