Evidence Of Neural Signal Transfer Between Distant Subjects Who Have Undergone Primordial Sound Meditation (PSM) Training

Leila Kozak [1], Leanna J. Standish [1], Heather King [1], L. Clark Johnson [2], Todd Richards [2], Marilyn Schlitz [3], David Simon [4], Deepak Chopra [4]

[1] Bastyr University Research Institute, [2] NeuroResearch Services/University of Washington, [3] Institute of Noetic Sciences, [4] Chopra Center for Well Being.

Purpose: The purpose of this study was to determine whether brain activation triggered by a visual stimulus in one subject of a pair could be detected in the unstimulated member of the pair when subjects were physically and sensory isolated from each other.

Methods: Simultaneous digitized EEG were recorded from 8 pairs of healthy human adult subjects using a "sender/receiver" paradigm (experimental set up is shown in Figure 1.) Pairs were tested in three consecutive visits. Each of those visits included 2 sessions in which both members alternated roles as "sender" and "receiver" (see Figures 2, 3 and 4). During each session, the sender was presented with a series of six alternating stimulus-on and stimulus-off conditions. The stimulus-on condition consisted of a flickering black and white checkerboard pattern (2.11 cycles/degree) presented at the rate of 1 per second. The stimulus-off condition consisted of a static checkerboard pattern.

Subjects

Sixteen healthy adults (26-57) were recruited, enrolled, and tested as pairs in the Bastyr University Consciousness Science Laboratory. Mean age was 44.17 years. Pairs of subjects met the following inclusion criteria: 1) they were trained in Primordial Sound Meditation (see description below); and 2) they were willing to follow a 30-day meditation protocol. Adherence to the 30-day meditation protocol was 90%. The meditation schedule required that both members meditated at the same time of the day, even if the members were in different geographical locations. Seven of the pairs were female, and the remaining one was male/female (married couple).

EEG methods

Two EEG systems (Lexicor, Neurosearch-24) were combined to allow simultaneous measurement of cortical EEG potentials from the two individuals designated as sender and receiver. Each Lexicor system had a computer controller card that digitized the EEG signal from the amplifier and also output a synchronization signal at the beginning of each visual stimulus or evoked potential epoch.

The output of the sender's visual evoked potential (VEP) synchronization signal was sent to the A2, A3, A4 channels of the receiver's EEG amplifier. The EEG equipment was configured so that an experimenter could control both the sender and receiver's EEG computerized acquisition systems from a single workstation. Figure 1 shows configuration of computer and EEG equipment.

Data acquisition

During EEG acquisition a standard 19-channel Electrocap (International 10/20 placements) was placed on the head of both sender and receiver. To maximize electrical contact with the scalp, a blunt 23-gauge needle was used to gently scratch the skin on the scalp, and 8 of the 19 channels (O1, O2, C3, C4, CZ, P3, P4 and Ground) were filled with conductive gel (ECI, Electrogel) to achieve impedance below 5 KOhms. Self-adhesive electrodes (E5 9 mm 3 ½" Din Socket) were applied to both ear lobes and then connected to the Electrocap to serve as reference. The wires from the cap were then connected to the amplifier for display and data acquisition. The EEG signal was acquired using the VEP mode of the Lexicor EEG system with the following parameters: 512 points per second sampling rate; high-pass filter off; one reversal of checkerboard once a second; 6 different conditions consisting of 3 Flicker (on) and 3 Static (off). To minimize experimenter error during data acquisition, software was developed to automate all steps and keystrokes necessary to acquire VEP EEG data during the sequential Flicker/Static stimulation conditions.

Signal Detection

The detection of event related potentials (ERPs) in the brain requires extremely sensitive methods (Johnson et al, 2002). Therefore, a computerized integrated digital EEG recording system as well as a sensitive and specific statistical method for the detection of single-sweep ERPs previously developed by our team were used for this study (Johnson et al, in preparation; Standish et al, in preparation). According to this method, a statistical signal detection algorithm is applied to determine whether brain activation in the receiver is higher when the sender is visually stimulated compared to when the sender is not stimulated.

Data pre-processing and Artifact rejection

Data sets were initially screened for 60-Hertz contamination. This form of noise can occur when a lead is inadvertently dislodged by a subject's movements during the experiment. None of the data collected from individuals in the receiver mode of this study had 60 Hertz noise contamination. In addition, we surveyed and controlled for electrical artifacts not related to brain activity. Specifically, muscular activity (e.g. coughing, eye-blinking, changing seated position, etc) can generate electrical artifacts that, for the purpose of this study, represented unwanted noise contamination. A review of the raw EEG identified epochs in which this contamination was obvious. These epochs were removed and replaced with a randomly selected epoch drawn from the available data within the relevant stimulus condition (e.g. Flicker or Static) of that person.

Statistical Analysis

Three statistical techniques have been developed to test for the existence of the "neural signal transfer" (NeST) phenomena: an "amplitude/variance" test, a "runs" test, and an "alpha spectrum" test. Although each is designed to test for a different signal characteristic, all three use the same approach for inferring statistical significance. This approach is usually referred to as a "randomization test" and is often used when a) statistical tables (e.g. F, χ2, etc.) cannot be applied or, b) for the analysis of data from single subject experimental settings. In this study both of these conditions apply.

The EEG data that forms the basis of the data record are known to be highly variable both between subjects and within subjects. Hence, the application of standard statistical techniques based upon some assumed sampling distribution is difficult to justify. In addition, the task at hand is to identify individual subjects whose data provide sufficient evidence to infer the existence of NeST effect. Consequently, every subject is a unique unit of analysis and the trial is inherently the repeated application of a "single subject" experiment. All tests in this analysis use a sampling distribution to determine the significance of an observed statistical value. This sampling distribution is derived for each subject (and each test) using the un-stimulated data contained in that subject's data record (e.g. the 150 seconds of EEG data collected while the distant sender partner was observing a Static image). The general method is to randomly select a point in this data. Then, using this randomly selected point as an anchor, generate the test statistic. This process was repeated 10,000 times. The resulting 10,000 sample statistics form the sampling distribution used to determine the statistical significance of an observed value in the data record associated with the stimulated (e.g. Flicker) portion of the "receiver's" data record.

FIGURE 1: EEG equipment configuration and set up

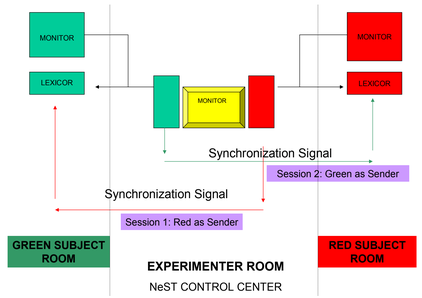
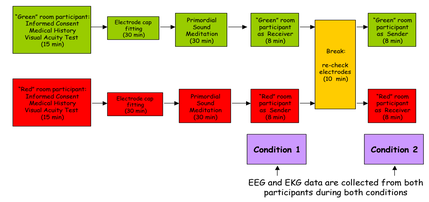


Figure 4: Experimental Protocol Flowchart



"Alpha spectrum" test: The alpha test shifts focus from the time domain to the frequency domain: it is a measure of the alpha specific brain frequency and how it changes with the sender's stimulus. It is designed to test whether the concentration of energy in the alpha band of the "receiver's" EEG signal is impacted by the changing stimulus condition of the sender. A Fourier transform is used to derive the frequency spectrum associated with each epoch. The cumulative power in the alpha segment of this spectrum (e.g. 8 – 12 Hz) is the test statistic. The test determines if this cumulative power systematically differs between the Static and Flicker conditions. Here too, 150 probability estimates are generated and subsequently combined using the "inverse χ2" meta-analysis method. It is this meta-analytic summary (e.g. the χ^2 value) and its statistical significance that are reported in Table 1.

"Runs" test: Global changes in the distribution of our test statistic are not the only way in which the effect could be discovered. We also tested these data using a non-random sequence model based upon the non-parametric "runs" test. This test is sensitive to continuous activation ("bursts" of activity) from one epoch to the next. To apply this test we define a "hit" as an epoch for which the sum of squares statistic of the raw EEG signal is significant at the 0.05 level. We use this criterion to generate a time series of binomial data (0 = non-hit, 1 = hit) from the 150 receiver epochs generated under the "Flicker" condition. We then use a form of the Runs test to determine if hits are observed in sequences (e.g. hits are clumped together) more often than the random model associated with the observed underlying probability of their occurrence would predict.

"Amplitude/Variance" test: The "amplitude/variance" test is a measure of the EEG amplitude in the visual evoked potential time range from 80 to 180. This test determines whether the brain activation (recorded in the raw EEG time domain signal in the receiver) systematically differs in the "Static" and "Flicker" conditions observed by the "sender." The test uses the sum of squared EEG observations in the segment of the signal that has the largest visual evoked potential (e.g. 80 to 180 milliseconds after stimulus onset). Using the "subject-specific" sampling distribution each epoch is tested to establish the probability that the observed statistic represents a significant deviation from the "Static" condition. The resulting 150 probability estimates are combined using the "inverse χ2" meta-analysis method. It is this meta-analytic summary (e.g. the χ2 value) and its statistical significance that are reported in the tables.

FIGURE 2: Experimental set up, session 1

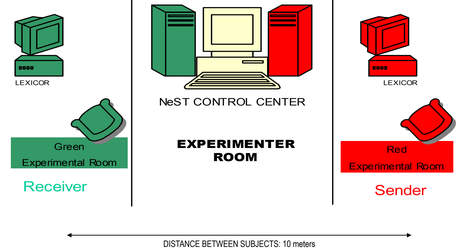


FIGURE 3: Experimental set up, session 2

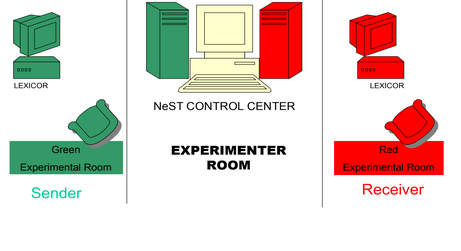


Table 1: Overview of Results for the Alpha, Runs and Amplitude/Variance Tests

The number in the cells represents the p value for that particular trial. The 1st visit (screening trial;) was used to identify subjects who demonstrated the effect. Results from subjects who presented statistically significant results during the 2nd or 3rd visits but whose 1st visit was not statistically significant are not reported. The 2nd & 3rd visits are viewed as replication trial and are considered only for those subjects who demonstrated the effect in the screening trial.

Subject ID	Screening Visit (Trial 1)			1st Replication (Trial 2)			2nd Replication (Trial 3)		
	Alpha	Runs	Ampl/var	Alpha	Runs	Ampl/var	Alpha	Runs	Ampl/var
GA*	0.0001						0.0001		
HA									
GB									
HB	0.0004								
GC									
HC*	0.00001	0.001					0.0001		
GD									
HD									
GE		0.01							
HE*	0.00001		0.001	0.00001					
GF									
HF									
GF2									
HH									
GG	0.0012								
HG									

* Identifies subjects who demonstrated the effect in the screening trial and reproduced the effect in at least one of the subsequent replication trials.

Because of the controversial nature of the phenomenon under investigation a conservative criterion has been applied to analyze the data. According to this criterion, the first visit (*screening trial*) was used to identify subjects who demonstrated the effect. Results from subjects who presented statistically significant results during the second or third visits but whose first visit was not statistically significant were not included in the analysis. Second and third visits were viewed as replication trials and were analyzed only for those subjects who demonstrated the effect in the screening trial. In other words, there were other subjects who had statistically significant results during the second or third visits, but their results were excluded because of the lack of significance during the first trial. Even with this stringent approach, 5 out of 16 subjects (31%) of the sample tested had statistically significant effects for the Alpha test. Since we are testing at the p ≤0.01 level, we would expect to observe at random 16*0.01 = 0.16 significant subjects. The fact that the observed rate of significance is over 30 times greater indicates that the null hypothesis is not valid. The probability of observing five hits out of 16 subjects under the null hypothesis is <0. 0.0000004 (4X10-7).

Results: Five out of 16 subjects in the receiver position had statistically significant (p ≤0.01, two tailed test) changes in alpha power (Flicker versus Static conditions of sender's stimulus) during the screening trial (see Table 1.) Two out of these 5 subjects had statistically significant (p ≤0.01) increases in alpha power (meaning that the Flicker signal was greater than the Static signal) while the other 3 subjects had statistically significant decreases in alpha power for the receiver synchronized to the sender's stimulus. The Runs test produced two subjects with a p ≤0.01 for the screening trial. The probability of observing two hits out of 16 subjects is <0.01. The amplitude/variance test produced only one subject with a p ≤0.01 for the screening trial, reaching no significance levels.

Discussion: Data from the current study suggest that some individuals may have the capacity to transfer brain signals under certain conditions. The fact that the alpha spectrum test identified statistical significant results may indicate that a global activation phenomenon may also be at work and that this signal transfer phenomenon may not be strictly a "transferred potential." The non-specificity of the transferred signal have also been described recently by other authors (Richards et al, 2002; Standish et al., 2003; Wackerman, 2003; Walach et al, 2001.) A recent fMRI study (Standish et al, 2003) suggested that this signal transfer may also be detected by fMRI scans (Standish et al, 2003). Evidence gathered to this point from EEG, GSR and fMRI studies seems to validate the hypothesis that, under certain conditions, neural events triggered in one human brain may be transferred to another without direct biological contact. Existing data seem to indicate that humans may connect through signals that are not accounted for in current neurophysiology. A possible interpretation of this signal transfer as a "manifestation of non-local interactions" (Grinberg-Zylberbaum et al., 1994) or "quantum entanglement," has been proposed (Wackerman et al, 2003; Walach et al, 2001.) Further research is warranted to investigate the nature of the signal, its underliying mechanism and the states of consciousness conducive to the manifestation of this phenomenon.

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