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Electroencephalographic Evidence of Correlated Event-Related Signals Between the Brains of Spatially and Sensory Isolated Human Subjects

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ABSTRACT

Objective: To determine whether correlated event-related potentials (ERPs) can be detected between the brains of spatially and sensory isolated human subjects.

Design and setting: Simultaneous digitized electroencephalograms (EEGs) were recorded from the occipital area in pairs of human subjects placed in sound attenuated rooms separated by 10 meters. One person relaxed in one of the rooms while the other received visual stimulation while in the other room. Prior to each experiment, members of the pair were randomly designated as sender and receiver. Sessions were subsequently repeated with subjects reversing their roles. Previous to each session, the sender was instructed "to attempt sending an image/thought." The receiver was instructed "to remain open to receive any image/thought from his/her partner." Alternating stimulus-on/stimulus-off conditions were presented throughout the session to the sender, while a stimulus-off condition was presented to the receiver.

Subjects: Thirty-seven (37) female, and 23 male subjects ($n = 60$; 30 pairs) participated in the study. Subjects knew each other well and claimed to have previous experience of being emotionally/psychologically connected to one another.

Outcome measures: A Runs test was applied to compare EEG "hits" in the receiver's EEG during the sender' stimulus-on condition versus sender's stimulus-off conditions. Test results at $p < 0.01$ were considered evidence of correlated brain signals. Pairs in whom at least one member had significant results were invited back for replication.

Results: Of the 60 subjects tested, 5 (4 women/1 man) showed significantly higher brain activation ($p < 0.01$) during their sending partner's stimulus-on condition as compared to stimulus-off condition. Using the Stouffer z meta-analytic method all receiver EEG results across all 60 subjects were combined by transforming the individual session p values into z scores. Data analyses showed overall significant results for EEG data recorded during the flickering condition ($z = -3.28$, $p = 0.0005$) as well as nonsignificant results for data recorded during the static condition ($z = 0.35$, $p = 0.64$). Four pairs participated in a replication experiment during which one pair replicated the effect.

Conclusions: These results indicate that in some pairs of human subjects a signal may be detected in the brain of a distant member of the pair when the brain of the other member is visually stimulated. These data support the findings of similar studies performed in seven laboratories reported in the peer-reviewed literature since 1963. Research in this area should now proceed with investigation of its physical and biologic mechanism, its generalizability to varying populations and relationships, and its clinical application.

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INTRODUCTION

The hypothesis that signaling occurs between the nervous systems of organisms that are spatially separated and sensorially isolated has been evaluated by several laboratories in several countries. Over the last 40 years seven independent laboratories have reported correlated brain signals using simultaneous electroencephalographic recordings from two people who are distant and isolated from one another (Duane and Behrendt, 1965; Grinberg-Zylberbaum et al., 1994; Radin, 2003; Sabell et al., 2001; Standish et al., 2001; Tart, 1963; Wackerman et al., 2003; Wallach et al., 2001). Radin (pp. 315–323) reports in this issue on similar findings using more salient visual stimuli.

Each laboratory has attempted to improve upon the electrophysiologic, psychophysiological, and analytic methods of the previous group. The phenomena of correlated electroencephalographic (EEG) signals has been reported under diverse names including such as extrasensory perception (Duane and Behrendt, 1965; Tart, 1963), "transferred potential" (Grinberg-Zylberbaum et al., 1994; Wackermann et al., 2003) neural energy transfer (Standish et al., 2001), neural signal transfer, distant neural signaling (Standish et al., 2003), quantum entanglement (Wackermann et al., 2003), and transpersonal healing (Achterberg, 1985).

Charles Tart (1963) published the first account of remote transfer of signals. Two years later a paper by Duane and Behrendt appeared in *Science* in 1965. In this study, 15 pairs of monozygotic human twins participated in an experiment in which simultaneous EEG were recorded from related and unrelated pairs of subjects. The authors reported that alpha rhythms elicited in one member of a pair were evoked in the other member even when the subjects were spatially isolated and had no sensory perception of one another. The phenomenon was only observed in two pairs of monozygotic twins and "in no instances did the induction occur between unrelated subjects" (Duane and Behrendt, 1965).

In 1994 Grinberg-Zylberbaum et al. (1994) reported that visual-evoked potentials (VEPs) in one human brain produced by photostimulationto a single member of a pair could induce similar evoked potentials in the other member located 14.5 meters away in an electrically shielded room. The authors reported that the "transferred potential" was observed only after the pair, previously unknown to one another, had spent 20 minutes with each other in "meditative silence" in order to induce a sense of "connectedness" (Grinberg-Zylberbaum et al., 1994). While the correlational methods used in Grinberg-Zylberbaum's study have been criticized (Standish et al., 2001) and the results largely ignored by the conventional scientific community, their data inspired a new group of investigators to explore the phenomenon.

Because the implications of measurable signals between human brains at a distance are profound, the findings warrant further investigation. Our approach to the study of this phenomenon has been to: (1) use a sender–receiver paradigm and record simultaneous EEG from both subjects; (2) utilize standard clinical EEG visual stimulation protocol (alternating black and white checkerboard that trigger reliable and high-amplitude VEP in the sender; (3) use a signal detection method appropriate for the measurement of what we hypothesized would be small and intermittent signals in the receiver; and (4) use statistical methods that do not require the assumption of waveform similarity between sender and receiver EEG signals, nor independence or normality (Standish et al., 2001). Because the goal of the study was to verify the previously reported phenomenon of EEG-correlated signals between humans at a distance we decided to recruit subjects who were, based on previous studies (Duane and Behrendt 1965; Grinberg-Zylberbaum, 1995), the most likely to demonstrate the phenomena. Thus, we recruited subjects who knew each other well, who reported experiencing a strong sense of emotional/psychologic connection (bonding) to each other, and who had meditation experience.

MATERIALS AND METHODS

Sixty (60) healthy human adults (18–65 years of age) were recruited, enrolled, and tested as pairs in the Bastyr University/University of Washington Consciousness Science Laboratory, Kenmore, WA. Mean age was 39.2 years ± 11.4. Each pair of subjects met the following inclusion criteria: (1) they knew each other well; (2) they claimed to have previous experience of being emotionally and psychologically connected to one another; and (3) they have some experience in meditation or other introspective practices. Twelve (12) of the pairs were both female, 13 were male/female pairs, and 5 were male/male pair. Duration of relationship between the pairs ranged from 6 months to 40 years. The Bastyr University and University of Washington's Institutional Review Board (IRB) provided approval and ethical oversight for the study.

Upon arrival, subjects were randomly designated to begin first experimental session either as "sender" or "receiver." To obtain data from all subjects in both roles, sender and receiver roles were reversed during a second recording session. Each subject sat in one of the two experimental rooms, which were separated from each other by the control room, creating a 30-feet distance between sender and receiver. Figure 1 shows room configuration and set up. All three rooms were sound attenuated but not electromagnetically shielded.

The use of electromagnetic (EM) shielding in these types of experiments assumes that the phenomenon studied is not EM in nature. If the phenomenon were mediated by EM signals, EM shielding would have reduced the probability of detecting the phenomenon. Since the mechanism of the phenomenon under study is unclear and data regarding the physical nature of the signal are insufficient at this time, this research group deliberately chose not to electromagnetically isolate the subjects.

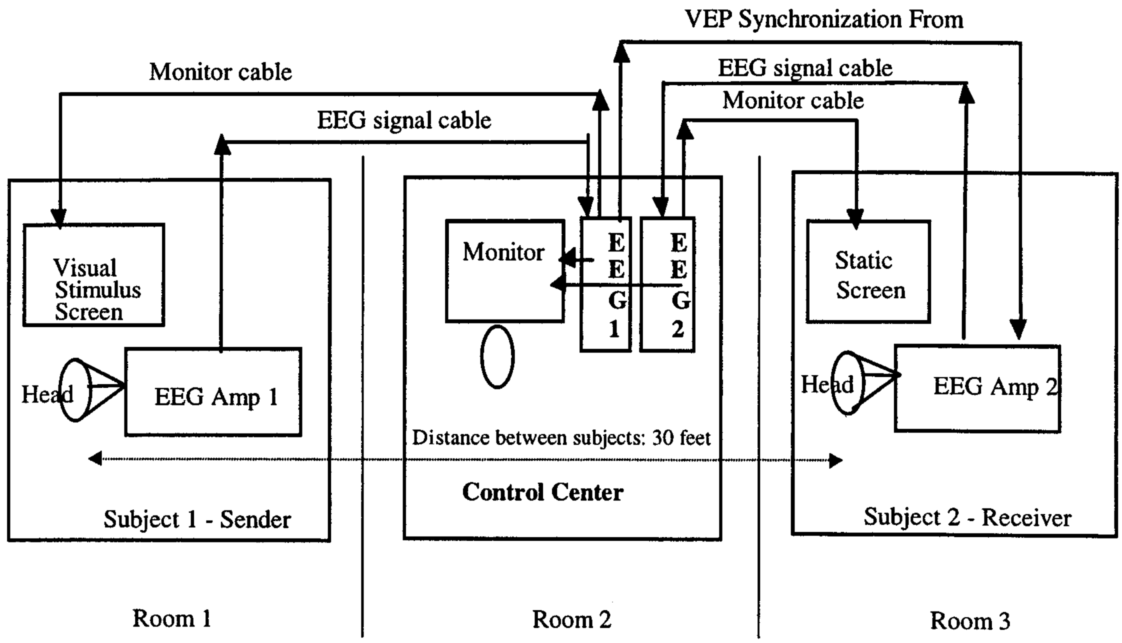

FIG. 1. Room configuration and setup.

Experimental design

The study was designed to determine whether brain activation in the member of the pair acting as a receiver differed during the epochs in which the sender was visually stimulated compared to epochs when the sender was not visually stimulated. To test this hypothesis we simultaneously collected EEG data from the receiver and the sender during 256-second sessions under two alternating conditions: stimulus-on (sender's video screen showing a flickering checkerboard pattern, "F") and stimulus-off (sender's video screen showing a static checkerboard pattern, "S"). A 64-second period of stimulus on condition was followed by 64-second period of stimulus off condition in the following sequence F → S → F → S.

At the beginning of each experimental session an 8-minute audiotaped FreezeFrame (McCraty et al., 1995) relaxation session was delivered via speakers to both subjects to facilitate a relaxation response and to enhance the sense of psychologic connectedness between study partners. The relaxation instructions included a suggestion to the pair to "attempt to connect to each other."

Stimulus

VEPs were elicited by viewing an alternating flickering black and white checkerboard protocol presented on the video screen. Pattern-reversal checkerboard stimuli are standard stimuli in human visual physiology research (Fortune and Hood, 2003; Sommer and Meinhardt, 2003). The sender was presented with an alternating schedule of four stimulus-on (flicker, F) and stimulus-off (static, S) conditions (F → S → F → S) with a beginning time that randomly varied from 20–50 seconds. The alternating schedule consisted of 64 reversals of the flickering checkerboard pattern (2.11 cycles/degree at a flickering rate of 1 per second) followed by 64 seconds of the static checkerboard pattern. In our study design, therefore, the flickering checkerboard represented a "stimulus on" condition that triggered VEPs while the static checkerboard pattern constituted a control condition ("stimulus off" condition) during which on VEPs were generated.

The receiver data set for every subject contained 256 epochs: 128 epochs collected during the sender's on condition (flicker) and 128 epochs collected during the sender's off condition (static checkerboard). Visual stimuli were presented on a 17-inch computer video monitor located 50 cm from the subjects' eyes. Eye fixation was directed to the center of the screen where a red dot subtending 0.5° of visual angle was presented. The receiver was presented with an unvarying image of the static checkerboard pattern throughout the session.

Data collection

Cortical EEG potentials were simultaneously recorded from both subjects using two identical and integrated EEG systems (Neurosearch-24, Lexicor, Boulder, CO). The Lexicor system in the sender's room digitized the amplified EEG signals while simultaneously generating a synchronization signal that was delivered to the receiver's Lexicor device at the beginning of each epoch. The experimental set-up allowed the researcher to control both the sender and receiver's EEG computerized acquisition systems from a single workstation located in a room between and equidistant from the two subjects (Fig. 1).

A standard 19-channel ElectroCap (ElectroCap International, Eaton, OH) was placed on each subject's scalp. Data were recorded from 4 of the 19 channels (O1, O2, CZ, ground). To maximize electrical contact with the scalp, a blunt 23-gauge needle was used to gently scratch the skin on the scalp, and electrodes were filled with conductive gel (ECI, Electro-Gel Eaton, OH) to achieve impedance below 5 Kohms. Self-adhesive 9-mm electrodes were applied to both ear lobes and then connected to the Electrocap to serve as reference.

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; stimulus reversal rate 0.5 Hz; 64 seconds per condition. To minimize experimenter error during data acquisition software was developed which completely automated the experiment's execution.

SIGNAL DETECTION AND STATISTICAL TECHNIQUES

In order to detect event- and time-correlated signaling between the sender and receiver we evaluated, in the receiver, the within-subject difference in EEG activity that occurred simultaneously with the sender's stimulus on and stimulus off conditions. Subjects served as their own control. In order to obtain a summed signal from the occipital area bilaterally the signal from O1 and O2 was summed and referenced to CZ using the following equation:

$$(O1 - CZ) + (O2 - CZ) \qquad \text{(Equation 1)}$$

DATA ANALYSIS

The analytic technique specified a detection region in which a measure of brain activity (the sum of squared EEG activity) is calculated in both the sender EEG and the receiver's EEG. We searched for a correlated EEG signal in the receiver's brain in the time segment of 80–180 ms after the presentation to the sender of each reversal of the flickering checkerboard. This time interval was selected according to the time window that corresponds to the P100 component of the VEP in the stimulated senders' brains. Our hypothesis was that the transferred signal in the receiver's brain, providing it existed, was likely to occur within the same time interval as the P100 component of the VEP in the sender's brain.

EEG data analysis sequence

Digitized EEG data from receivers were sorted into a large file for the four 64 epoch conditions (two 64-epoch segments of data collected during the sender's flicker condition, and two 64-epoch segments of data collected during the sender's static condition). The sender's synchronization signals sent at the start and end of each stimulus condition were used to mark the stop and end of each segment of the receiver's EEG data. Each condition was coded as either F (stimulus-on) or S (stimulus-off) based on the sender's experimental condition. The average of the squares of the EEG signal was calculated for the time region between 80–180 ms after the sender's stimulus trigger for each of the 64 epochs. Average brain activity signal was compared between the F (stimulus on) and S (stimulus off) conditions using a Runs test. Receiver EEG data collected during the Static condition were used to construct a within-subject control statistic by which to compare EEG data collected from each receiver during the sender's flicker condition.

The probability that EEG power was higher or lower in the stimulus on (flicker) condition compared to the stimulus off (static checkerboard) condition was calculated for each 1-second epoch using a person-specific, within-subject randomized sampling distribution derived from the static condition.

RUNS TEST

The Runs test is used to detect nonrandom sequences of binomial data (i.e., ones and zeroes; Statsoft Inc, 2003). It measures the probability of a sequential series of hits ("ones" that occur one after the other in a series). A hit was defined as each 1-second EEG amplitude that exceeded the criterion amplitude set by the Monte Carlo simulation distribution.

In order to create this distribution of control data. a random starting point was selected from within the 128 seconds of digitized EEG data collected during the stimulus off (static checkerboard). The test statistic (e.g., the sum of squared observed values) was calculated using the next 100 ms from this randomly selected starting point. This process was repeated 10,000 times. Because the 128 static EEG samples were drawn from the null distribution for each receiver subject, these values were used to estimate the value for which only 5% of randomly generated samples were greater. The Monte Carlo-derived distribution of control data was used as within-subject control data for each subject's EEG data while in the receiver role. Each of the 128 epochs recorded during the sender's stimulus on condition was compared to the control data distribution. The static data from each receiver was used to construct a within-subject sampling distribution.

Evidence of remote brain signaling was obtained if the receiver's EEG data recorded during the sender's stimulus on (flicker) condition differed from the receiver's EEG activity during the sender's stimulus off (static) condition. To apply the Runs test we defined a hit as an epoch for which the sum of squares statistic of the raw EEG signal is significant at the 0.05 level of the Monte Carlo-simulated distribution of EEG amplitudes during the sender's static condition. The receiver data set for every subject contained 256 epochs from which 128 epochs were recorded while the sender was in the static checkerboard (unstimulated) mode. The other 128 epochs were recorded while the sender was in the flicker (stimulated) mode. A Monte Carlo-simulation method developed by May et al. (2001) for physiologic data was applied to generate random data that was used as the within-subject critical value for each receiver subject's EEG data collected during and simultaneously with the sender's flicker conditions (Table 1). We used this criterion to generate a time series of binomial data (0 = nonhit, 1 = hit) from the 128 receiver epochs generated under the flicker condition. We then applied the Runs test to determine if hits were observed in sequences (e.g., hits are clumped together) more often than the random model would predict. The random model for each receiver subject was generated by the within subject's data collected during the static condition. A nonrandom series of hits in the receiver's occiput during the stimulus on condition was defined as evidence of remote brain-to-brain signaling.

The intrasubject critical value was applied to the 128 one-second EEG samples recorded during the flicker condition to generate a time series of binomial data in which a hit was detected when the observed value during the flicker condition was greater than the critical value. The Runs test was then applied to determine if EEG hits in the receiver's EEG were observed in nonrandom sequences more often during the sender's flicker condition than during the static condition. Those subjects with Runs test results with p values < 0.01 were considered to provide evidence of a correlated brain signal associated with their sending partner's flicker condition. Pairs of subjects who showed significant Runs test at the $p < 0.01$ level during the first EEG experiment were invited to return to the laboratory for replication.

RESULTS

Of the 60 subjects, 5 (8.3% of 60 subjects) showed significantly different brain activation at a $p < 0.01$ levels during their sending partner's flicker condition compared to the static condition. Table 1 presents data for each of the 60 subjects, including intrasubject results for Runs tests using Monte Carlo-simulation technique. Of the 5 subjects who showed significant Runs test values during their partner's flicker condition, 4 were female, 1 was male. The mean age of the 5 "successful" subjects was 34.7 ± 9.8 years compared to 39.2 ± 11.4 years in "unsuccessful" pairs. Because we were testing at the $p < 0.01$ level, we would expect to observe at random $60 \times 0.01 = 0.6$ significant subjects. The fact that the observed rate of significance was more than 8 times greater indicates that the null hypothesis is not valid. In fact, the probability of observing five hits of 60 subjects under the null hypothesis is less than 0.0003.

Using the Stouffer z meta-analytic method (Hunter and Schmidt, 1990), all receiver results were combined across all 60 subjects by transforming the individual session p values into z scores. Overall significant results for EEG data recorded during the flickering condition were found ($z = -3.28, p = 0.0005$) as well as nonsignificant results for data recorded during the static condition ($z = 0.35$, $p = 0.64$).

A replication experiment was pursued by inviting the five pairs who produced significant results to try the experiment again 1–2 weeks later. One of these five pairs was unable to participate in the replication experiment due to personal circumstances. Of the 4 pairs who participated in the replication experiment, only one showed statistically significant results ($p = 0.0001$, see Table 1). The Stouffer meta-analytic z score method was again applied to the EEG data collected during the 16 replication trials in the receivers (4 pairs of subjects $\times$ 2 receiver sessions per pair $\times$ 2 conditions F and S). Runs test p values for each subject were converted to a Z score and the joint probabilities calculated using the Stouffer method. Neither the eight static replication receiver EEG data nor the EEG data collected during the flicker condition, when analyzed as a whole, significantly differed from chance (static data $p = 0.34$; flicker data $p = 0.44$).

DISCUSSION

These EEG results suggest that in some pairs of human subjects a signal may be detected in the brain of a distant member of the pair when the brain of the other member is visually stimulated. In one such pair the effect was replicated. A functional magnetic resonance imaging (fMRI) study of the same pair under identical stimulus-on/stimulus-off protocol reported similar results suggesting that this phenomenon may be detected by two independent neurophysiologic methods (Richards et al., 2003). The phenomenon was not observed in all pairs, all study subjects or during all experimental sessions, including the replication sessions for pairs screened for significant p values using the Runs test.

Several accounts of correlated signals between human brains at a distance have been previously reported (Duane and Behrendt, 1965; Grinberg-Zylberbaum, 1994; Rebert and Turner, 1974; Sabell et al., 2001; Standish et al., 2001; Tart, 1963; Wackermann et al., 2003; Walach et al., 2001). However, rigorous methodology for the evaluation of this phenomenon had not been developed until recently (Johnson et al., 2002; Standish et al., 2001; Wackermann et al., 2003; Walach et al., 2001). Anomalous correlations between brain activity in nonstimulated subjects with brain responses of stimulated subjects using up-to-date neurophysiological techniques and appropriate statistical methods have also been reported recently by two similar studies carried out by two other independent groups (Radin, 2004; Wackermann et al, 2003). Both studies reported using a sender–receiver paradigm in which EEG was simultaneously recorded from pairs of subjects who were physically/sensory isolated from

TABLE 1. RUNS TEST EEG RESULTS (n = 60)

Pair #	Subject ID	Age	Gender	*Experiment 1* p value for static condition	*Experiment 1* p value for flicker condition	*Experiment 2 (replication)* p value for static condition	*Experiment 2 (replication)* p value for flicker condition
1	AR	26	M	0.4834	0.7084		
	DE	28	M	0.4378	0.1495		
2	CG	31	F	0.6045	0.0907		
	DG	30	M	0.3335	0.8644		
3	CH	28	F	0.3243	0.3243		
	DH	24	F	0.6083	0.3436		
4	CI	54	F	0.6673	0.3409		
	DI	46	F	0.7588	0.7588		
5	CJ	51	F	0.8378	0.0369	0.0895	0.9474
	DJ	28	F	0.7924	0.0001	0.1533	0.4830
6	CK	56	M	0.8302	0.3493		
	DK	54	F	0.2772	0.6880		
7	CL	32	F	0.9828	0.9980		
	DL	33	M	0.2121	0.2121		
8	AI	50	F	0.5959	0.2138		
	AQ	24	F	0.1057	0.5473		
9	CM	28	M	0.5577	0.4008		
	DM	25	M	0.4924	0.9538		
10	CN	43	M	0.2266	0.6266		
	DN	51	F	0.3955	0.2562		
11	CO	44	F	0.4628	0.1092		
	DO	47	F	0.8488	0.0223		
12	CP	55	F	0.6728	0.6728		
	DP	56	F	0.6854	0.6854		
13	CQ	32	F	0.4386	0.0049	0.1564	0.5016
	DQ	34	F	0.1730	0.0238	0.5992	0.9188
14	CR	50	M	0.7813	0.4998		
	DR	34	F	0.8457	0.6974		
15	CS	38	F	0.9352	0.4813		
	DS	42	M	0.7503	0.3220		
16	CT	29	F	0.0167	0.0001	0.3616	0.6341
	DT	27	M	0.0568	0.6573	0.8080	0.6512
17	CU	57	F	0.7938	0.4530		
	DU	64	F	0.0500	0.7709		
18	CV	27	M	0.5739	0.1830		
	AP	26	F	0.8381	0.5146		
19	CW	25	M	0.9238	0.0001	0.8338	0.0001
	DW	28	F	0.0372	0.7671	0.6726	0.3445
20	CX	31	M	0.5173	0.2633		
	DX	29	M	0.4355	0.1976		
21	CY	54	M	0.2262	0.1425		
	DY	59	F	0.0824	0.1451		
22	EA	49	F	0.5780	0.6288		
	FA	44	F	0.8819	0.3542		
23	EB	34	M	0.5628	0.0478		
	FB	35	M	0.3249	0.7349		
24	EC	51	M	0.9972	0.1194		
	FC	24	F	0.4754	0.9449		
25	ED	51	F	0.8255	0.4436		
	FD	42	F	0.9414	0.0001		
26	EE	44	M	0.3810	0.3055		
	FE	32	F	0.0303	0.5640		
27	EF	46	F	0.2413	0.9623		
	FF	53	M	0.7494	0.2999		
28	EG	47	F	0.4927	0.3601		
	FG	45	F	0.7390	0.4920		
29	EH	27	M	0.1768	0.5541		
	FH	29	M	0.0386	0.9163		
30	EJ	32	F	0.3962	0.2572		
	FJ	36	F	0.4187	0.7502		
Stouffer's z test				0.64	0.0005	0.34	0.44

Electroencepatographic (EEG) data recorded from the receiver's brain while the sender's visual system was stimulated with a flickering checkerboard (Flicker condition, stimulus "on") was compared to within-subjects' control EEG data recorded from the receiver's brain while the sender viewed a static checkerboard (Static condition, stimulus "off"). Subjects with p values < 0.01 are shaded. Stoufeach other (Radin, 2004; Standish et al, 2001, 2003; Wackermann et al. 2003) Some of these studies used pattern-reversal checkerboard patterns, which are standard in VEP research (Standish et al, 2001, 2003; Wackermann et al, 2003) while another study used a live video image of the receiver subject as a stimulus (Radin, 2004). All of these studies implemented appropriate artifact control methods, randomization techniques, and nonparametric statistics to analyze the data (Radin, 2004, Standish et al, 2001, 2003; Wackermann et al, 2003).

More support for the hypothesis of corrected signals between distant brains comes from preliminary functional magnetic resonance imaging studies. The pair of subjects who was able to replicate statistically significant EEG results during our herein reported replication experiment was retested using fMRI methods (Richards et al., 2003). This fMRI study used an alternating schedule of six random length stimulus-on/stimulus-off conditions similar to that developed for the EEG experiment (Standish et al., 2003). An increase in blood oxygenation significant at $p < 0.01$ was observed in area 18 and 19 of visual cortex in the subject acting as a receiver while the sender was presented with the stimulus-on conditions. No correlated signals were observed in the receiver's brain during the stimulus-off conditions. Results were replicated in a second scan (Richards et al., 2003).

A possible explanation for this occurrence is that spontaneous EEG correlations may be occurring without stimulation. However, spontaneous EEG correlations have been ruled out by introducing a built-in control (stimulus-off) condition interspersed in between the stimulus-on conditions presented to the sender subject. Statistically significant ($p < 0.01$) correlations were only found in the receiver's brain activity associated to the sender's stimulus-on conditions. No correlations were found associated to the stimulus-off condition. In other words, there were no false-positives among the control static data. Statistically significant brain activation in the receiver was detected only during stimulus on conditions for the sender, and never across all 60 subjects, during the sender's static condition.

Limitations of this study were the absence of random blocks in the stimulus-on/stimulus-off conditions, the inclusion of only two varieties of control conditions and the testing of bonded pairs. Although unlikely, it may be possible that the lack of a random block design helped the subject who acted as a receiver during the second recording session guess when the stimulus-on condition appeared in the sender. However, if this were the case, it would be expected that only the subjects who participated as receivers during the second session would present statistically significant results. However, subjects who began the experiment as senders as well as those who began the experiment as receivers presented statistically significant results. In addition, our study design assumes that bonding mediates the signal transfer phenomenon, while it may be possible that the phenomenon does not require bonding to occur (Wackermann et al., 2003). Therefore, future studies should include a random block design for the stimulus-on/stimulus-off conditions, an extensive set of control conditions (such as the total absence of stimulus to the sender, the absence of a sender, testing of receiver during active imagery, et cetera, and testing of bonded as well as unrelated pairs. Another limitation to the study was the deliberate use of emotionally neutral visual stimuli. The use of emotionally significant visual stimuli, such as a photograph of each person's partner, may produce more robust signals.

Another possible criticism is that our Monte Carlo method for obtaining within-subject control EEG data from the receiver may have oversampled the control data for each subject and could bias the null distribution that served as the within-subjects control data. In this study 10,000 values randomly taken from the EEG data recorded from the receiver's brain during the sender's static condition.

Another important issue was our choice to not isolate the two subjects using electromagnetic shielding. It is possible that the visual stimulus on the sender's video monitor could have been the cause of the EEG correlations observed in the receiver located at 10 meters. This possibility should be tested in future studies by introducing other control conditions such as the visual blocking of the sender's monitor. However, it is unlikely that an artifactual electromagnetic pulse generated by the presentation of the flickering checkerboard stimulus in the sender's room would affect EEG signals 80 ms after the visual stimulation. In our study we chose to look for the correlated transferred signal in the receiver the time band when the VEP in the sender occurred (80–180 ms).

In spite of the study's limitations, the data presented are, at least, intriguing. The fact that three independent laboratories using rigorous methodology and similar experimental set ups have produced similar results (Radin 2004; Radin, pp. 315–323; Standish et al., 2001, 2003; Wackermann et al., 2003), is suggestive of a phenomenon that at least warrants further replication. Randomization of stimulus presentation and additional control conditions should be tested. Future experiments should also investigate whether the phenomenon implies a signal transfer that varies as a function of distance or if quantum entanglement is at play (Radin, 2004; Radin, pp. 315–323; Standish et al., 2001; Wackermann et al., 2003; Walach et al., 2001). Other methods of measuring brain activity, including MRI and magnetoencephalography (MEEG), should be explored to validate the consistency of these findings.

Since 1963 seven independent laboratories in the United States, Mexico, England, and Germany have published data showing statistically significant correlated EEG signals between two humans who are separated up to 10 meters and in sensory isolation from one another. Since 1963, each laboratory has used different psychophysical, electrophysiologic, and statistical methods that began in 1963. That correlated brain signals appear to occur between human brains at a distance seems established after 40 years of research. Research must now proceed with studying its physical and biologic mechanism, its generalizability to varying populations and relationships, and its clinical application.

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