Article

Brain-to-Brain Interaction at a Distance Based on EEG Analysis

William Giroldini*[1,3] & Luciano Pederzoli[1,2]

[1] EvanLab, Firenze, Italy
[2] Science of Consciousness Research Group, Dipartimento di Psicologia Generale, Università di Padova, Italy
[3] Italian Association for Psychical Research (AISM), Milano, Italy

Abstract

This article presents a summary of research conducted between 2014 and 2018 regarding the possibility of a distant mental interaction between pairs of sensorially isolated subjects. A total of 85 experimental sessions were completed, during which the EEGs of each subject of the pair were recorded (respectively called "Sender" and "Receiver"), all while the Sender was given a series of light and auditory stimuli of one second duration. Members of the pairs knew each other well and were also experienced in relaxation and meditation techniques. The cerebral response to a series of stimuli is well known and is called the ERP (Event Related Potential), but the aim of this study was to look for a possible – presumably weak – response also in the Receiver.

Specifically, we studied the possibility of applying a frequency modulated stimulus (from 10 to 18 Hz) in accordance with the Steady-State method and observing any possible distant response to the same frequency. The overall evaluation of all the experimental sessions was carried out using the Global Synchrony (GS) analysis, which effectively allowed us to observe a weak but important and totally unconscious response in the Receiver ($P = 0.001$), coinciding with the stimulus given to the Sender. While the normal ERP response of directly stimulated subjects (Sender) caused an average increase in the GS by about 12-18%, in the non-stimulated subjects (Receiver) this average increase was about 0.5%.

Although very weak, this effect appears to truly be associated with information transfer between two people outside any normal means of sensory communication. These results are discussed and an experimental procedure is suggested for the actual transfer of information (stimulus frequency) between the two subjects of a pair, similar to digital binary information. This type of research is deemed fundamentally important in understanding the nature of Consciousness, based on a general model of "entanglement" between two minds.

Keywords: mind-to-mind, interaction, EEG, ERP, steady-state potentials, mental entanglement, consciousness.

This article presents the overall results of research conducted in the last few years (2014 to 2018) by the authors together with other researchers regarding the study of a possible distant mental interaction (mind-to-mind) between two sensorially isolated, but mentally and emotionally connected, people.

* Correspondence: William Giroldini, EvanLab, Firenze, Italy. Email: wilmayas@tin.it

The possibility that the electrical activity of two brains can display a correlation in the absence of any normal sensory connection has been the subject of at least thirty studies (see Table S1 in Giroldini et al, 2016) and many of these have reported a significant correlation.

Amongst specific studies using EEG and Magnetic Resonance (MRI) we cite Wackermann et al. (2003), Achterberg et al. (2005), Ambach et al. (2008), Manolea (2015), Persinger et al. (2010), Radin (2004), Richards et al. (2005) and Standish et al. (2003). These studies are important because they can contribute to a better understanding of the nature of Consciousness, which involves aspects of neurophysiology, biochemistry, psychology, and quantum physics, as well as philosophical aspects.

The studies described herein were carried out by recording the EEG of each pair of participants, in which the Sender was given a light and sound stimulus lasting one second, while the Receiver was relaxed and totally isolated from the Sender.
An initial study (Giroldini et al, 2016) highlighted a distinct increase in the Receiver's brain coherence (or synchrony) coinciding with the sensory stimuli given to the Sender. This result has been independently confirmed by Radin (2017).

A second study (Giroldini et al, 2018) used Steady-State stimuli modulated to frequencies of 10 Hz, 12 Hz, 14 Hz, 15 Hz, and 18 Hz, and even this study has shown a significant increase in the Receiver's cerebral synchrony to the same stimulation frequency of the Sender. Both of these studies were also analyzed with a new software program created by the author G.W. and based on the GW6 method described in Giroldini et. al (2016b), herein called Global Synchrony.

Materials and Methods

Participants

A total of thirty adults – 15 women and 15 men – ranging in age from 30 to 70, took part in the studies. The primary criteria for their inclusion were their mutual familiarity (friends, spouses, etc) and their knowledge of basic relaxation and/or meditation techniques. All volunteers were informed of the experiments' aims. Furthermore, most of them were firm believers of the existence of "psychic abilities" and this belief could have enhanced their mental connection.

Equipment

To avoid any kind of electrical connection between the Sender and Receiver, the EEG recordings were made using two 14 channels Emotiv Epoc devices, each linked via a wireless 2.4 GHz connection to a dedicated laptop computer powered by its own battery. The Emotiv Epoc has two efficient digital notch filtres at 50 Hz and 60 Hz to guard against disturbances in the electricity network. The sample frequency on each channel is 128 samples/sec. This frequency is more than enough to allow an analysis of all the EEG frequencies among 0.5 Hz and 42 Hz (from Delta to Gamma1).

In the 2014-2015 experiments, the 14 channels were connected to the AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, AF4 locations using the standard version Emotiv Epoc.

In the 2016 experiments however, Bionen (Florence, Italy) professional EEG headsets were used to increase recorded signal quality. Each headset was connected to an Emotiv Epoc by a multi-contact connector after having completely disassembled the device (Fig 1 and 2), placing the electronics into a designated plastic container.

This time the chosen channels were: Fp1, F3, C3, O1, F7, T5, Fp2, F4, C4, P4, O2, F8 e T6. In 2014-2015 the auditory stimulus was a 500 Hz continuous sinusoidal sound administered for one second through two 32 ohm earbuds inserted into the ears, at a volume of about 80 dB. This sound was inaudible beyond half a metre away, therefore could not have reached the isolated Receiver in another room.

A simultaneous one second visual stimulus was given with an array of 16 high luminosity red LEDs 50 cm away from the Sender, whose eyes were closed, since the light was visible through the eyelids.

In the two experiments conducted in 2016 the simultaneous one-second auditory and visual stimuli were on-off modulated at three frequencies, 10 Hz, 12 Hz, and 14 Hz (duty cycle = 50%), using an audio carrier frequency of 900 Hz.

This method of stimulus administration, called Steady-State (Pastor et al. 2003, Ahn et al. 2016), was deemed potentially favourable because it allowed the EEG signal to be filtred in a narrow band around the stimulus frequency to improve the signal/noise ratio. In the two experiments carried out in Florence in 2014-2016 the members of each pair were placed at a distance of 5 metres from each other in two sound-proof rooms.

In the other two experiments done in Milan in 2016, one room was divided into two separate areas, with the subjects 8 metres apart. In this case the sound and light stimuli frequencies were on-off modulated at 15 and 18 Hz; furthermore, only the Receiver's EEG was recorded to simplify the experiment, since the focus was to determine if the Receiver displayed a significant signal corresponding to the stimulus given to the Sender.

The perfect synchronisation of the two Emotiv Epocs' EEG recordings was considered extremely important. To this end, specific software was developed to manage the data acquired from the two independent computers, one of which acted as "master" and gave the command for the Sender's sensory stimulation. The "master" simultaneously sent digital information to the second computer about the start and end of the stimulus, via a shielded serially connected cable.

Despite an electrical connection between the two computers, the two EEG Emotiv Epocs were guaranteed to be completely electrically isolated from each other, and therefore also each member of the pair.

Data acquisition in the two computers was synchronous to an accuracy greater than 1/128 s.

Fig. 1. The professional EEG headset

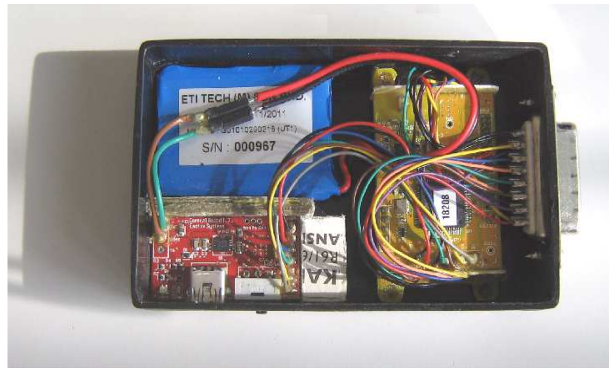

Fig. 2. The disassembled Emotiv Epoc

Procedure

In the experiment carried out in Florence (Italy) in 2014-2015, the Sender was given 128 continuous (non-modulated) stimuli of one second each, at random intervals of 4 to 6 seconds.
In the 2016 Florence experiment, the Sender was given three groups of 32 random stimuli, on-off modulated at 10 Hz, 12 Hz, and 14 Hz; the three groups of 32 stimuli were separated by random intervals ranging from 20 to 30 s, while the stimuli were all separated by the same interval of 4 s.
In another two experiments conducted in Milan in 2016, the Sender was given 100 stimuli, on-off modulated at 15 Hz, and from 90 to 100 stimuli modulated at 18 Hz, separated by random intervals of between 4 and 6 seconds. Only the Receiver's EEG was recorded.

In all cases, the participants were in a relaxed state on comfortable armchairs and the Receiver in particular was instructed to maintain minimal body movement and, if possible, to hold a mental image of the Sender.

Table 1 gives a summary of all the experiments:

Experimental series	Number of trials	Number of stimuli/trial	Stimulus frequency	Year
F25	25	128	none	2014-2015
F(10)	20	32	10 Hz	2016
F(12)	20	32	12 Hz	2016
F(14)	20	32	14 Hz	2016
M(15)	20	100	15 Hz	2016
M(18)	20	90-100	18 Hz	2016

Table 1. Experimental series performed in Florence (F) and Milan (M) during the period 2014-16

Data Analysis

EEG signal analysis was performed using a new independent software programme created by co-author GW in order to apply a uniform analysis on all experimental data obtained from 2014 to 2016. This programme includes a signal pre-processing stage comprised of a 0.8 Hz high-pass filtre followed by a band-pass filtre, with selectable bandwidth, based on the Fourier Transform and Antitransform. The pre-processing ends with a signal normalisation stage. The entire pre-processing sequence does not significantly modify signal phases, since this information is considered very important for subsequent analyses.

In this way each EEG file contributes equally to all the others, eliminating differences due to variable amplitude and EEG signal artefacts of different participants. This new programme is rather complex and contains many optional details (especially in pre-processing) that give different numerical results to those documented in Giroldini et al. (2016) and Giroldini et al. (2018). Nevertheless the global result of all processing agrees well with previous analyses (made with other programmes) and essentially confirm already published results.

Analysis of the Sender's EEG signals was done using simple averaging of time-and-phase-locked epochs and allowed easy identification of so-called ERPs (Event Related Potentials).
Furthermore, it was possible to easily identify ERPs also by calculating the signal power in a conveniently filtred EEG band.

Nonetheless, when applied to Receivers, no known technique was able to identify a signal equivalent to the ERP.

For this reason, in 2015 the author GW developed a new method for analysing ERPs, described in Giroldini et al (2016b), which has been crucial in identifying a weak by significant response in the Receiver coinciding with the stimulus given to the Sender. This method, here called Global Synchrony, has been described in the abovementioned work, however its basic principles are worth noting here.

This method is based on examining 4 seconds of data (1.5 s pre-stimulus, 1 s stimulus, 1.5 s post stimulus) and then calculating the Pearson's linear correlation between all channel pairs, using a pair of fixed duration data segments during about 250 ms.

This segment pair (sliding window) is then slid along the time axis of the two signals (for all the possible combinations), generating a series of curves R(I, X), where I represents pair combinations, I = 91 in this case (14 electrodes x 13/2) and X is the time-samples. Subsequently this series of curves is processed to produce a single graph Sync(x), that basically represents the global variations of correlation (or synchronization) between all EEG channels, using suitable pre- and post-stimulus periods as a baseline.

The resultant Sync1(x) curve shows a peak coinciding with the visual/auditory stimulus given to a subject.

This method therefore helps to support the other ERP identification techniques, but Global Synchrony has proven to be particularly useful because it allows identification of a significant weak response also in the Receiver.

While in the Sender the response is very evident and does not require statistical analysis (see Fig 3), for the Receiver it was necessary to create a specific programme to calculate the response's significance level based on the GS routine (see Fig 4).

In order to compare these observed experimental values with a random estimate, for each Receiver and for each stimulus condition, a new dataset of almost 50 Sync1(x) curves for every trial was created based on a random position of the stimulus zone within the EEG recording and in the same quantity of real stimulus number (32 or 100 or 128 stimuli), obtaining a so-called "random dataset" of Sync2(x) curves.

It is thus possible to calculate an average curve of type Sync2(x), which represents the random expectation from which are extracted statistical parameters necessary for evaluating the significance level of results.

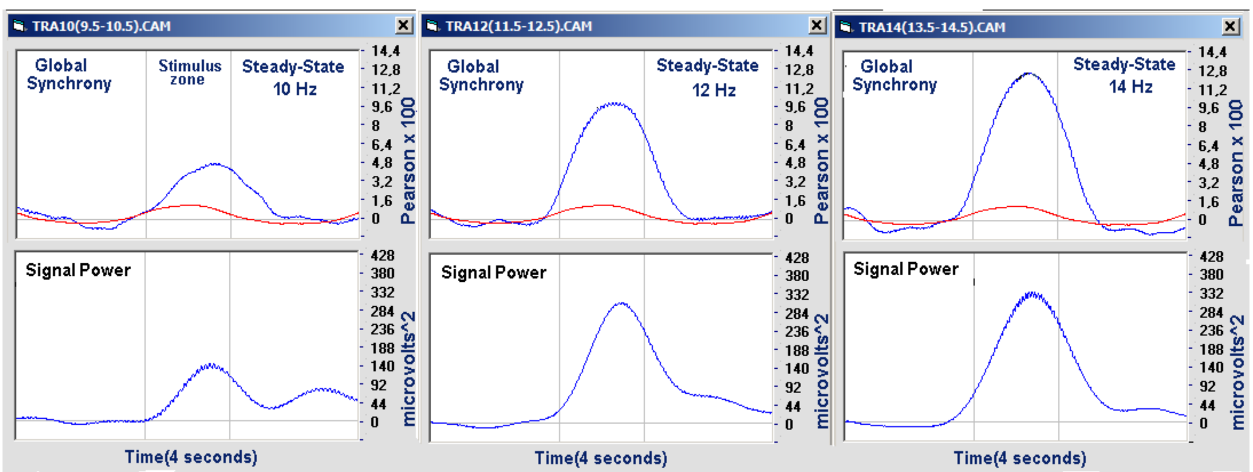

Fig. 3. Examples of Senders' responses: averages of 32 stimuli for 20 trials, filtred in a 1 Hz band centred respectively at 10 Hz, 12 Hz and 14 Hz and calculated using the Global Synchrony and the Signal Power methods. The response to the stimuli is easy to detect with any method in the Senders. The red curves in the upper graphs represent the expected values due to chance.

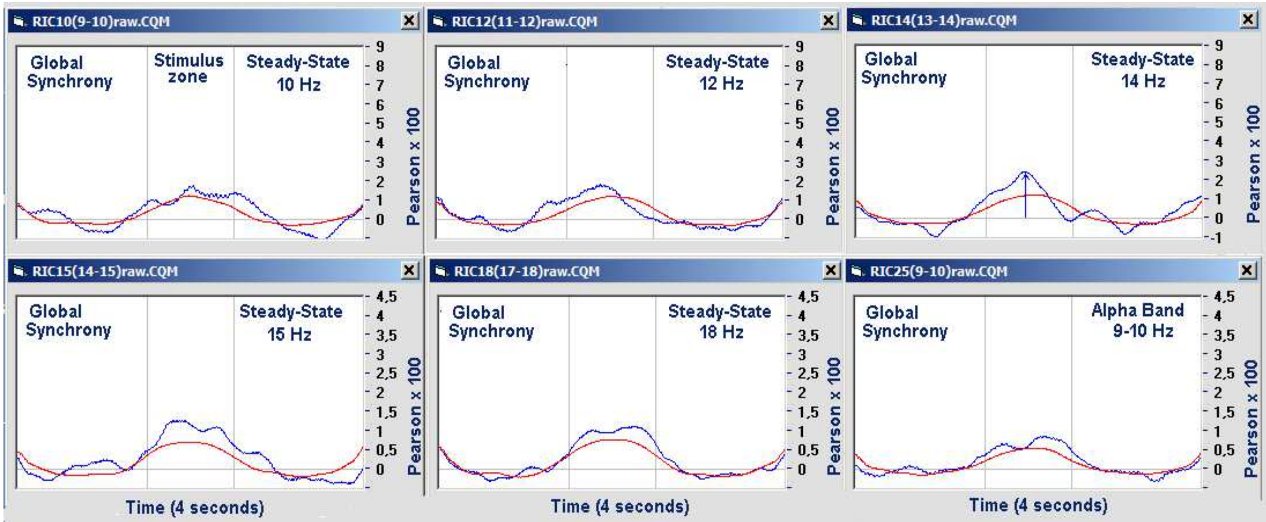

Fig. 4. Global Synchrony response in the Receivers (non-stimulated subjects). The blue curves in the graphs represent the experimental results and the red curves represent the expected random chance.

The following table was thus calculated, which represents the statistical analysis of 6 independent experimental series. The serie F25 was filtred in the band 9-10Hz (centre of the Alpha band).

Exper. series	**Stimulus Frequency**	**Experim. max Pearson correlation (mean and sd)**	**Random max Pearson correlation (mean and sd)**	**Paired t-test (one tailed)**	**Probability**
F25	none	0.877 (0.85)	0.563 (0.95)	1.64	P = 0.06
F(10)	10Hz	1.791 (2.67)	1.263 (1.99)	1.18	P = 0.14
F(12)	12Hz	1.844 (1.83)	1.222 (1.86)	1.49	P = 0.07
F(14)	14Hz	2.447 (2.89)	1.238 (1.86)	2.90	P = 0.01
M(15)	15Hz	1.284 (1.12)	0.716 (1.08)	2.34	P = 0.03
M(18)	18Hz	1.122 (0.70)	0.786 (0.92)	1.63	P = 0.06

Table 2. comparison between the experimental values and the random values using a new independent software programme and EEG data pre-processing followed by the Global Synchrony method. The t-test is calculated using the Standard Deviation of the random correlations. The arrow in the right top of Figure 4 represents the max Pearson value calculated in this Table.

When all individual results of the 125 trials are added together and compared with the curve obtained from the sum of the random data set, we get two graphs (Fig 5) which represent the global result of 6 experimental series carried out from 2014 to 2016. These 125 trials are derived from 85 experimental sessions, in which 20 sessions had three series of stimuli at frequencies of 10, 12, and 14 Hz.

Finally, Table 3 summarises the final statistical analysis, showing a significant effect (P = 0.001) calculated as the difference between the experimental Global Synchrony and what would be expected by chance.

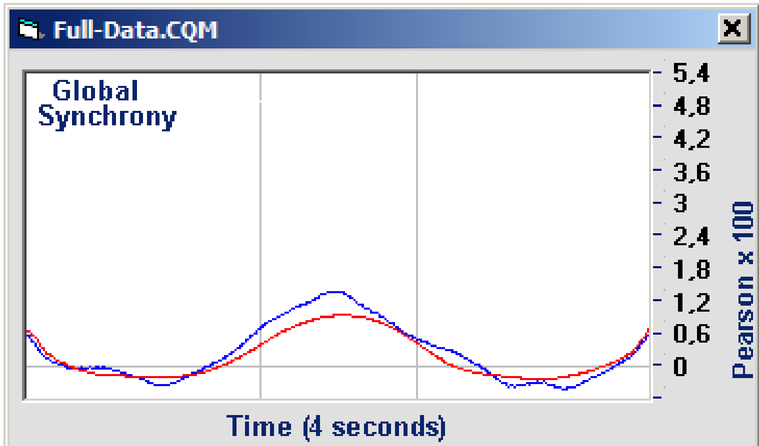

Fig. 5. Average Global Synchrony curve calculated over all 125 trials. The experimental curve (blue) is significantly higher than the curve representing chance alone (red).

Experiment. series	**Stimulus Frequency**	**Experim. max Pearson corr. (mean and sd)**	**Random max Pearson correlation (mean and sd)**	**Paired t-test (one tailed)**	**Probability**
Full(125 trials)	10-12-14-15-18 Hz	1.406 (2.05)	0.954 (1.68)	3.0	0.001

Table 3. cumulative result of 125 experimental sessions from 2014 to 2016.

Discussion of Results

This new overall independent analysis of the experiments done from 2014 to 2016, confirms previously published results. Effectively it confirms that two subjects who are mentally and emotionally connected can display a weak but significant transfer of information between them, evidencing in the Receiver also neurophysiologically as a weak increase (of the order of 0.5%) of cerebral Global Synchrony.

Although the directly stimulated subject (Sender) is obviously aware of the received stimulus, the other member of the pair (Receiver) does not consciously perceive anything, yet his/her central nervous system unconsciously recognizes a weak stimulus that produces a slight increase of the Global Synchrony at the same time as the remote stimulus.

This effect has been proven by previous neurophysiological studies mentioned above, which taken together suggest that the human mind can interact distantly with another mind without using normal sensory channels (electromagnetic waves, sound waves, touch, smell, etc).
Specifically, moreover, the results of this work show that the modulated frequency visual/auditory stimulus, at a frequency between 10 to 18 Hz inclusive, given to the Sender can be better identified in the Receiver using narrow-band filtration (1 Hz) of the EEG signal to

improve the signal/noise ratio, otherwise it is too difficult.

As already stated, if a standard analysis is performed on the Receivers based on simple averaging of time-and-phase-locked epochs, no ERP is obtained. In fact, this technique requires ERPs to be almost perfectly in phase in both time and waveform, otherwise there is a statistical cancellation effect of the ERPs themselves.

From this observation we can reasonably deduce that, in response to the stimulus given to the Sender, there is no stable waveform comparable to an ERP in the Receiver, nor a significant variation in the EEG signal strength; we only know that in the Receiver there is a slight change in cerebral coherence (or synchrony). Nonetheless we cannot exclude the possibility of this being due to a waveform associated, but out of phase, with the stimuli, or other characteristics of EEG activity undetected by the described method.

However, the Global Synchrony method seems particularly useful because (as described in Giroldini et al 2016b) it works well even in the presence of substantial jitter (variations in signal delay and its waveform). We can therefore conclude that this method represents a valid technique for identifying a weak response in Receivers even in the presence of jitters and strong background noise – a normal characteristic in EEGs.

For this reason, any future developments in the EEG analysis of this type of experiment should consider a method based on inclusion of coherence and cerebral synchrony possibly coupled with methods based on neural networks.

From that expounded here, moreover, it seems advantageous to give the Sender 90 – 100 stimuli at random intervals to obtain statistically more significant values in GS without unduly tiring the subject.

Cross-checking Steady-State frequencies

The results described here would assume a particular significance if they were selective with respect to Steady-State stimulus frequency. In other words, we need to check if by filtring the EEG signals in a frequency band that is different to that given to the Sender, we still get a significant GS result.

This check was implemented particularly on the M15 and M18 series (comprised of 100 stimuli: see Table 1) which were filtred at the frequencies of 18 Hz and 15 Hz respectively, obtaining two Global Synchrony curves defined here as “cross-frequency”.

Similarly, the three Steady-State at 10, 12, and 14 Hz, comprised of 32 stimuli, were each filtred at the other two frequencies, obtaining a total of 6 GS cross-frequency curves. The same type of cross-frequency curves were then added together and compared to the sum of the GS curves filtred at the exact stimulus frequency.

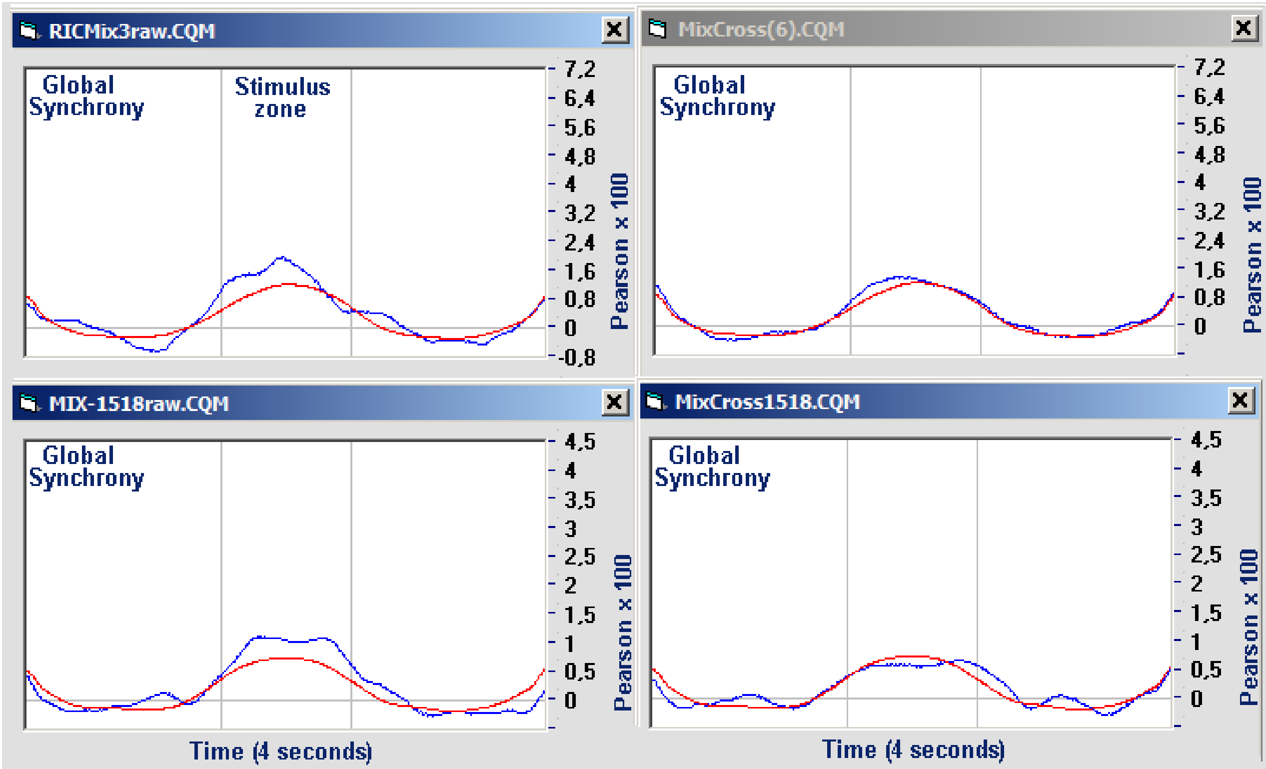

Fig 6. Top left are the three F10, F12, F14 series added together and on the right the 6 cross-frequency series added together. Bottom left shows the two M15 and M18 series added together and compared to the respective cross-frequency series. Note that the cross-frequency curves (on the right) do not differ significantly from chance expectation, while those on the left do.

Experimental series	Stimulus Frequency (Hz)	Experim. max Pearson correl. (mean and sd)	Random max Pearson correl. (mean and sd)	Paired t-test (one tailed)	Probability
Mix3F.	10+12+14	2.0 (2.36)	1.23 (1.96)	2.5-3.0	P = 0.003
Mix1518	15+18	1.14 (0.94)	0.745 (1.05)	2.4	P = 0.01
Cross3F	10+12+14	1.36 (1.92)	1.23(1.96)	0.72	ns
Cross1518	15+18	0.66 (1.13)	0.745(1.05)	0.51	ns

Table 4. comparison of two cumulative steady-state series with calculated cross-frequency series.

The graphs in Fig. 6 clearly show that if the EEG data are filtred in a different frequency band to that of the stimulus, we obtain insignificant GS results with respect to chance expectation (red curves in graphs), and still much less than those produced by filtration at the frequency stimulus. The slight positive effect observed in the 6 series cross-frequency graph with 32 stimuli (top right) falls within randomness, but can also be caused by a partial superposition effect of the stimulus frequency bands. Indeed, the 10-12-14 Hz frequencies differ by 2 Hz, while the 15 and 18 Hz differ by 3 Hz and, at a neural response level, the stimuli themselves assume a bandwidth > 1.5Hz, easily observable by way of a Fourier analysis of the Sender's EEG signals coinciding with the stimulus. In general, we can say that the Receiver's neural responses show an appreciable selectivity in frequency.

A method for transmitting real information from mind to mind

In this article we used the terms Sender and Receiver to indicate two different roles, implying that information is transmitted and received as in normal communication channels. However, whether or not the correlations that emerged from the experiments described herein (as well as the cited studies) are proof of actual information transmission between two sensorially isolated subjects has yet to be determined beyond a doubt.

According to the current prevailing understanding of the mind and brain it is simply impossible for two distant minds to connect, in that mental activity, and Consciousness in particular, depends only on the "local" bioelectrical interactions of the approximately 100 billion cerebral neurones.
Nonetheless the most recent theories of Consciousness tend to take this type of distant mental interaction into consideration, theorising the existence of a "quantum entanglement" between two minds inspired by the well-known and proven entanglement between two sub-atomic particles, which represents a fundamentally important phenomenon in modern Quantum Physics.

An example of a theory that proposes, as the source of Consciousness, the existence of entanglement in neuronal microtubules is that put forward by Penrose and Hameroff (2014). However it is not clear if this theory allows a distant mental connection.

Another recent theory, the Generalized Quantum Theory (Filk et al. 2011, Walach et al. 2016), proposes the existence of a "quantum entanglement" between two minds, however at the same time it denies that this is true "communication", but rather a type of strange "acausal connection" between two minds.

To quote Walach et al: "The relationship or correlation between two or among more than two subsystems is acausal. Regarding this characteristic, their correlation cannot be used to transfer information between or among the subsystems [Non Transmission axiom (Lucadou et al. 2007)]."

We believe that there can in fact exist a macroscopic form of "quantum entanglement" between two minds, but we think it is possible to *experimentally* rebut the quoted Non-Transmission axiom, as for any falsifiable scientific theory according to Karl Popper. In other words, we think it is indeed possible to transmit real information between two isolated minds.
The method described herein has in fact the goal of proving whether or not it is actually possible to transmit – in a purely mental way – real information from subject A to sensorially isolated subject B.

In order to obtain the best experimental results, we believe it is necessary to strictly adhere to the following conditions:

a) Determine three Steady-State stimulus frequencies (F1, F2, F3) at least 3 Hz apart, for example 12, 15, & 18Hz, or 11, 14, & 17Hz. The information to be transmitted is the chosen frequency in each trial, which (obviously) must only be known by the Senders.

b) Determine in advance the number of stimuli (at least 100), and the start and end times of each stimulus in each trial. This advance information is useful for synchronizing times and precise alignment of stimuli in the Receivers' EEG recordings.

c) Total isolation of Sender and Receiver over long distances to eliminate any form of conventional communication between them.

d) Select a certain number of Sender/Receiver pairs (at least 10 or 15) who have performed well individually in simple tests such as those described in this article.

e) Organize an experiment in which multiple Senders (10 – 15) simultaneously receive the same visual/auditory stimulus at the F1 steady-state frequency (we have reason to believe that multiple synchronized Senders are more efficient that one).

f) Make EEG recordings of different Receivers (10 – 15) simultaneously with high accuracy in relation to the stimulus timing, using the pre-determined time information.

g) Subsequently, carry out a GS analysis on all subjects, filtring the signals in the three bands (about 1 Hz wide) centred on the F1, F2, F3 frequencies.

h) Calculate the GS for each frequency and identify the maximum correlation value (as the average of all the 10 or 15 Receivers): this value corresponds to one of the three frequencies. Consider therefore this frequency as the transmitted information – the method is simply like a "majority vote". It is of course possible to also calculate the significance of this result.

i) By repeating this experimental procedure many times it is possible to transmit, in each group of attempts, a single frequency. The sequence of frequencies can constitute a coded message, because it is possible to easily prove how well the "received" frequencies match the transmitted ones by calculating their relative probabilities.

Finally, it would be advantageous to put together a research group which includes the participation of M. Persinger to confirm the theory that it is possible to increase mental connection (Rouleau et al 2015) by simultaneously applying a particular magnetic field to both Sender and Receiver before the tests.

Conclusions

We believe that the combination of all the studies on a distant connection between two minds is indicative of properties of the mind far from the classical reductionist view, but a more detailed theoretical discussion will be covered in a later article.

Undoubtedly, to allow a proper temporal synchronization, the method described herein requires foreknowledge of certain information and it is also inefficient in terms of speed of transmission of information (bit/s). However, it allows us to know if it really is possible to transmit information from mind to mind according to a classical "causal" method, in which a known stimulus generates a statistically significant and easily identifiable EEG response in the Receiver, rather than theorizing about a strange acausal relationship between two minds.

What we have here, in the authors' opinion, is a contribution of great importance towards understanding the true nature of Consciousness and the mind.

References

1) Giroldini W., Pederzoli L., Bilucaglia M., Caini P., Ferrini A., Melloni S., Prati E., Tressoldi P. (2016). EEG correlates of social interaction at distance. *F1000Research*, *4*, 457. doi.org/10.12688/f1000research.6755.5

2) Giroldini W., Pederzoli L., Bilucaglia M., Melloni S., and Tressoldi, P. (2016). A new method to detect event-related potentials based on Pearson's correlation. *EURASIP Journal on Bioinformatics and Systems Biology*, *11*. doi.org/10.1186/s13637-016-0043-z

3) Giroldini W., Pederzoli L., Bilucaglia M., Prati E., and Tressoldi, P. (2018). Exploring Brain-to-Brain interaction at a distance. www.researchgate.net. doi:10.13140/RG.2.2.29858.12489

4) Wackermann, J., Seiter, C., Keibel, H., and Walach, H. (2003). Correlations between brain electrical activities of two spatially separated human subjects. *Neuroscience Letters*, 336, 60–64.

5) Achterberg J., Cooke K., Richards T., Standish L. J., Kozak L., and Lake J. (2005). Evidence for correlations between distant intentionality and brain function in recipients: A functional magnetic resonance imaging analysis. *Journal of Alternative and Complementary Medicine: Research on Paradigm, Practice, and Policy*, 11(6), 965–971.

6) Ambach W. (2008). Correlations between the EEGs of two spatially separated subjects—a replication study. *European Journal of Parapsychology*, 23,2, 131–146. http://ejp.wyrdwise.com/EJP v23-2.pdf

7) Manolea A. (2015). Brain to Brain Connectivity During Distal Psycho-informational Influence Sessions, Between Spatially and Sensory Isolated Subjects. *Procedia-Social and Behavioral Sciences*, 187, 250–255

8) Persinger M. A., Saroka K. S., Lavallee C. F., Booth J. N., Hunter M. D., Mulligan B. P., ... and Gang N. (2010). Correlated cerebral events between physically and sensory isolated pairs of subjects exposed to yoked circumcerebral magnetic fields. *Neuroscience Letters*, 486(3), 231–234.

9) Radin D. I., (2004). Event-related electroencephalographic correlations between isolated human subjects. *Journal of Alternative and Complementary Medicine*, 10, 315–323.

10) Richards T. L., Kozak L., Johnson L. C., and Standish L. J. (2005). Replicable functional magnetic resonance imaging evidence of correlated brain signals between physically and sensory isolated subjects. *Journal of Alternative & Complementary Medicine: Research on Paradigm, Practice, and Policy*, 11(6), 955–963.

11) Standish L. J., Johnson L. C., Kozak L., and Richards T. (2003). Evidence of correlated functional magnetic resonance imaging signals between distant human brains. *Alternative Therapies in Health and Medicine*, 9(1), 128–128.

12) Radin D. (2017). Electrocortical correlations between pairs of isolated people: A reanalysis. *F1000Research*, *6*, 676. https://doi.org/10.12688/f1000research.11537.1

13) Pastor M. A., Artieda J., Arbizu J., Valencia M., and Masdeu J. C. (2003). Human Cerebral Activation during Steady-State Visual-Evoked Responses. *Journal of Neuroscience*, *23*(37).

14) Ahn S., Kim K., and Jun S.C. (2016). Steady-State somatosensory evoked potential for brain-computer interface - Present and future. *Frontiers in Human Neuroscience 9:716.* doi: 10.3389/fnhum.2015.00716.

15) Filk T., and Römer H. (2011). Generalized quantum theory: Overview and latest developments. *Axiomathes*, 21(2): 211–220. doi: 10.1007/s10516-010-9136-6

16) Hameroff S. and Penrose R. (2014). Consciousness in the Universe: a review of the "Orch OR" theory, Phys. Life Rev. 11, 39-78.

17) Walach H., Tressoldi P., and Pederzoli L. (2016). Mental, behavioural and physiological nonlocal correlations within the Generalized Quantum Theory framework. *Axiomathes*, *26*(3), 313–328. https://doi.org/10.1007/s10516-016-9290-6

18) Rouleau N., Tessaro L., Sarakoa K., Scott M., Lehman B., Juden-Kelly L., and Persinger M. (2015). Experimental evidence of superposition and superimposition of cerebral activity within pairs of human brains separated by 6000 km: central role of the Parahippocampal regions. *NeuroQuantology,* V.13, 4, 397-407. doi: 10.14704/nq.2015.13.4.891