Remote mental interaction: insights into recent research

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Abstract

This paper presents a summary of research conducted by the authors from 2014 to 2018 concerning a study on the possible remote mental interaction between pairs of subjects who are sensorially isolated from each other.

The experimental methodology was based on the simultaneous electroencephalographic (EEG) recording of a pair of subjects named ‘Sender’ and ‘Receiver’, placed in conditions of complete sensory isolation from each other. The ‘Sender’ was randomly administered a series of light and auditory stimuli lasting one second, while the ’Receiver’ was simply in a relaxed condition in silence and with eyes closed.

The members of each pair knew each other well and also had experience with relaxation and meditation techniques.

When a person is subjected to a series of brief sensory stimuli, a well-known EEG response called ERP (Event Related Potential) is generated and the purpose of this research was to observe a possible weak response even in sensorially isolated ‘Receivers’. The main analysis of the data was carried out using a method called Global Synchrony (GS), which allowed in fact to observe a weak but significant response completely unconscious in the ‘Receivers’, coinciding with the stimulus provided to the ‘Sender’.

Significant and concordant results were also obtained by analyzing the data with different methods, based for example on Machine Learning algorithms.

The results obtained in these researches suggest a real association with a transfer of information between two people without any traditional means of sensory communication.

The possibility that this result is due to some kind of sensory leakage is then evaluated, but a careful examination of the data makes this possibility extremely remote.

In addition, a theoretical model of mind-mind interaction based on a possible quantum entanglement process between two macroscopic systems consisting of billions of particles and molecules, such as the human brain, is discussed.

It is finally underlined the importance of performing independent replications of these experiments because, if confirmed, these results can be decisive for a better understanding of the mind-consciousness relationship and for some basic aspects of Quantum Mechanics that is, in particular, about the role of the observer and the non-local effects (quantum entanglement) of complex systems.

Keywords: mind-to-mind interaction, EEG, ERP, steady-state potentials, non-local effects, entanglement, consciousness.

Introduction

This paper discusses the overall results of research conducted between 2014 and 2018 by the authors, together with other researchers, regarding the study of a possible mind-to-mind interaction between two sensorially isolated, but mentally and emotionally connected people.

The possibility of observing a significant relationship between the brain waves of two people in the absence of any normal sensory connection has been the subject of numerous studies in the past, and many of these have reported a significant correlation.

Two of these studies used MRI (Magnetic Resonance Imaging of the brain) - Richards et al. (2005) and Standish et al. (2003) - but in the vast majority of cases electroencephalographic recording techniques have been used, e.g. Wackermann et al. (2003), Achterberg et al. (2005), Ambach et al. (2008), Manolea (2015), Persinger et al. (2010), Radin (2004), etc. An updated 2016 list of these papers is presented in Table 1 in Giroldini et al. (2016).

These researches have played an important role in establishing the real existence of correlations between two minds that seem to violate some axioms of classical physics and can contribute greatly to the understanding of the nature of consciousness, called "the hard problem" by philosopher David Chalmers.

The studies examined here were carried out by recording the EEG of a pair of subjects and administering at random a series of short light and auditory stimuli to the first subject (Sender) while the second subject (Receiver) was in a relaxed state and sensorially completely isolated from the Sender.

A first study by Giroldini et al. (2016a) showed a significant increase in brain coherence (or synchrony) of the Receiver coinciding with the sensory stimuli provided to the Sender. This result was confirmed by Radin (2017) through an independent analysis of the data using a different method.

A second study by Giroldini et al. (2018) used short ON-OFF modulated Steady-State type stimuli at frequencies of 10 Hz, 12 Hz, 14 Hz, 15 Hz, and 18 Hz.

Again, a significant increase in brain synchrony of the Receiver was revealed at the same stimulation frequency as the Sender.

Both of these studies were analyzed using software developed by author GW and based on a new method of Event Related Potentials (ERP) analysis, described in Giroldini et. al (2016b), and here referred to as Global Synchrony.

Finally, a further study by Bilucaglia et al (2019) re-examined data from the same two previous research studies using an approach based on Machine Learning algorithms and again obtained significant results in line with those already acquired.

Participants, materials, methods, and results

A complete table of the experiments performed, how participants and materials were selected, and the methods used are detailed in Giroldini & Pederzoli (2018).

However, over the years, some have speculated that the significant results obtained were caused by weak coupling of the two EEG instruments by direct irradiation, or by a slight sensory leakage of the sound stimulus between the two subjects, although acoustically isolated in two chambers. Here is a qualified example of such objections by Gerald Marsh:

"I read your article with great interest and thought the use of the Pearson correlation is quite innovative. If true, and replicable, the paper would have enormous implications. But I have a problem with the Equipment and Procedure sections. The Emotive *EEG has a wireless connection and you did not describe how the two EEGs were shielded from one another, nor if the two rooms had separate power lines. Given the fact that the effect is small and only appeared when Pearson correlation was used to bring the received signal out of the 'noise' even a very small coupling of the two EEGs via direct radiation or by coupling to the power lines could well explain your observations."*

For these reasons, we feel it is important to provide with this article further details on the technical modalities used.

EEG recordings were made using two 14-channel Emotiv Epoc type EEG instruments, battery powered and each connected to its own laptop computer via its own 2.4 GHz wireless connection. The Emotiv Epoc is equipped with two efficient 50 Hz and 60 Hz digital notch filters against network noise and the sampling rate of each channel is 128 samples/s, with a bandwidth of 0.5 - 45 Hz.

The distance between the two EEG instruments was between 5 and 6 meters, with the members of the pair placed in two separate rooms that were both acoustically and light isolated.

The two wireless connections of the Emotiv Epoc are highly selective, so much so that even at a distance of less than half a meter between the two instruments no mutual interference between their data is detectable, since these data are encoded with a specific digital identity (as in Bluetooth connections). Accurate tests have been conducted to verify the absolute non-interference between the digital data of the two instruments.

It was also guaranteed the total electrical independence of the EEG instruments and computers, being all battery powered.

Not even the possible disturbances generated by the power lines justify the results obtained, both because, during the measurements, they were all turned off at a distance of more than 10 meters from the experimental area, and because the Global Synchrony analysis is based on an algorithm that calculates the difference in correlation between the various EEG locations compared to an average reference value pre- and post-stimulus in which it is assumed only that any residual field at 50 Hz remains constant in the typical time interval of 4 s of the measurement (1. 5 s pre-stimulus + 1 s stimulus + 1.5 s post-stimulus). See graph in Fig. 1

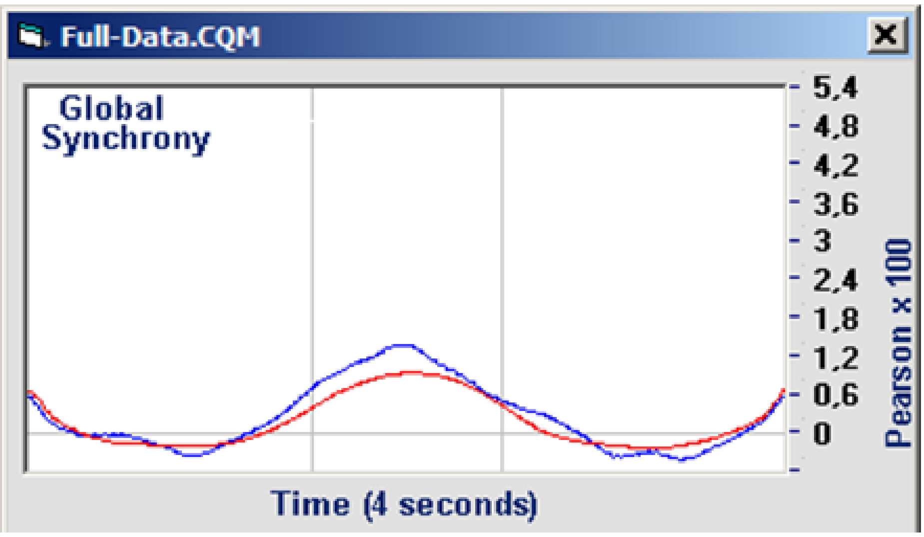

Fig. 1: Average curve of Global Synchrony calculated on all 125 trials performed. The experimental curve (blue color) significantly exceeds the curve expected by randomness (red), which was drawn from a large number of emulations, each calculated by imposing a random time position on the stimulus in the Receivers.

Finally, to evaluate the hypothesis that the observed significant effect may be due to a minimal sensory escape (auditory type), we have already performed a data analysis in accordance with the best method to highlight auditory and visual ERPs, in fact a normal auditory or visual ERP can be identified by filtering the signals in the 1-12 Hz band and then classically calculating the average of the epochs in phase with the stimulus. This calculation used all available data, resulting in a graph like the one in Fig. 2 (2014-2015 experimental series).

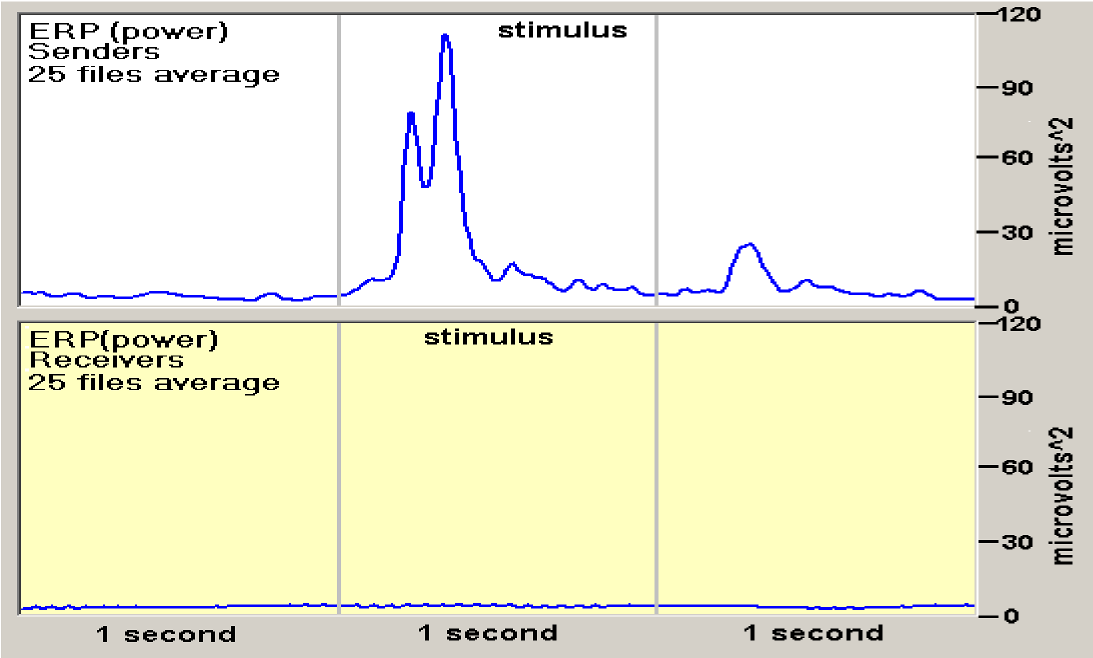

Fig. 2: Average power of all ERPs in the 2015 experimental series. The top graph shows the result in the Senders receiving the stimulus, at the bottom is the graph in the Receivers, which is virtually flat and with no evidence of normal responses.

In Fig. 2 it can be clearly seen that in the Receivers there is no trace of a normal sensory ERP, which should be present instead if there was even a weak sensory leak.

A similar result was obtained in all subsequent experimental series.

In fact, statistically significant results were obtained only by filtering signals in the narrow band Alpha 9-10 Hz (2015 series) or by filtering signals in the Steady-State stimulus band (10, 12, 14, 15, 18 Hz) with a bandwidth of about 1Hz, and then applying the Global Synchrony algorithm.

This result tells us that in the Receivers there is not a normal sensory ERP, but a weak variation of the correlations between all EEG channels, as it results from the elaborations with the Global Synchrony method.

The filtering of narrowband signals serves to increase the signal-to-noise ratio, which would otherwise be too low.

In fact, the classic method of calculating an ERP based on the average of time-locked signals is very sensitive to small phase shifts (temporal) between two ERPs, while the Global Synchrony method is very little affected by such an eventuality and probably this difference is fundamental to identify a weak response in the Receiver.

Moreover this method can be applied on Receiver data only, without the need to know Sender data at the same time.

Need for independent replications

The importance of the results obtained cannot be underestimated, as they may imply a strong paradigm shift regarding the properties of consciousness and the function of the brain.

The scientific method requires that experiments are replicable and the ones we are talking about have all the requirements to be replicated: we hope that other research groups will replicate them improving and confirming them.

Independent replications of our experiments should, in our opinion, consider the following suggestions:

a) Increase the distance between Sender and Receiver to at least 100 meters, possibly with electromagnetic shielding of subjects (Faraday cage) and high sensory isolation.
b) Use battery powered EEG equipment with more than 14 electrodes and with wireless connection to computers.
c) Provide the Sender at least 100 stimuli at a time, preferably of the Steady-State type, at a frequency between 12 and 15 Hz and with a duration of 1 second, separated by a random interval comprised between 3 and 5 seconds.
d) Time synchronization between the two EEG systems must be accurate, better than 0.005 seconds and with complete electrical isolation between the two EEG systems. If the Sender's computer sends a start-stimulus data to the Receiver's computer in correspondence with each stimulus, this process must occur without any interference with the EEG signals. Alternatively, both computers can be synchronized with an external clock (e.g., a GPS signal or similar).
e) Use pairs of subjects in strong emotional relationships with each other, carefully pre-selected for motivation and ability to relax, and reuse several times the pairs that provide the best results.
f) The preferred method of data analysis may be Global Syncrony, without excluding any new technique (e.g., the use of artificial intelligence) that can provide meaningful results and new information about the characteristics of the phenomenon.

Compatibility of remote brain-to-brain interaction with current physics

Within the neurological sciences and conventional brain studies, direct remote interaction between two brains (i.e. conscious minds) without any traditional means of transmission/reception is not allowed. However, this situation is reminiscent of that in which classical physics found itself before the birth of Einstein's theory of Relativity and then the development of Quantum Physics, in which puzzling phenomena are possible. For example, in Quantum Physics, dual wave-particle behavior, interference between particles, tunnel effect and in particular the entanglement phenomenon. On this last phenomenon are based theories such as Generalized Quantum Theory (Filk et al. 2011, Walach et al. 2016) that is directly inspired to interpret also mind and consciousness.

We know by now that for example in a pair of electrons ’entangled’, from any distance they are separated, a change in the spin state of one of the two causes an instantaneous change in the spin of the other, such as to maintain unchanged the value of the initial quantum state of the pair.

This phenomenon is simply not admitted by classical physics, but it has been demonstrated conclusively by numerous experiments since the 1990s.

On the other hand it has always been believed that this correlation cannot be used to transmit information at superluminal speed, because the existence of a correlation (higher than the classical value - Bell's Theorem) between the two particles can be deduced only by comparing the results of measurements performed on both particles, and this comparison is done by sending the results at speed less than or equal to the speed of light. In addition, the entangled state is very fragile and is destroyed by the measurement itself.

For these reasons it seems that entanglement does not allow a real exchange of information at a distance (possibly without any delay) between two macroscopic physical systems.

However, the most advanced studies on this phenomenon are showing more and more clearly that there are states of entanglement involving a large number of atoms, molecules and even microscopic objects almost visible to the naked eye, which suggests the real possibility of a usable and instantaneous communication at a distance between two physical systems.

For example, Ockeloen-Korppi et al. (2018) and Clarke J. et al. (2020) published research in which macroscopic mechanical and optomechanical objects were put in entangled states, opening a new phase of research on entanglement and its possible technological applications.

A new branch of physics is also in full development, studying methods to make 'weak measurements' on a quantum system without irreversibly collapsing the wave function, an example can be found in Sacha Kocsis et al. (2011). We are convinced that soon it will indeed be possible to achieve true instantaneous remote communication (i.e., exchange of useful information) between two entangled macroscopic systems. A common objection to this possibility is based on the idea that superluminal communication would lead to temporal paradoxes, e.g., effects preceding causes.

In reality, satisfying certain conditions, one would not encounter any temporal paradoxes even with superluminal communication.

Here is an example: suppose we have two systems, A and B, consisting of thousands (or millions) of atoms and placed in entangled state. We then separate the two systems (A and B) at subluminal speed and in conditions that preserve the entangled state for long periods of time (days, months, years and beyond). Finally, we operate a series of 'weak measures' on A and B to cause-observe modifications of A and B at system level (perhaps the global average spin of A and B?). Under such conditions we would not encounter any time paradox, because the preparation of the two systems A and B and then their separation would be irreversible processes in time and no longer modifiable.

In the light of these considerations, the idea that entanglement can be involved in the explanation of remote correlations between mind and mind does not appear any more pure fantasy.

At least two theories of consciousness are based on these concepts: one is the theory of Penrose & Hameroff (2014) which postulates entanglement phenomena in the so-called 'microtubules' of neurons, from which the normal state of consciousness of humans could arise, and in which individual states of consciousness would develop on contiguous time intervals of the order of 300 ms, thus providing also the basis for the sensation of time passing. Each individual state of consciousness, according to this theory, comes from a corresponding collapse of a global wave function within the microtubules. However, it is not clear whether this theory admits a remote mental connection. One of the objections that are made to this theory claims that the decay time of entanglement, called 'decoherence time' would be too short to be compatible with the theory itself.

In a second and more recent theory, Fisher (2015) developed a proposal that entanglement is not due to molecules or electrons in the brain, but to the nuclei of Phosphorus atoms present in all fundamental molecules of living cells (DNA, ATP and hundreds of enzymes) and in bones as Calcium Phosphate. Phosphorus, in fact, is the only atomic nucleus (in addition to Hydrogen, in living systems) to have a non-zero spin. According to Fisher, entanglement between two Phosphorus atoms at the nuclear level is stable over very long timescales (as much as 24 hours or more) when encased in structures such as the Posner molecule (Swift & Fisher 2017).

However, both these models, Penrose-Hameroff's and Fisher's, concern quantum physical processes taking place in a person's brain and do not seem at first sight suitable to justify a remote correlation between two brains. If the results of our experiments are correct and replicable, in fact, we observe the real transmission of a weak information from the Sender to the Receiver in the form of a slight modification of the internal correlations between the EEG locations of the Receiver. We assume that this effect is instantaneous and does not depend on the distance between the two subjects. In this case it would be possible to agree a priori the exact instant of application of each stimulus to the Sender. With this additional information it would be possible, processing the EEG of the Receiver only, to transmit a bit of information (0 - 1) and observe the presence of a significant effect on the global average of all stimuli processed in the Receiver.

If all this will be confirmed in future and independent experiments, then probably it will be necessary to think about a theory that interprets consciousness maybe as a quantum physical field with typical non-local properties, i.e. able to create an entanglement with another remote consciousness with which has been previously in relation. The problem of consciousness and its relation with Quantum Mechanics has been the subject of heated debate for at least 80 years.

It follows the great necessity of the continuation of these studies and the replication of this type of experiments.

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