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RESEARCH ARTICLE

EEG CORRELATES OF MEDIUMSHIP

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Abstract

There is a long and rich tradition of individuals, called “mediums,” who claim to have a particular and subjective experiences in which they report to have communication with deceased persons through a subjective interior vision or hearing voices coming from the spirits of persons. Several scientific studies have investigated the reliability of the information provided by mediums, under double-blind conditions, with results that are often significant, beyond random expectations. In this study, however, we investigated certain EEG (electroencephalogrhi c) characteristics of seven mediums, all women, who were completely normal and well integrated into society and everyday life. We compared the EEG data in two conditions: a) during a period of simple relaxation in silence and without thinking about anything, and b) during the perception of the alleged spiritual entities of deceased persons.The most interesting result, although not statistically significant (P=0.07) given the low number of subjects involved, was an increase in brain activity in the Beta-Gamma band (25-45Hz) across the entire cerebral cortex, as well as an increase in synchronization between the two cerebral hemispheres, during the phase of perception of deceased entities. Five of the seven mediums showed this activation pattern, which could not be attributed to artifacts from muscle movements or other factors, while two mediums showed no significant variations. In particular, the greater Beta-Gamma activation was found at locations T7 and T8, corresponding to the auditory cortex, with a maximum in th e left hemisphere.This observation suggests that mediums actually perc eive “internal” voices that generate real increased activity in the auditor y cortex, in a condition that we believe may be a special and natural borderline situation of activation of their CNS. The question remains open as to whether this sensitivity is really associated with an extrasens ory characteristic of human consciousness.

Introduction.

There has long been a cultural tradition of individuals describing subjective experiences of alleged communication with deceased persons. This practice is called Mediumship, or Spiritism, and is very popular in Brazil and widespread throughout the world. People who believe they can contact the spirits of the dead persons are called “mediums” and many of them belong to associations or small cultural circles that spread and promote this mystical-

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religious practice. Many associations refer to the ideas of Allan Kardec (1804-1869) [1], considered the founder and codifier of Spiritism, a religious and philosophical doctrine of which he was the main promoter worldwide, with a large following especially in Brazil.

The persons (mediums) who practice mediumship have been the subject of discussion in the fields of psychology and psychiatry, in an attempt to understand whether the statements (verbal or written) of these people are the result of psychological dissociations such as unconscious states, imaginative elaborations, altered states of consciousness similar to dreams or hypnotic trance, or pathological states, or whether they are role performances constructed on a socio-cultural and ideological basis linked to religious doctrine.

The most recent research on mediumship has sought to focus attention on the quality of mediums' statements, i.e., whether the information about the deceased is non-trivial and more genuine, working under double-blind conditions, compared to random expectations, and whether the mediums' personalities differ from the average population (Schwartz et al. 2003 [2], Roy and Robertson 2004 [3]).The results are consistent with the idea that most mediums do not have dissociative disorders, psychosis, or mental illness, are socially well accepted, especially in their communities, and lead completely normal lives.

Furthermore, some current research (Tressoldi et al. 2022[4], Sarraf et al. 2021[5]) has shown that the quality of information provided by mediums about deceased persons is statistically more accurate than responses from non-mediums or random pairings between targets and all other responses.Based on evidence from controlled studies on the accuracy of mediumistic communications and “near-death” experiences, some scholars believe it is plausible that certain individuals, in altered states of mind, can actually communicate through extrasensory perception with some form of non-local consciousness.

The concept of non-local consciousness is derived from an interpretation of Quantum Mechanics where the well-known phenomenon of non-locality (also called entanglement) becomes the basis of various theories of consciousness, some of which have a strong metaphysical character (Hameroff & Penrose 1996 [6], G. Tononi 2016[7], F. Faggin 2024[8]). Therefore, this study on mediums can be seen as part of a global research effort on the nature of consciousness.

Scientific research has long sought to study altered states of consciousness (such as mediumistic trance, hypnosis, meditation, sleep, etc.) using EEG (electroencephalographic) techniques and various other more complex techniques, such as functional magnetic resonance imaging (fMRI).In the present study, the electro-cortical activity of seven mediums, all women, was recorded in two simple conditions: the first in a state of simple relaxation, the second during the presumed perception of communication with deceased entities.

The quality of the mediumistic communications associated with the EEG recordings was not studied, as this type of investigation would require a large amount of data, time, and resources, far exceeding what was possible for this research. However, five of the seven mediums had previously been tested in an independent study that verified the good overall quality of the mediums' statements (Tressoldi P., Liberale L., Sinesio F. 2025[9]). Therefore, in this study, we simply compared the EEG parameters of two states of consciousness for each subject: a) simple relaxation without mental tasks or commitments, and b) the state during the mental perception of communication with the spirits of the deceased.

Materials and Methods:

Participants.

Seven experienced female mediums we recruited in this study through associations that have been promoting research and meetings between people interested in mediumship and spirituality, in the city of Milan, for many years. All the mediums were contacted and interviewed by the Authors, obtaining informed consent for the anonymous and statistical processing of the EEG data obtained from the experiments.The mediums ranged in age from 35 to 60, and all had between one and several years of experience in mediumistic contact. For the purposes of this research, it was necessary to select mediums who maintained a sufficient degree of self-control during mediumistic perception, so as to be compatible with the technical requirements of a good EEG recording.

In fact, some mediums can fall into a state of consciousness called “incorporation trance” or “mediumistic trance” where they lose control of themselves and move excessively, making it impossible to obtain a correct EEG recording, which requires the absence of movement artifacts. Two additional candidates were excluded from this study due to excessive movements during trance.

Procedure.

Each participant was seated comfortably in a chair or armchair, then the EEG cap with electrodes and conductive gel was placed on their head, and the impedance and quality of the signals were checked. A second elastic bathing cap was placed over the first to further stabilize the positioning of the electrodes and minimize head muscle movements.Each medium then had to remain in a state of simple relaxation for about 5 minutes, with their eyes closed, in silence, without moving, and without thinking about anything, in order to record a baseline EEG. Subsequently, the mediumsentered their usual receptive state of consciousness until they signaled perceived contact, initiating a second 2-3 minute recording of the “perception” state, in silence, with eyes closed and without body or head movements.

The EEG recording was then interrupted, and the medium could verbally report her sensations and perceptive experience. This procedure could be repeated up to three times. With some mediums, it was possible to record only one session of good quality.

EEG Acquisition and Analysis.

Recordings used a 14-channel Emotiv Epoc system connected to a laptop computer via a 2.4ghz wireless receiver.This EEG instrument was modified from the original version and was connected to a professional headset (Bionen, Florence) with 20 Ag/AgCl electrodes, 14 of which were connected to the AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, and AF4 according to the international 10-20 standard.The Emotiv Epoc electronic circuit is equipped with an efficient 50 and 60 Hz notch filter to remove interference from the electrical network.The sampling frequency was 128Hz/channel at 14 bits, with a bandwidth from 0.3Hz to approximately 46Hz. The electrodes were filled with conductive gel to ensure an electrode-skin impedance of less than 10Kohm. All signals were recorded with reference to the interconnected A1 and A2 ear lobes.

All recordings were visually inspected and very few epochs with artifacts were eliminated. The EEG signals were then high-pass filtered at 0.8Hz to eliminate lower frequencies.The EEG recordings were not subjected to a process of removal of (presumed) muscle activity (EMG signals) using techniques such as ICA for the reasons discussed in the final section of this article.The analyses were performed using custom dedicated software that performed the following processing:

1- Frequency analysis using Fourier transform for each channel (0.8-46Hz) on intervals of 1 second (or 2 seconds) without overlapping, and with a rectangular window.
The average Fourier was calculated on each channel and as the average of all channels, and the various EEG bands were quantified as average amplitude (not as power).

2- Calculation of EEG synchronization using Pearson's correlation applied to 1-second (or 2-second) intervals on the EEG signal. With 14 EEG channels, 91 combinations of channel pairs can be calculated, and in particular, an average synchronization between the two cerebral hemispheres (49 combinations) can be calculated, then synchronization within the left hemisphere (21 combinations) and right hemisphere (21 combinations). The method is also described in Giroldini 2025 [10].

3- Calculation of Coherence, defined as the calculation of EEG synchronization for each frequency in the range from 1 to 46Hz. This type of Coherence varies from +1 to -1, where +1 means that two signals at frequency f are in perfect phase, while the value -1 means that the two signals are in counterphase. This coherence can essentially be interpreted as an analysis of the correlation between two signals in the frequency domain. This mathematical routine was developed in Visual Basic 6 and is described in detail in Giroldini 2025[11].
Furthermore, to obtain better results, we used an EEG reference based on interconnected ear lobes. In fact, a typical reference based on the average of all channels can eliminate most of the in-phase signals on many frequencies and in many locations (RW. Thatcher et al. 2004 [12]) and in the Author's opinion, it may not correctly represent brain synchrony.

4- Calculation of the Envelope Frequency Correlation (EFC). This mathematical routine, developed in Visual Basic 6 by the Author, is also described in detail in the same reference (Giroldini 2025[11]).Let's assume we have (as in our case) 14 EEG channels. It is possible to calculate the Fourier for each channel and for each short segment of data (for simplicity, every second).

The result is a three-dimensional vector FT(c, f, s) where c=1-14 are the EEG channels, f=1-46Hz are the frequencies, and s=1 - P are the total seconds of the EEG recording; for example, over three minutes, P is 180. This vector FT(c, f, s) could be used to construct a spectrogram, i.e., a graphical representation showing the spectral composition of a signal along the time axis (it is used especially in music, but is also often used with EEG). However, this vector can be used to evaluate how the various EEG frequencies may appear quasi-simultaneously (or not) on different EEG channels.The basic idea is to calculate the amplitude over time of each frequency in each channel.
Then calculate the Pearson correlation between all the amplitudes of the channel pairs, which with 14 channels amounts to 91 pairs. Finally, calculate the average of the 91 correlations for each frequency. The result is an EFC(f) vector that describes the degree of quasi-simultaneity of the same EEG frequency between different electrodes.This calculation is not sensitive to the phase between different signals (such as Coherence) but only to the presence of quasi-simultaneous frequencies in different channels within one second. For example, an Alpha rhythm, or a particular Beta rhythm, may (or may not) appear almost simultaneously on multiple channels.
In fact, EFC(f) highlights this aspect.

Results:

Several graphs were calculated corresponding to the average Fourier of the 7 participants in the two conditions: initial relaxation and perception of the presumed entities.

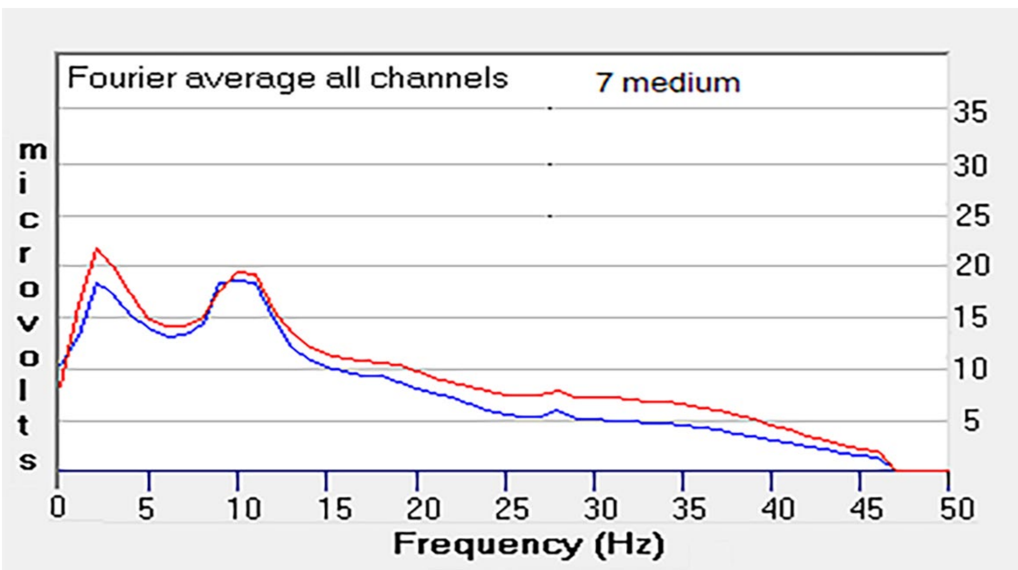

Figure 1: Average Fourier of the 7 subjects in initial conditions of simple relaxation (blue curve) and during perception (red curve).

The frequency analysis shows an excess of activity in the Beta band (approximately 13 to 45 Hz) and especially above 25 Hz. Frequencies above 45 Hz cannot be recorded with the instrument used, as a low-pass filter acts at the level of the EEG electronic circuit, which is essential for eliminating 50Hz network interference.

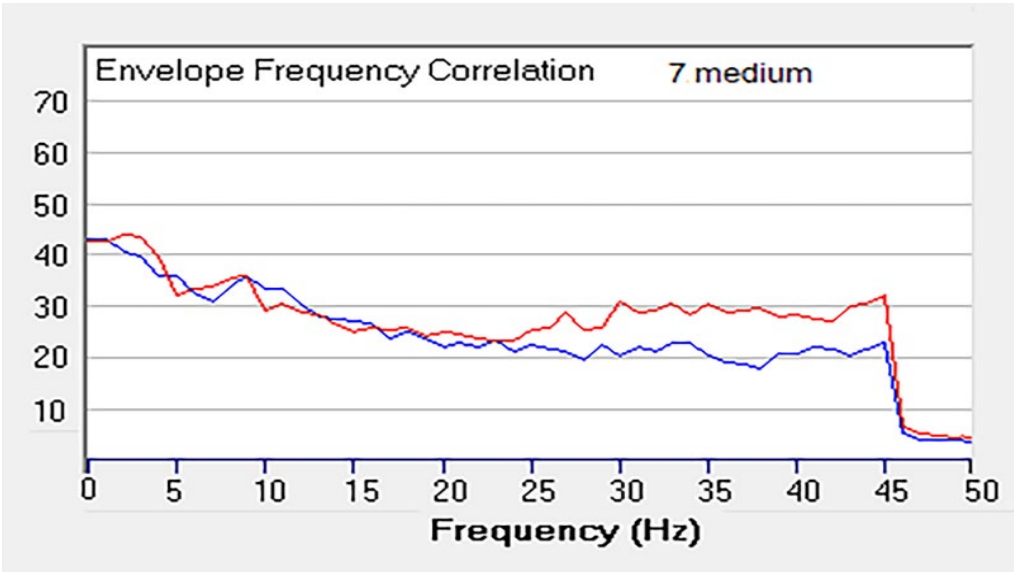

Figure 2: Average graphs of the Envelope Frequency Correlation (EFC) in the two conditions: relaxation (blue) and perception (red curve).

This analysis highlighted an increase in activity, especially in the Beta band (25-45Hz) during the perception state.

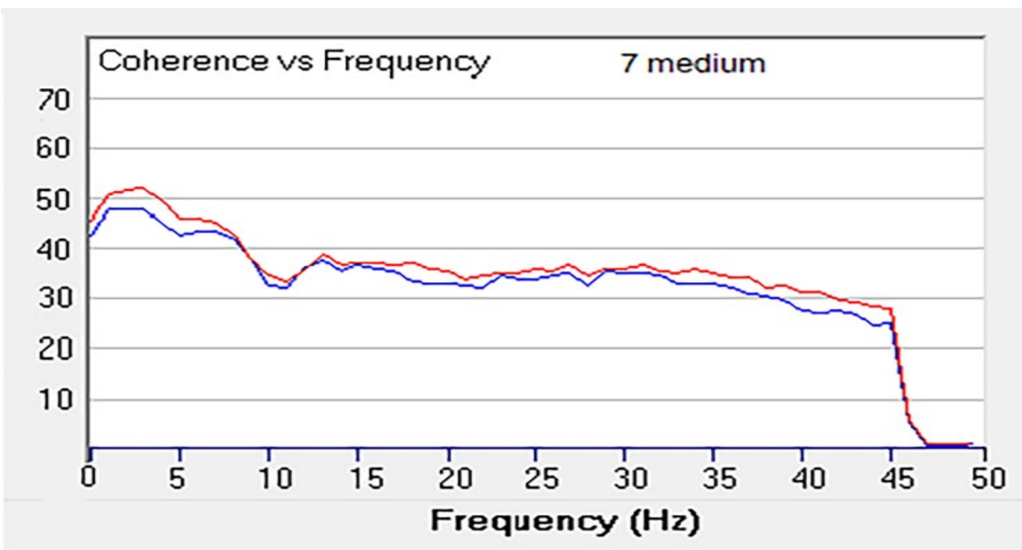

Figure 3: Average graphs of Coherence in the relaxation condition (in blue) and during perception (in red).

In this case, there is again an increase in EEG coherence, especially in the Beta band (25-45Hz) and also slightly in the Delta band (1-4Hz). Another way of expressing the results is to create a table in which various items are calculated numerically, which are respectively:

1. Synchrony between the two hemispheres
2. Synchrony within the left hemisphere
3. Synchrony within the right hemisphere
4. Average amplitude in Beta1 (13-25Hz)
5. Average amplitude in Beta2 (25-45Hz)
6. Average EFC amplitude in the 25-45Hz band
7. Average Coherence amplitude in the 25-45Hz band.

Table 1: seven items calculated in comparison between Relax and Perception.

	Relax	Perception	One tailed t-test	Probability
Synchro betw. hemisph.	36.3 ± 6.2	39.7 ± 6.1	1.03	N.s.
Synchro left hemisph.	51.6 ± 6.1	52.9 ± 5.7	0.4	N.s.
Synchro right hemisph.	49.7 ± 7	52.1 ± 6.0	0.7	N.s.
Beta 1 (13-25Hz)	7.63 ± 1.17	9.0 ± 3.50	0.98	N.s.
Beta2 (25-45Hz)	3.62 ± 0.76	5.2 ± 2.74	1.45	P = 0.07
EFC (25-45Hz)	21.0 ± 7.8	28.6 ± 12	1.40	P= 0.07
Coherence (25-45Hz)	31.3 ± 4.9	33.5 ± 4.7	0.85	N.s.

No item reaches statistical significance, mainly due to the low number of subjects (7) on whom the statistical comparisons are performed. However, it is clear that all variables increased in the condition of perception of the alleged entities. There are also significant individual differences between the results of the different mediums, in terms of the differences between initial relaxation and the perceptual state.

In particular, two mediums showed almost no difference in the seven variables, while the remaining five mediums showed an interesting "Beta activation pattern" which is best represented by the two graphs corresponding to the average of the five mediums (the two mediums that showed no significant difference are excluded).

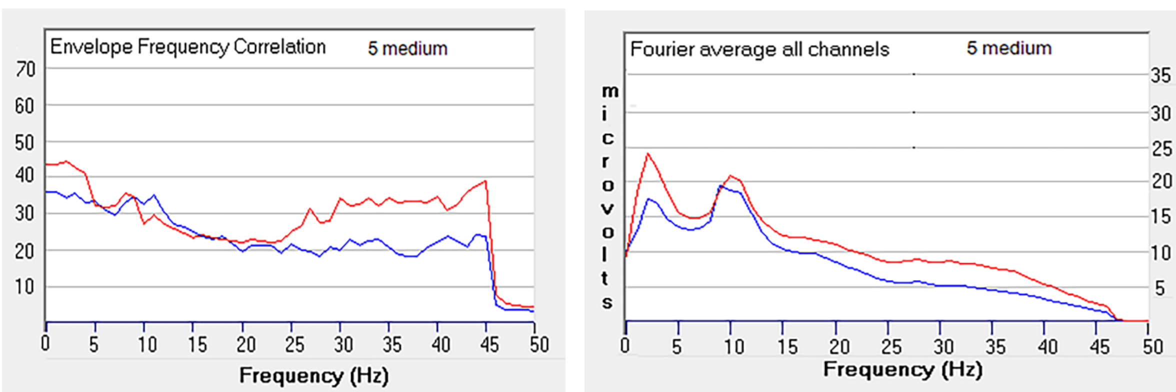

Figure 4: EFC (Envelope Frequency Correlation) and Fourier graphs of the 5 selected mediums

These mediums showed an interesting common pattern consisting of increased Beta-Gamma activity extending up to 45Hz, as well as an increase in Delta activity (1-4Hz), in addition to an overall increase in brain synchrony. The Theta and Alpha bands, on the other hand, showed no significant differences.Based on these interesting observations, we then calculated a map of Beta-Gamma activity (25-45Hz) expressed as the Percep/Relax amplitude ratio in the 14 EEG locations measured.

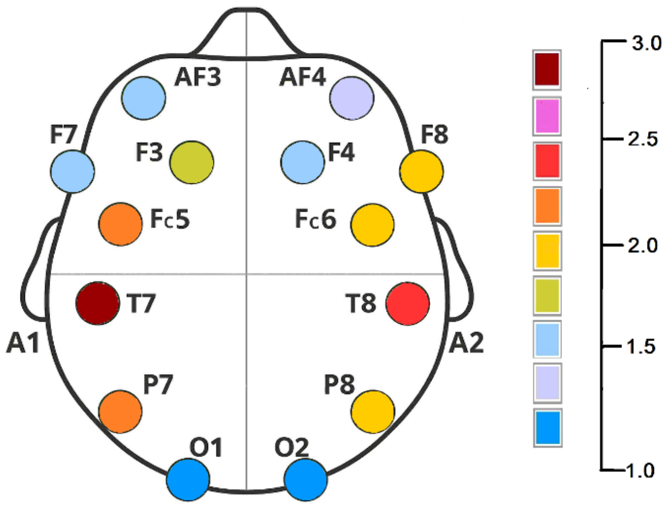

Figure 5: Map of the amplitude ratio between Perception and Relaxation for the 14 EEG locations, in the beta-gamma band.

This fig. 5 shows that the ratio is always positive (the amplitude is always greater in Perception in all locations) with a maximum of up to 2-3 times in locations T7 and T8.

Discussion.

A study described by Delorme et al. (2013)[13] with some mediums obtained results very similar to ours, highlighting an increase in activity in the Beta (18-45Hz) and Gamma (75-110Hz) bands during the condition of "communication" with deceased persons. Bastos et al. (2016) [14] also reported an increase in Beta activity in the 13-32 Hz band (limited to 32 Hz for technical reasons). The results found by del Rosario-Gilabert & Vigué-Guix (2025) [15] in a single case of a highly experienced medium during ESP perception are also very interesting. In this case too, the maximum difference was found in the gamma band(30-45Hz) in the frontal locations.

It has long been known that during important cognitive and perceptual tasks, an increase in EEG activity in the Beta-Gamma band is observed. (Fitzgibbon et al. 2004[16], Yu Haihong et al. 2024[17]).In a manner entirely analogous to Delorme's work, the mediums included in this research did not enter a state of deep trance, as a deep trance can lead to loss of control over body and head movements, which would have made it impossible to acquire EEG signals correctly.However, the increase in Beta-Gamma band activity raises the same doubts expressed by Delorme. In fact, muscle artifacts, such as saccadic micro-movements or slight muscle movements on the surface of the head, can induce Beta-Gamma signals that can be superimposed on true central nervous system activity, as described by Yuval-Greenberg et al. (2008)[18].

On the other hand, Melloni et al. (2009)[19] contested the importance of this possibility, which must always be evaluated in relation to the actual conditions of EEG signal recording, i.e., by visually monitoring the behavior of the subjects during EEG recordings.In our case, continuous observation of the subjects during EEG recordings (both during the relaxation phase and afterwards) did not show any differences in behavior (body and head movements) that would suggest significant or greater contamination of EEG data with electromyographic signals during the perception of the alleged entities. For this reason, the EEG recordings were not subjected to a process of removal of muscle activity (EMG signals) using techniques such as ICA, as this technique involves an arbitrary decision to consider an ICA component as an artifact rather than an authentic EEG signal.

Therefore, we believe that the increase in Beta-Gamma activity in the mediums (at least in five of them) reflects real mental activation, a subjective perception of images and voices, which represents a very interesting state of consciousness worthy of further investigation.There is a possibility that these subjects, who are completely normal in everyday life, are nevertheless in a borderline situation with regard to their ability to perceive inner voices. Steinmann et al. (2017)[20] investigated auditory hallucinations in schizophrenic subjects using EEG and found that these individuals have significantly greater connectivity (synchrony) in the gamma band between the bilateral auditory cortices during conscious perception of syllables, compared to normal subjects. Many other studies have found important associations between the gamma band and auditory hallucinations, for example Spencer et al. (2009)[21].

The fig. 5 shows that the maximum of Beta-Gamma activity is in locations T7 and T8, which correspond (approximately) to the bilateral auditory cortex, and is greater in the left lobe. This observation suggests that mediums actually perceive “internal” voices that generate real increased activity in the auditory cortex.In this work, as already pointed out, the reliability of the mediums' statements was not studied, but only a verification of any EEG differences between a basal state of consciousness and that during perception was done. A more comprehensive future study, similar to that of Delorme, could attempt to associate an index of reliability of perceptions with the level of Beta-Gamma activation.

In addition, motion sensors (miniaturized accelerometers) could be added to the EEG headset to independently monitor involuntary movements. The question therefore remains open as to whether this high sensitivity of mediums to perceive voices and images from a "spiritual world" is really associated with a characteristic of human consciousness to come into direct contact with other consciousnesses and entities, as suggested in ESP (Extra Sensory Perception) and NDE (Near Death Experience) , where much research, including quantum theories, seems to point in this direction.

Conflict of Interest.
All authors declare that they have no conflict of interest. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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