

Out-of-Body experience induced by hypnotic induction: a neurophenomenological study

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ABSTRACT

The main objective of this study was to compare the neurophenomenology of the Out-of-Body-Experience (OBE) state induced by hypnotic suggestion on a group of five selected participants with other states of consciousness, specifically the state of imagined OBE and hypnosis.

From a phenomenological point of view, a comparison of the OBE state with that of deep hypnosis, measured by using the Phenomenology of Consciousness Inventory, gave higher scores of Self-Awareness, Memory, Rationality, Voluntary Control and Imagery for the OBE.

From a neurophysiological perspective, the major difference – with respect to all other control conditions – was an increase in the power spectrum density and a decrease of coherence of the delta band when participants were required to answer questions posed by the hypnotist during their OBE state, suggesting that this could be the neurophysiological marker of this special state of consciousness.

Keywords: Out-of-Body-Experience; Hypnosis; EEG; Neurophenomenology; Consciousness

INTRODUCTION

This is the first neurophenomenological study of Out-of-Body Experiences (OBEs) induced via hypnotic suggestion on a sample of five participants chosen according to their susceptibility to hypnosis and their willingness to undergo this type of induced OBE.

Amongst so-called non-ordinary, or altered, states of consciousness (see Cardeña & Alvarado, 2014 for a review), OBEs represent one of the most interesting of these phenomena. Together with so-called Near-Death-Experiences (NDEs), the OBE is the only non-psychopathological state of consciousness in which participants report a detachment of the core consciousness – or First-Person Perspective (1PP) – from their bodies (Carruthers, 2015; Metzinger, 2005). From a theoretical viewpoint, if this state of consciousness represents a true dissociation, or functional independence, between the centre of consciousness and the body (brain included), it would have important implications for the debate regarding the mind-body relationship in that it would represent evidence of a partial independence of the 1PP from its physical body.

Although OBEs are rare in the healthy population, ranging from 9% to 20% depending on samples studied (Alvarado, 2000), and since they are almost always spontaneous and uncontrollable by the experiencer, the study of their phenomenological characteristics and neural correlates is impossible during the actual experience unless simulations are used, such as carrying out the Mental Own-Body Transformation task (Blanke et al., 2005), the Pattern-Glare task (Braithwaite, Brogna, Bagshaw, & Wilkins, 2013) or post-experience interviews.

It was only recently that (Smith & Messier, 2014) were able to study changes in neural activity using fMRI in a young lady who was able to achieve an OBE state at will, observing an activation of the left supplementary motor area and the supramarginal and posterior superior temporal gyri, the latter two overlapping with the temporoparietal junction, an area of the brain that deals with attention, memory, language, and social processes, and which are considered to have a high-order role in creating a social context for behaviour (Carter & Huettel, 2013). Its failure in integrating multisensory information from one's own body has been considered the cause of illusory body representations that are similar to those experienced in the OBE (Blanke & Arzy, 2005). Furthermore, these authors found a specific involvement of the left middle and superior orbital frontal gyri, regions often associated with action monitoring, suggesting that within this state of consciousness is a state of awareness that differentiates it from other states - for example, that induced by hypnosis.

For the past few years our research group has been successfully studying the possibility of bringing about an OBE state by way of hypnotic suggestions on participants with a high degree of hypnotizability and a willingness to experience this particular state of consciousness (Tressoldi et al., 2015; Tressoldi et al., 2014). The advantage of this procedure is that during the controlled OBE it is possible to dialogue with the participants in order to learn the phenomenological characteristics of their OBE state, given that the participants' control over their cognitive activities and vocal chords does not interfere with this state of consciousness.

The ability to induce OBEs willingly therefore allows the study of their neurophenomenological characteristics with great accuracy as well as a comparison with other consciousness states, such as deep hypnosis or simply an imaginary OBE state.

The aim of this study is to integrate the phenomenological information about this particular consciousness state, obtained both through real-time dialogue during the experience and written questionnaires afterward, with EEG activity data, comparing them with different control conditions, to wit: relaxing with eyes open; imagining an OBE; being under hypnosis; having a free OBE; conversing with the hypnotist while having an OBE; and finally returning to a normal state of consciousness. If, as previous studies show, the OBE state indeed represents something different to other states, we would also expect a different neurophysiological correlate, especially during conversation with the hypnotist.

METHOD

Participants

The five participants were chosen for their experience in hypnosis and for having passed test sessions with the hypnotist in which an OBE induction was performed. Their relevant personal data and previous hypnosis/OBE experience are shown in Table 1. Their level of OBE knowledge was assessed on a scale of 1 to 5 (1 = nil, 5 = very good) based on previous OBE experience and general knowledge about it as stated by each participant.

None of the participants had medical or psychiatric problems, nor were any taking medications that would affect their state of consciousness; this was ascertained by a semi-structured interview before being included in the study.

The hypnotist has many years of experience in the techniques of inducing OBE states through hypnotic suggestion, and took part in previous experiments of (Tressoldi et al., 2015; Tressoldi et al., 2014).

Table 1: Participants' personal data and hypnosis/OBE experience

ID	Age	Sex	Previous Hypnosis experience	Previous OBE experience	OBE knowledge
Elen	43	F	Four sessions	Four, induced by hypnosis	Good
Annalie	58	F	Three sessions	None	Fair
Anton	47	F	Three sessions	Three, spontaneous	Good
Federic	24	F	One session	None	Fair
Daniel	64	F	Eight sessions	Four, spontaneous	Very good

EEG equipment

Participants' EEG activity was recorded using the 14-channel Bionen® professional headset in accordance with the 10/20 system (FP1, F3, C3, P3, O1, F7, T5, FP2, F4, C4, P4, O2, F8 and T6) plus two auricular electrodes (A1, A2) which served as reference points. The sample frequency was 128 Hz, with a bandwidth from 0.2 to 45 Hz, a built-in fifth order low-pass digital filter as well as two notch filters at 50 and 60 Hz respectively as protection against noise produced by the local electricity network.

Confirmatory hypotheses

a) The transition from a hypnotic state to an OBE state will result in a reduction in activity that is typical of deep hypnosis and characterized by sudden EEG activity, usually in the Beta and Gamma bands (Cardeña, Jönsson, Terhune, & Marcusson-Clavertz, 2013). This is clearly a very generic hypothesis given the lack of studies in the area, and therefore there are no exact predictions of which frequency bands should be different.

b) The request to imagine having an OBE with respect to the actual OBE condition will give different results. This too is a very generic theory for the same reasons as the previous one.

Procedure

The study consisted of one session for each participant. Sessions for four participants were conducted in the same location, a room inside a meditation centre, whereas the fifth participant's session was conducted at EvanLab, a private laboratory owned by the first-named author.

Each participant was made comfortable on a recliner and the room soundproofed and dimly lit.

Before beginning the study, each participant received an explanation about the experiment's aim and type of activity to be undertaken in each session, after which they each signed an informed consent form in accordance with the guidelines of the Ethics Committee of the Department of General Psychology, University of Padova, in compliance with the Helsinki Declaration's ethical principles for medical research involving human participants.

The session was comprised of six distinct phases, defined as follows:

- 1) Relaxation with eyes open for about 2 minutes;
- 2) Imagining as being out of body for about 2 minutes after given the following direction: "*close your eyes and for two minutes imagine having an OBE*";
- 3) Induction into a hypnotic state via suggestion to attain an OBE state. The duration of this phase depended on each participant's answer and varied from around 7 to 9 minutes;
- 4) Unrestricted OBE state for about 2 minutes; questions during OBE for 1 minute; unrestricted OBE state for around 2 minutes; questions while in OBE state for 1 minute;
- 5) Re-entry into body and relaxation with eyes open for around 2 minutes.

The hypnotist decided when to start and stop recording of EEG activity for each phase. The assistant in charge of the EEG data capture recorded the beginning and end of each phase as per the hypnotist's directions. Details of the hypnotic and OBE induction procedure can be found in the Supplementary Material.

Interview during the OBE state

Once the OBE state was reached, after approximately two minutes each participant was asked several questions to investigate the phenomenology of this experience. This was then repeated before returning to a normal state of consciousness.

Structured assessment of OBE phenomenology

The OBE's phenomenology was evaluated by application of the Phenomenology of Consciousness Inventory – PCI (Pekala, 1991).

The PCI is comprised of 53 questions requiring answers based on a Likert scale with a range of 7 (from 0 to 6), widely used for evaluating cognitive and emotional aspects of different non-ordinary states of consciousness (see following paragraph). Its psychometric reliability and efficiency has been shown by many studies to be satisfactory (Pekala, 2013).

The questionnaire was compiled individually after a lengthy explanation of the answering procedure for its various items, and was given to each participant after the OBE induction session.

Furthermore each participant was asked to provide an answer to the question: *Did you experience anything unexpected during the OBE?*

PCI Scoring

The PCI answers were processed by a program created by co-author PT using an Excel spreadsheet to automatically calculate the score. For each participant an average score was calculated for the 12 main categories: Altered Experience, Positive Affective, Negative Affective, Attention and Imagery, Self-awareness, Altered state of awareness, Arousal, Rationality, Voluntary control, Memory, Internal dialogue plus the Reliability Index.

EEG data analysis

All EEG recordings were processed offline using the MATLAB toolbox EEGLAB (Delorme & Makeig, 2004). The data were first band-pass filtered using a 45-Hz low-pass filter to eliminate the 50 Hz electrical noise. Each recording was then segmented into six epochs, corresponding to the distinct phases described previously. Epochs were then visually inspected to manually remove rare artefacts like head movements. Artefact-reduced data were then subjected to Independent Component Analysis (Mento & Vallesi, 2016; Stone & Stone, 2002). All independent components were visually inspected by a trained expert (GM) and those related to clearly recognizable artefactual signatures according to their morphology and scalp distribution were discarded. The most common artefactual discarded components included eye blinks, eye movements or constant

oscillatory activity induced by external devices. The remaining components were then projected back to the electrode space to obtain cleaner EEG epochs.

Both the raw and the artifact-cleaned EEG recordings are freely available on https://figshare.com/articles/HypnOBE_EEG_data/3471842

Power Spectrum Density

The artifact-clean recordings were then imported into the Brainstorm software (Tadel, Baillet, Mosher, Pantazis, & Leahy, 2011; <http://neuroimage.usc.edu/brainstorm>) to run additional analyses. These included the computation of the Welch’s power spectrum density (PSD) analysis, which was performed separately for each phase within and between subjects. The following frequency bands were considered: delta 2-4 Hz; theta 5-7; alpha 8-12, beta 15–29, gamma 30-59. Between each band there were missing frequency values to avoid possible overlapping ‘boundary’ effects. The power relative to each band was calculated by considering a 2 seconds window with a 50% overlapping rate.

Quantitative comparisons were carried out by estimating the effect size of each comparison between the PSD percentages that differed the most; this was performed by application of the BEST package (Kruschke, 2013) with the R program, and the relative Bayes Factor, using the JASP software (Jasp Team, 2016) choosing a Cauchy distribution value of .70 as the prior probability.

RESULTS

Phenomenological Data

Table 2 below presents the hypnotist’s questions and the answers given by each of the five participants.

Table2: Questions and answers during the OBE state.

Elen	Annalie	Anton	Federic	Daniel
<p><i>Where did you go?</i> I was up, in the sky, because I like watching things from above and I wanted to see how the sun lights up the earth.</p> <p><i>How does the sun do it?</i> I saw the light coming from right to left and hit this blue planet.</p>	<p><i>Where did you go?</i> I was dancing near the sun, then I came back. At a certain point, I came down to earth again</p>	<p><i>Where did you go?</i> I went to where I was in the previous OBE (watching earth and Mt Etna from</p>	<p><i>Where did you go?</i> To Mars...</p> <p><i>What did you see?</i> Nothing of interest: I lay on the surface.</p> <p><i>What is the surface like?</i></p>	<p><i>Where did you go?</i> I made a few journeys: I went underwater in the sea... on top of a mountain...</p>

<p><i>Were you watching from the outside?</i> Yes.</p>	<p>and went to Peru, in the forests (the Amazon?)</p>	<p>above) and I wanted to once again feel what I felt before.</p> <p><i>And did you?</i> A bit less, but yes I did.</p>	<p>It felt warm... really warm.</p> <p><i>What did it feel like?</i> More or less like earth.</p>	
<p><i>Where did you go this time?</i> In water. First of all I went into the ocean to see if things are visible in the dark: I wanted to know if things can be perceived like when they are outside, in the air.</p> <p><i>And can they be?</i> Yes.</p> <p><i>How do you perceive them, as in your physical body or differently?</i> I sense shapes.</p> <p><i>But can you feel the water temperature, its consistency, or not?</i> No.</p> <p><i>What shapes did you perceive?</i> Something like algae attached to rocks.</p> <p><i>Did you perceive fish or other animals?</i> Yes, marine animals.</p> <p><i>Known or unknown?</i> Known.</p>	<p><i>Where did you go this time?</i> I continued from where I was before, then I went to Nepal, with the monks. After that I went to the peak of the highest mountain (Everest) and stayed there, standing at first with arms out, then I sat and looked around.</p>	<p><i>Where did you go this time?</i> I wanted to contact someone higher up.</p> <p><i>Did you?</i> I felt enveloped: I could not see, but it felt like I made contact.</p>	<p><i>Where did you go this time?</i> Ireland.</p> <p><i>Did you see anything interesting in Ireland?</i> Cliffs, then I looked below and there was a bit of land on the sea. I went there and there was a small cave, not very deep.</p> <p><i>Was there anything inside the cave?</i> No, there was nothing when I went there, apart from the area where people sometimes go...</p>	<p><i>Where did you go this time?</i> I went to G's house (eldest son) to see the children (3, two of which are baby twins).</p> <p><i>Were all three of them there?</i> No, only one of them, a small one, then I noticed that G's father-in-law (deceased) was present in the house.</p>

Comment

It is interesting to note the large variation in reported experiences, although all involved journeys to terrestrial and non-terrestrial places in order to experience new sensations and emotions. The ability to visit extra-terrestrial places and terrestrial ones inaccessible to the human body could simply be products of imagination or the participants' desires, but the descriptions of the experiences seem genuine.

PCI scores

The average score of the twelve subdimensions and the Reliability score of each participant are shown in Table 3. The average of all subdimensions of the five participants is furthermore compared to that observed by (Cardeña & Terhune, submitted) using a group of eleven participants in deep hypnosis. The difference between these two groups was quantified using Hedges' effect size g .

Table 3: Mean scores in the Phenomenology of Consciousness Inventory subdimensions of each participant.

ID	AE	PA	NA	A	I	SA	ASA	AR	R	VC	M	ID	RI
Elena	4.6	2.8	0	3.8	4.5	6	6	1	6	5	6	0	3
Annalia	5.8	4.3	.16	4.8	5.75	4	5.7	0	5.3	2	5	0	.2
Antonella	4.6	3.6	0	4.8	5	5.3	5.7	0	3.3	1.7	6	5.5	.6
Federica	3.3	1.6	0	3	5.25	5	2.3	1.5	5.7	2.7	6	0	1.2
Daniela	4.5	3	.8	4.8	5	5.3	5	.5	3	3.3	5	5	0
Mean (SD)	4.56 (.88)	3.06 (1.0)	0.19 (.35)	4.24 (.82)	5.1 (.45)	5.12 (.73)	4.94 (1.5)	0.6 (.6)	4.66 (1.4)	2.94 (1.3)	5.6 (.55)	2.1 (2.8)	1 (1.2)
Cardeña & Terhune (2016) n.11	3.36 (1.06)	2.32 (.98)	1.31 (1.35)	4.55 (1.35)	4.27 (1.12)	3.2 (1.04)	4.25 (1.39)	1.54 (1.74)	2.94 (1.76)	2.0 (1.03)	4.19 (1.25)	2.21 (2.04)	
Effect size Hedges'g	1.12	.71	.91	.23	.80	1.88	.45	.59	.97	.79	1.21	.04	

AE=Altered Experience; **PA**= Positive Affective; **NA**= Negative Affective; **A**= Attention; **I**= Imagery; **SA**= Self-awareness; **ASA**= Altered state of awareness; **AR**= Arousal; **R**= Rationality; **VC**= Voluntary control; **M**= Memory; **ID**= Internal dialogue; **RI** = Reliability Index.

Comments

When we look at the effect size in bold type, it is easy to note the large differences between the consciousness states experienced by our participants and that experienced by those of the (Cardeña, & Terhune, submitted) study. Going from the largest to the smallest values we can see that the OBE experience was denoted by higher scores of Self-Awareness (1.88), Memory (1.21), Altered Experience (1.12), and Rationality (.97), a lower score of Negative Affective (.91) and higher scores of Voluntary Control (.79), Imagery (.80) and Positive affective (.71).

Even if new participant samples are required to prove the reliability of these results, we can tentatively affirm that the state of consciousness induced in our sample differs substantially from a state of deep hypnosis. The higher levels of Self-Awareness, Memory, Rationality and Voluntary control, as well as a higher level of positive emotions and low level of negative emotions, is compatible with the phenomenology reported in cases of spontaneous or post-traumatic OBEs and with the theory of it being a cognizant and volitional mental state, even though its characteristic mechanisms are very different to the normal one.

Open question: The five participants’ responses to the open question: “*Did you experience anything unexpected during the OBE?*” are shown in Table 4.

Table 4: Answers to the question: *Did you experience anything unexpected during the OBE?*

Elen	Annalie	Anton	Federic	Daniel
Access to unknown things and a far richer perception of the world around me.	The freedom to be and go around in joy.	I found myself in a place without time or shapes, without tangible space; I felt certain that there is a “higher” place where anyone can go. I did not expect to feel such peace and a feeling of love that is so important.	I did not know what to expect from this experience, also because it was my first OBE. Nonetheless, I can definitely say I was excited and amazed by my journey, which gave me an awareness I had previously only sensed I had.	A knowledge of being able to heal the physical body. That is all, because I had already experienced it many times.

Comment

It is interesting to note that all participants report experiencing something unexpected with respect to both their previous knowledge about this state of consciousness and, in the case of Anton and Daniel, with respect to their spontaneous experiences.

EEG RESULTS

Confirmatory hypotheses

a) The transition from hypnosis to the OBE state will be marked by a reduction in activity typically found in deep hypnosis.

This is the study’s main theory. The PSD percentages of different bands during Hypnosis, Free (unrestricted) OBE, and OBE Interview states are shown in Figure 2.

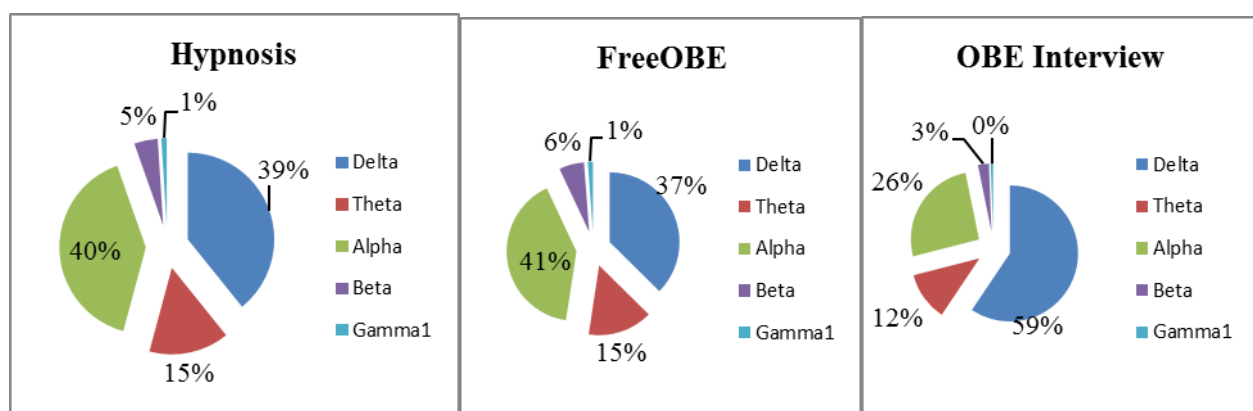


Figure 2: PSD percentages across EEG frequency bands for Hypnosis, Free OBE, and OBE Interview conditions.

When comparing the hypnosis state with the Free OBE and OBE Interview states, we note a significant similarity between Hypnosis and Free OBE, while the OBE Interview state shows an approximately 20% increase in the delta range, associated with an approximate 15% decrease in the alpha range.

The estimated of *p*-values and the effect size from the comparisons of OBE Interview vs Hypnosis and OBE Interview vs Free OBE states, with their respective HDIs and Bayes Factor values, are shown in Table 5.

Table 5: *p*-values estimated with the Wilcoxon test after 10000 resampling and effect sizes with their respective HDIs and Bayes Factor values of the PSD percentages comparisons of OBE Interview vs Hypnosis and OBE Interview vs Free OBE states.

EEG band	Hypnosis vs OBE Interview			FreeOBE vs OBE Interview		
	Wilcoxon*	ES [95%HDIs]	BF ₁₀	Wilcoxon*	ES [95%HDIs]	BF ₁₀
delta	.03	.96 [-.32, 2.2]	3.8	.06	.81 [-.30, 2.01]	2.8
alpha	.06	.81 [-30, 1.99]	2.6	.06	.92[-.35, 2.37]	3.3

*=10000 resampling

b) An imaginary OBE, with respect to the OBE phenomenological state, will be different to that achieved through hypnotic induction.

A comparison of the Imaginary OBE state with Free OBE and OBE Interview states is shown in Figure 3.

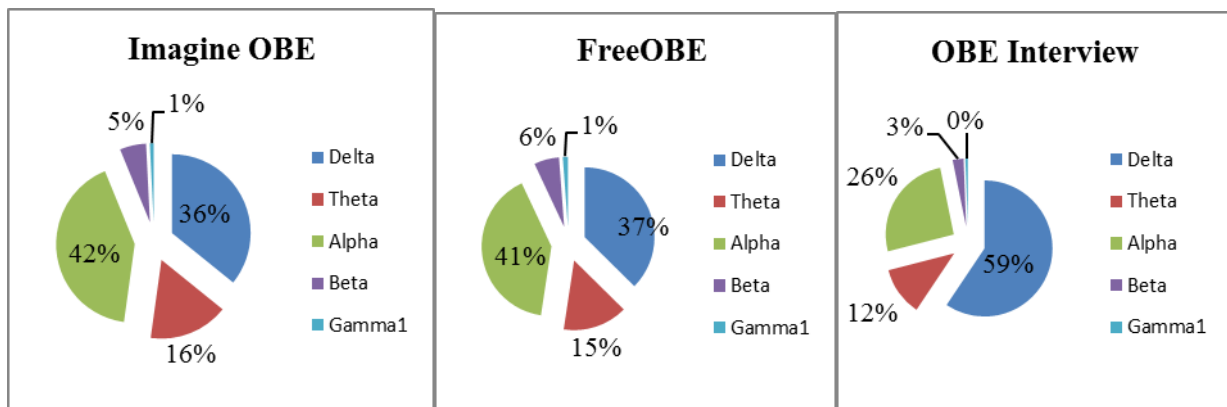


Figure 3: PSD percentages of different EEG frequency bands for Imaginary OBE, Free OBE, and OBE Interview states.

Comment

The Imaginary OBE and Free OBE states show no particular differences. However, a large difference between the Imaginary OBE and OBE Interview states is apparent in an approximately

23% increase in delta for the OBE Interview, associated with an approximately 16% decrease in the alpha band.

An estimate of the effect size from a comparison of the Imaginary OBE/Free OBE and Imaginary OBE/OBE Interview states, with their relative HDIs and Bayes Factor values, are shown in Table 6.

Table 6: *p*-value and effect sizes with their respective HDIs and Bayes Factor values of PSD percentages comparison of Imaginary OBE with Free OBE and OBE Interview states.

EEG band	Imagine OBE vs Free OBE			Imagine OBE vs OBE Interview		
	Wilcoxon*	ES [95% HDIs]	BF ₁₀	Wilcoxon*	ES [95% HDIs]	BF ₁₀
delta	.43	.17 [-1.18, .78]	.48	.06	1.26 [-.12, 2.7]	6.8
theta	.18	.44 [-.55, 1.4]	.22	.06	.91 [-.34, 2.24]	3.3
alpha	.36	.14 [-.78, 1.15]	.5	.06	1[-.22, 2.3]	3.9

*=10000 resampling

Comment

The main differences appear as an increase in delta activity during the transition from the Imaginary OBE state to the OBE Interview state, mirroring those observed in the transition between the Hypnosis and OBE Interview states.

The peculiar increase in delta activity in the OBE Interview condition is clearly depicted in the EEG topograph presented in Figure 4 which represents the delta band changes with respect to the Eyes Open condition.

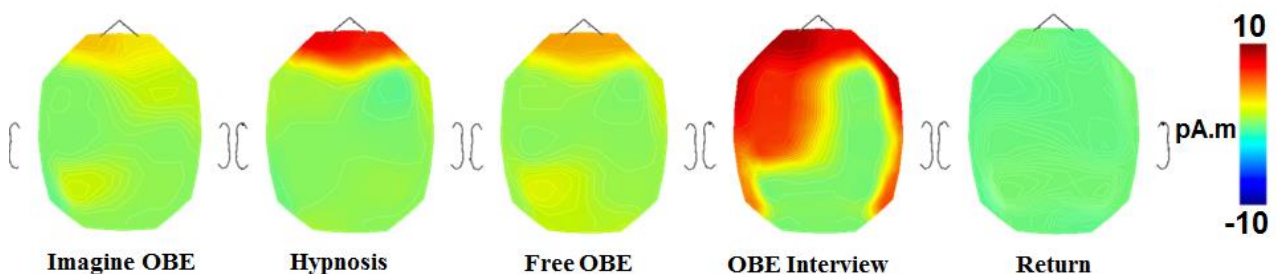


Figure 4: Changes in delta band activity in the five conditions with respect to Eyes Open (red = increase; blue=decrease).

Delta band functional connectivity

In order to further explore the characteristics of the delta band under different consciousness conditions, we estimated the difference from the eyes open state of the imaginary coherence (iCOH) by using the `bst_cohn.m` function implemented in the Brainstorm software. The imaginary coherence allows estimation of the phase-lagged coherence among the different EEG channels providing a functional connectivity index which is insensitive to the effects of volume conduction (Nolte et al., 2004).

From the 14 x 14 matrix, we estimated the percentage of variance of the first component by using the `prcomp()` function in R. The descriptive statistics with the corresponding confidence intervals estimated with the 1000 resampling by using the function `boot()` in R, are presented in Figure 5. The statistical comparisons between the OBE Interview condition with all other conditions are presented in Table 7.

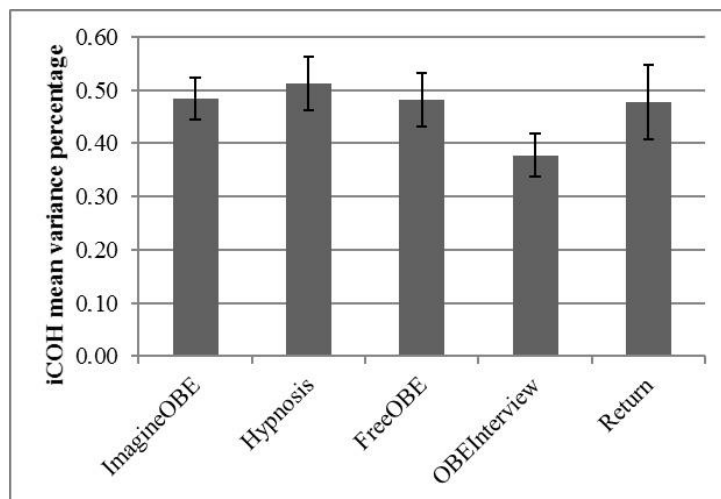


Figure 5: Means and confidence intervals of iCOH variance percentage of the different conditions.

Comment

In the OBE Interview condition there is an approximately 10% reduction of the coherence variance with respect to all other conditions, among which were no substantial differences.

Table 8: Effect sizes with corresponding HDIs and Bayes Factors of the comparisons between the mean iCOH variance of the OBE Interview with all other conditions

OBE Interview vs	<i>ES</i> (HDIs)	BF ₁₀
ImagineOBE	1.8 [.03,3.8]	17.3

Hypnosis	2.9 [.12,6.0]	40.9
FreeOBE	1.1 [-.17,2.6]	5.2
Return	.86 [-.37,2.15]	2.6

Comment

Both the ES and the Bayes Factor values show a clear difference of the OBE Interview coherence variance of delta band with respect to all other conditions from Hypnosis, Imaginary OBE, FreeOBE and Return in decreasing order.

DISCUSSION

The main objective of this study was to determine if the neurophenomenology of the hypnotically-induced OBE state differs from that of other consciousness states, particularly from the Imaginary OBE and Hypnosis.

From the phenomenological aspect, as reported by participants during and after the OBE state, there is undoubtedly a state of consciousness that differs significantly from that of Deep Hypnosis (see PCI results) and from ordinary consciousness. Although showing a high Altered Experience value, the OBE state produces higher scores of Self-Awareness, Memory, Rationality, Voluntary Control and Imagery, relative to scores from the Deep Hypnosis group.

Furthermore, answers to the question *Did you experience anything unexpected during the OBE?* indicate that all participants experienced something they had not expected with respect to their current knowledge and previous experiences. We also stress that the chosen participants had absolutely no reason whatsoever to lie or pretend to be in an OBE state.

From a neurophysiological perspective, taking into account that a low number of participants inevitably produces less precise estimates of all statistical parameters, the differences between the OBE state – and particularly between the OBE Interview state – and those of Hypnosis and Imaginary OBE are rather specific and characterized by an increase in the PSD and a decrease of connectivity of delta activity.

At the moment we can only speculate as to the reason for such a conspicuous increase in delta during the OBE Interview state with respect to the Imaginary OBE, Hypnosis, and Free OBE states, given the lack of previous data.

A possible cause for the delta activity could be a simple interference from slow eye movements (e.g. Hagemann & Naumann, 2001), but we recall that, except for the Eyes Open phase, the participants always had their eyes closed and therefore there is no reason to expect an increase in slow eye movements only during the OBE Interview phase.

This hypothesis is also challenged by the fact that all the eye-blink or eye-movement oscillatory correlates were reliably identified by the ICA and discarded without any loss of either time-domain or frequency-domain resolution.

Moreover, a comparison of the PSD from six anterior channels with that from six posterior channels (which should be more impervious to possible eye motion interference) actually shows a higher percentage of delta in the posterior channels: 86% vs 27% (see Figure 1S in Supplementary Material).

It is also interesting to note that verbal responses to the hypnotist's questions while in the OBE Interview state correspond to a rapid increase in EEG activity, especially in the gamma1 band, but only in the anterior channels, as shown in other states, for example (Friedman & Thayer, 1991 and Goncharova, McFarland, Vaughan, & Wolpaw, 2003).

The second neurophysiological marker of the condition of OBE interview is a decrease of the coherence of the delta band among the different channels compared to all the other control conditions, in particular with Imaginary OBE and Hypnosis. Given the exploratory nature of this data, any interpretation is speculative. For the moment, given that a reduced coherence of the delta activity was also observed in a group of experienced meditators by Lehmann et al. (2012), we can say that this neurofunctional feature provides further support for the theory that the OBE Interview state is a distinct state of consciousness.

What could the delta band's cognitive correlate be? Knyazev's (Knyazev, 2012) review on physiological and cognitive correlates of delta activity indicates that it may be associated with *“evolutionary old basic processes which in waking adults are overshadowed by more advanced processes associated with higher frequency oscillations”*. Is it possible that in an OBE state, the human mind has to resort to this type of process to answer the hypnotist's questions?

Until our studies are independently reproduced, we can for the time being assert that the OBE state's neurophysiological marker is a particular PSD increase and a coherence decrease in delta activity relative to all other consciousness states, especially when contact with the physical body is required.

If the results of this study represent solid proof of the possibility of inducing a controlled OBE state, it would open extremely interesting opportunities for the detailed study of cognitive characteristics of this particular state of consciousness, with all its further implications about mind-body and mind-brain relationships.

In anticipation of results from a multi-centre preregistered study expected to be completed in 2017, we very much hope that this subject attracts other colleagues and we encourage other research groups to replicate our results.

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AUTHOR CONTRIBUTIONS

This study was conceived by LP, WG, and PT. GMD and GM contributed to the EEG analyses. All authors agreed on the present version of the paper.

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SUPPLEMENTARY MATERIAL

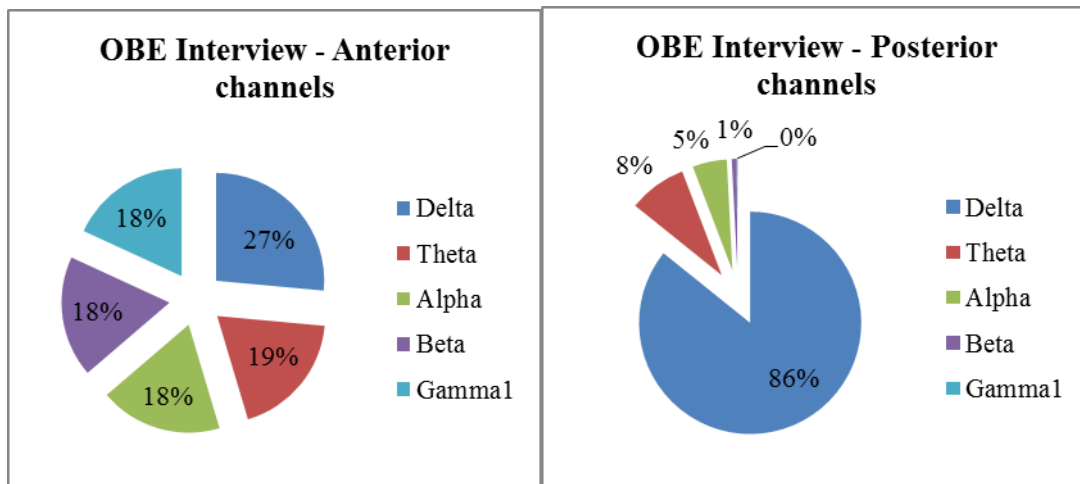


Figure 1S: Anterior (Fp1, Fp2, F7, F8, F3, F4) vs Posterior (P3, P4, T5, T6, O1, O2) PSD percentages of the different EEG bands, in the OBE Interview condition.

STANDARD HYPNOTIC INDUCTION

INTRODUCTION

To induce relaxation a traditionally common technique was used, repeatedly stressing the words *relax, muscles, tendons, and ligaments*, occasionally mentioning the specific anatomical area on which to focus. The purpose is to distract the subject's attention from normal bodily sensations, which in this situation are considered unwanted background noise, and reach a pre-hypnotic phase based on visualization. This is followed by complete physical relaxation, with the five senses still fully alert to stimuli, and then the typical descending staircase leading to a light at the bottom. An awareness of the elevator is required to avoid boredom and a fear of losing one's balance due to walking down the spiral staircase. Even inside the elevator, the senses are alternately stimulated rapidly. When the elevator reaches its destination, hypnotic conditioning is almost complete. A final stage is added in which sensory stimulation continues further, then suddenly stops when the appearance of a cloud-like armchair causes all physical sensation to cease, thus entering the true hypnotic stage. It is important for the guiding voice to remain calm and take part in what is happening.

RELAXATION PHASE

“Begin to relax your toes: start relaxing the muscles and tendons of both big toes, then the next toe, then all the muscles and tendons of the third toe, move to the fourth and then the little toe. Focus on the foot and relax all muscles and tendons of the top of the foot, then those on the sole. Now concentrate on the ankles and relax all those muscles, tendons and ligaments. Move up to the calves and totally relax the muscles, and those of the shin.

Now focus on the knees and relax everything there: muscles, ligaments, tendons... everything inside the knees. Now move your attention to the thighs and let them relax completely, then relax the groin. Move to the gluteal muscles and relax those, then the lower abdominals. Go inside and relax all the intestinal and stomach muscles – let them all go. Focus on the back and relax all muscles and tendons from buttocks to neck.

Now return to the front and relax the remaining abdominal wall muscles, the chest and all the trunk muscles, then focus again on the digestive system: try and stop motion as much as possible, then return to the back and move to the shoulder blades. Relax everything above those: muscles, tendons, everything, and on the front of your body relax everything above the collar bones, especially the neck.

Focus on the shoulder joints and relax them completely: muscles, tendons, ligaments... then move down to the arms and relax likewise there. Totally relax the muscles, tendons and ligaments which join at the elbow. Move down the forearms and focus on relaxing everything there. Now relax the wrists too and their ligaments. Go to the top of your hands and relax all tendons, then the muscles and tendons of the palms.

Now focus on relaxing all the tendons in the thumbs and return to the neck. In the neck, relax all the muscles and tendons in the throat, then those at the back. Move to the muscles in your scalp... relax those also. Relax your forehead, ears, the cheek muscles, the nose, the mouth muscles, and those in the chin.

Now your body is completely relaxed; your heartbeat is slow, each breath is deep, slow, and relaxed, and the blood circulates freely. You are feeling totally at ease and your body has ceased transmitting signals”.

(without interruption) PRE-HYPNOTIC PHASE

“Now you are walking barefoot in a meadow surrounded by flowers, you can smell the grass and under your feet you feel the stems with each step, along with the soft earth, which is warm and a little damp. You see many beautiful flowers in many shades of colors: red, blue, orange, purple, yellow, indigo, white. You feel a gentle breeze which carries the scents of all those flowers. With those scents, your mouth can taste their nectar, like diluted honey, a different taste for each flower.

You hear birds chirping and insects buzzing, you see wispy clouds in a clear sky, you feel the sun's warmth on your skin... you are totally at ease.

You walk towards a cave-like opening in which you see a balustrade. You approach it and see a very long descending spiral staircase, going deep down into yourself, at the end of which there's a small very bright white light you want to reach.

Beside the balustrade, you see an elevator. You walk towards it and press the call button. The doors open and you go inside, pressing the down button. The elevator moves quickly with a light hiss. There is a mirror in front of you, and you see a reflection of yourself as more relaxed and light due to the acceleration. You are bathed in a gentle blue light, and in the background you hear a relaxing music playing at low volume. Under your feet, you feel the pleasant roughness of carpet and you lean on the wall, which is a smooth and polished wood.

You catch the smell of freshly baked pastries. Looking around, you see a small triangular table in a corner on which are some pastries. You step towards it, look at them and choose one which appeals to you. As you bring it to your mouth you smell its aroma and then feel its warmth from the oven. You put it in your mouth and savor its delicious taste.

You're very much enjoying this pastry, knowing that when you finish eating, the elevator will have reached its destination inside you. You eat it slowly and as you are almost finished, you feel the elevator decelerating, slowly at first, and then more forcefully. The floor counter appears again and begins the countdown: -10., -9., -8..., -7....., -6....., -5....., -4....., -3....., -2....., -1....., 0. The elevator stops and the doors open, you exit and find yourself in a room made of rough stone, with a pleasant temperature and humidity, suffused in a green light which casts no shadows; a nice background music is playing and there is an heady fragrance of flowers in the air.

There is a black leather armchair in the middle of this room. You go and sit on it, and as you sink into the chair you feel like you're sitting on a cloud. You suddenly feel weightless. It is amazing – you really feel great. You can sense only the leather's slight roughness under your arms and its smell. After a short while those fade away too..."

HYPNOTIC PHASE

.....

POST-HYPNOTIC PHASE

"Now rise from the black armchair, go to the elevator and press the call button. The doors open, you enter and press the up button. The doors close and it starts to move with a light hiss. You are perfectly at ease and enjoy the smell of the pastries, the background music and the diffuse blue light as you look at your reflection in the mirror.

The elevator travels very quickly and then begins to rapidly slow down. The floor counter is again visible and begins the countdown: 10., 9., 8..., 7...., 6....., 5....., 4....., 3....., 2.....,1....., 0. The elevator stops, the doors open, you exit and are back here again”.

USEFUL INFORMATION FOR A HYPNOTICALLY INDUCED OBE

In an OBE induced hypnotically, the subject is not referred to as a patient, because there is no therapeutic intention or goal; rather, the subject has freely and knowingly volunteered to undergo this experience purely for interest and for its potential usefulness. It is therefore more appropriate to refer to the hypnotist as ‘Guide’ and the hypnotized as ‘Traveller’, given that an OBE is a journey outside the body.

Before beginning the OBE procedure, it is best that the Guide and the potential Traveller have a detailed discussion to clarify whether there is a genuine desire for knowledge, or simply curiosity. In the latter case, it is hardly worth continuing with the OBE because it is extremely unlikely anything useful for research purposes will result. A prolonged exchange of ideas will allow a potential Traveller to remove doubts and establish a relationship of mutual trust, therefore facilitating good results. The object is not treatment of any kind, but obtaining as much information as possible for both parties, hence the Traveller must be strongly motivated, and not only fearless of hypnosis but have a strong desire for it. All of the above make the hypnotic induction phase easier.

It is important for the Traveller to understand that his/her role is equally as important as the Guide’s, although totally different, since the Traveller must be able to answer questions without concern for their purpose and giving the best possible descriptions of what has been seen and felt. The role of the Guide is getting the Traveller to answer appropriate questions, keeping the Traveller’s attention focused and helping to overcome any possible difficulties.

During the entire session the Guide must remain fully focused on the Traveller, so as to be aware of any subtle sensations and to impart the feeling of a shared experience without implying direct involvement (the Guide must always remain alert and detached). This is simply non-judgment of what the Traveller says and accepting whatever is described.

All of this can cause the Guide go into an altered state of consciousness such that it becomes difficult to even perform simple arithmetic.

At the conclusion of the OBE session the Traveller, while returning to normal consciousness, should have some time to comment about the more salient points of the OBE itself. In the meantime

an audio recording of the session can be prepared, the repeated listening of which can aid the Traveller in remembering more details or removing uncertainties.

TRAINING FOR THE FIRST INDUCED OBE SESSION

DETACHMENT FROM THE PHYSICAL BODY

To avoid possible traumas with related trembling, jolts, and perceived loud noises, a gradual 'exit' from the body is induced at the end of the induction stage using the following guidelines:

"You are now gently moving out of your body, slowly and without haste, until you find yourself completely outside of it. You do not feel any discomfort, but you actually feel better once outside." Wait for few seconds in silence, then: "Now that you are 'outside' your physical body, you only need to express the intention to move or travel and you will do so immediately. Try to turn around and then go up towards the ceiling and look down at your body below."

MOVING THROUGH WALLS

The next step must be executed immediately, without waiting for replies and before the physical body begins to pull the 'outside entity' back into itself, and consists of making the non-physical entity move through walls and/or ceilings. Depending on the experiment location, you choose the most suitable wall surface and then give the following instructions: "Now move towards that wall/ceiling, lean on it and note that you can go through it as if it were a projected image rather than a real object. Express the intention of moving through it and you will find yourself immediately on the other side."

CONTROL OF SPEECH

At this point it is important to establish two-way communication with what we have defined the 'outside entity'. We have found the following instructions to be optimal: "Now that you are outside the room, find a peaceful place, stop and be fully aware of being outside your body; concentrate on your physical body for the time needed to allow it to talk. When you have done this, say 'yes'."

FLIGHT AND TRAVEL TECHNIQUES

Upon receiving the confirmatory 'yes', two-way communication has now been acquired. It is advisable, however, not to linger there, because focusing on the physical body results in a loss of control of the 'outside entity' and in this early stage of training it is best to avoid distractions. We choose a location known to both parties and we commence (first travel procedure): "Now go to

(place name). Move around purely through intention. Go slowly at first, then gradually move faster, following the road you are familiar with. While travelling, practice full control of motion. When you arrive at the destination, say ‘yes’.”

For the return trip another technique is used (second travel procedure): “Now return to your point of departure in a straight line and as fast as possible, ignoring roads. When you get there, say ‘yes’.”

The third technique is done at infinite speed (instantaneously). The instruction is: “Think of the train station and try to get there immediately. When you are there, say ‘yes’. Did you get there instantly or not?”

THE TRAIN’S DEPARTURE

If the answer is ‘yes’, the train station has been reached, and therefore:

“Find a train about to leave, go in front of it, then enter it, either standing on the tracks or floating above them. Wait until the train departs the station and get it to move along you. Look inside it as it moves past and note that you feel nothing.”

TIME AND DATE

Since the ‘outside entity’ is at a train station, we can ask it to read the time and date; the answer is usually inconsistent with the actual time, which can be either in the past or in the future (normally by no more than a few months). When asked if it is night or day, the answer usually matches the perceived time, but when asked if the sun is shining and if shadows are seen, the answer is usually this: “There is a diffuse light, which casts no shadows.” Even people, which usually crowd a train station, are very often not seen at all, or just perceived as ‘lots of shadows’. After this experience, we check that the ‘outside entity’ has no problems placing itself in the middle of a road while cars are passing by, without fear of injury.

At this point basic training has finished; questions can be asked and answers received, delayed at first and eventually with greater speed. It must be remembered however that in order to speak, the ‘outside entity’ must always focus on the physical body, thus reducing its level of attention even when speaking get easier. If more complex answers are required, it is suggested to give the ‘outside entity’ time to concentrate on the answer, as in the following instruction: “Look at (or listen to) such and such, take your time to concentrate on it to the exclusion of anything else, then answer only when you are sure of your answer.”

NB: the best results are obtained when the Traveller has had time (at least half an hour) to relax sight and hearing before undergoing the OBE. The more pleasant the journey is, the better.