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THE NEUROPHENOMENOLOGY OF OUT-OF-BODY EXPERIENCES INDUCED BY HYPNOTIC SUGGESTIONS

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Abstract: Inducing out-of-body experiences in hypnosis (H-OBEs) offers an almost unique opportunity to investigate them under controlled conditions. OBEs were induced as an imaginative task in a resting condition (I-OBE) or in hypnosis (H-OBE) in a group of 15 high hypnotizable subjects. A 32-channel EEG was recorded, and the spectral power and imaginary coherence of each frequency band and each couple of electrodes were calculated. At the end of each session, the Phenomenology of Consciousness Inventory (PCI) was administered to assess the phenomenological aspects of the subjects' experience. Significantly higher scores in the altered state, positive affect altered experience, and attention subdimensions of the PCI were reported in H-OBE than in I-OBE, which were associated with a significant decrease of power in beta and gamma band activity in right parieto-temporal derivations. These results suggest that the H-OBE may offer a useful experimental model of spontaneous OBEs.

Near-death experiences (NDEs) and out-of-body experiences (OBEs) are intriguing phenomena, which have fascinated humanity

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across recorded time, from the myth of Er in Plato's *Republic*—the soldier who, thought dead, traveled through Hades and witnessed the process of reincarnation—to Jack London's novel *The Star Rover* (London, 1915). London, who defined himself as a fervent material monist, narrated the memories of previous lives and the OBEs of Darrell Standing, a prisoner sentenced to death, bound in a straitjacket in an isolation cell at San Quentin State Prison. In this long-lasting condition, which London defined as a sort of living death, Standing could exit from his physical body and travel with his mind, also visiting Jake Oppenheimer (a prisoner executed in 1913) in another cell at San Quentin. What is intriguing is that London drew his fiction from the testimony of real San Quentin prisoners, Jake Oppenheimer and Ed Morrell, the latter reporting the OBEs. It is also noteworthy that in the book the main character's experiences lead him to keep his mental health and resilience, enduring jail, torture, and facing execution in full bliss and self-control. This is in line with the transformative power of NDEs (e.g., overcoming the fear of death) disclosed by scientific studies published some 80 years later (Greyson, 2003, 2014; Van Lommel, 2011).

NDEs and OBEs—as well as all subjective phenomena, including consciousness itself—were disregarded or misunderstood due to their ostensible incompatibility with the ruling reductive physicalist stance until the latter 20th century (Facco, Agrillo, & Greyson, 2015; Facco & Fracas, 2018; Facco, Lucangeli, & Tressoldi, 2017). Therefore, they were mainly considered as plain, meaningless byproducts of organic or functional brain disorders leading to a multisensory disintegration and, clinically, only a matter of diagnosis and/or pharmacological manipulation (Blanke, Landis, Spinelli, & Seeck, 2004). On the other hand, studies reporting seizures as a cause of OBEs (Britton & Bootzin, 2004; Bünning & Blanke, 2005) were later disproved by the absence of a clear relationship between the two (Greyson, 2014). In fact, the relationship between NDEs, OBEs, and seizures is a conjecture without evidence for the following reasons: (a) They are not part of the symptomatology of epilepsy (Rodin, 1989); and (b) in a study by Greyson (2014), 7% of patients with seizures reported OBEs, but they occurred only once or twice in their lives and could not be associated to epilepsy, EEG, or medications. OBEs have also been recognized as phenomenologically and neurophysiologically different from autoscopies and heautoscopies (see Brugger, Regard, & Landis, 1997; Lopez, Halje, & Blanke, 2008). Thus, OBEs are neither related to seizures nor psychiatric disorders and cannot be considered as their byproducts—that is, out of body does not necessarily mean "out of one's mind" (Agrillo, 2011; Greyson, 2000).

OBEs may also occur in up to 26% of the nonclinical population, challenging reductionist interpretations of OBEs in terms of brain damage, although they may still be neuropsychologically interpreted as the result of right parieto-temporal dysfunction leading to a disruption of multisensory integration (Braithwaite, Samson, Apperly, Broglia, & Hulleman, 2011). In short, the nature of OBEs remains unclear, suggesting the need for further study of their neurophenomenology and their possible cognitive and metacognitive implications.

Both NDEs and OBEs belong to the field of nonordinary mental expressions (NOMEs), a topic including other intentionally achieved or spontaneously occurring uncommon experiences—like hypnosis, meditation, and mystical experiences (Cardeña & Facco, 2015; Facco et al., 2015)—and different phenomena sharing some interesting links and common aspects (Facco, 2017, 2018; Greyson, 2014). The term *nonordinary* emphasizes their nonpathological nature and their peculiarity with respect to usual ordinary conscious activities, a fact, in turn emphasizing the sociocultural, epistemological, and, perhaps, inadvertently prejudicial implications of their previous definition as *altered states of consciousness*.

Unlike artificially induced full-body illusions (Altschuler & Ramachandran, 2007; Blanke & Metzinger, 2009; Bourdin et al., 2017; Ehrsson, 2007), spontaneous OBEs are difficult to investigate given their unpredictability. In fact, they may occur within NDEs—that is, following severe injuries, such as cardiac arrest or head trauma (Charland-Verville et al., 2014; Parnia et al., 2014; van Lommel, 2011)—or nontraumatic events—for example, deep meditation and strong emotions (Cardeña & Alvarado, 2014). Two previous pilot studies (Pederzoli et al., 2016; Tressoldi et al., 2015, 2014) have shown the possibility of inducing OBEs by specific hypnotic suggestions, thereby making it possible to prospectively explore their phenomenological features and electroencephalographic (EEG) correlates under controlled conditions.

A recent phenomenological comparison among OBEs experienced within NDEs, spontaneous nontraumatic OBEs, and those induced by hypnosis (H-OBE; De Foe, Al Khafaji, Pederzoli, Prati, & Tressoldi, 2017) showed several similarities; they included an increased awareness associated with positive emotions (e.g., "It was as if suddenly I knew everything that was being communicated. It was incredible, beyond words."), a loss of a sense of time, (e.g., "The concept of time wasn't at all present."), and a sensation of having no physical confinements, unlike being in a physical body (e.g., "I feel totally free; I do not perceive boundaries or shapes."). These reported similarities between NDEs, spontaneous OBEs, and H-OBE show some common aspects with mystic experiences (Chen, Qi, Hood, & Watson, 2011) as well as the experiences reported by high but not low hypnotizable subjects during neutral hypnosis (Cardeña, Jönsson, Terhune, & Marcusson-Clavertz, 2013). As a whole, they suggest a link between all of these different NOMEs, reflecting the still ill-known meaning of the inner, nonpathological, and mysterious activities of the human mind, including their metacognitive value and transformational power.

Thus, the OBE phenomenology is rich from the subjective first-person perspective (1PP) and suggestive of a real experience of detachment of the self from its physical body, associated with the perceived ability to expand one's cognitive capacities beyond the space and time constraints imposed by brain and body. On the other hand, a few, uncommon cases of patients witnessing what happened in the emergency room while they were out of body during cardiac arrest appear unbelievable and challenge our knowledge of both consciousness and the pathophysiology of brain anoxia (Parnia et al., 2014; Sabom, 1998; van Lommel, 2001). Nevertheless, they are observed facts and, as such, call for a scientific interpretation, while integrating the 1PP and 3PP may help investigating their phenomenology beyond the limits of the reductionist approach, only aiming to disclose brain mechanisms of these complex and intriguing experiences.

The aim of this study was the comparison between the neurophenomenology of the H-OBEs and those imagined when in a state of ordinary consciousness (I-OBE) in subjects without any previous experience of spontaneous OBEs. As a main working hypothesis, we proposed that an overlapping of the functional underpinnings of these two phenomenological states would support the view that these experiences are a byproduct of participants' mental imagery. On the other hand, the presence of clear neurophenomenological differences between H-OBEs and I-OBEs would provide new information on their nature, as well as on the physiology of consciousness, selfhood, and the capacity of dissociation between 1PP and the physical body. In other words, H-OBEs might turn out to be phenomenologically different from I-OBE as well as OBE illusions elicited by physical stimulation and show common elements with spontaneous OBEs occurring both in nonclinical conditions and in NDEs. If this is the case, H-OBE—which may be experimentally induced and, thus, reproducible—might be a good model of spontaneous OBEs.

The minimal phenomenal selfhood (MPS) perspective has been defined by Blanke and Metzinger (2009, p. 7) as "a phenomenal property, namely the conscious experience of being a self. It is the experience of being a distinct, holistic entity capable of global self-control and attention, possessing a body and a location in space and time." Instead, in OBEs one can express an MPS without a physical body, as well as the possibility of moving around in space and time without constraints, often with a perceived enhancement of consciousness, global self-control, and attention, the nature and mechanisms of which are still unclear.

Several efforts have been dedicated to identifying the neural correlates of hypnosis by neuroimaging techniques, EEG, and event-related potentials (ERP), and an increasing number of studies have been published in the past two decades. There is now evidence that hypnosis yields intentional and complex changes in brain areas and circuits; for example, relaxation and absorption lead to the activation of the anterior cingulate cortex (ACC) somatosensory and motor cortex as well as a decreased perfusion of temporal lobes (Rainville, Hofbauer, Bushnell, Duncan, & Price, 2002; Rainville et al., 1999; Rainville & Price, 2003). Relaxation is also paralleled by increased perfusion of occipital cortex and decreased perfusion in the brainstem, cerebellum, thalamus, basal ganglia, and prefrontal cortex, whereas absorption is paralleled by increased perfusion of brainstem, prefrontal cortex, and decreased occipital perfusion. Furthermore, hypnosis has been reported to affect the activity of the default modality network (Deeley et al., 2012; McGeown, Mazzoni, Venneri, & Kirsch, 2009), likewise meditation (Brewer et al., 2011; Jang et al., 2011; Pagnoni, Cekic, & Guo, 2008; Taylor et al., 2013). It is worth emphasizing that the anterior cingulate cortex is a crucial area in pain perception, monitoring of conflict between incongruent stimuli, arousal, attention, cognition, emotion, motivation, and movement control (Casiglia et al., 2010; Egner, Jamieson, & Gruzelier, 2005; Faymonville, Boly, & Laureys, 2006; Frith, 2002; Mak, Hu, Zhang, Xiao, & Lee, 2009; Muller, Bacht, Prochnow, Schramm, & Seitz, 2012; Raz, Fan, & Posner, 2005; Vincent, Kahn, Snyder, Raichle, & Buckner, 2008).

Hypnotic suggestions to induce an experience of pain, unlike imagined pain in resting conditions, strongly affect both the activation and connectivity of brain areas belonging to the pain neuromatrix. Instead, hypnotic suggestions of analgesia allow for a significant increase in pain threshold, up to the level of surgical anesthesia (Derbyshire, Whalley, Stenger, & Oakley, 2004; Facco, 2016; Facco et al., 2011; Facco, Pasquali, Zanette, & Casiglia, 2013; Faymonville et al., 2000, 2003; Hofbauer, Rainville, Duncan, & Bushnell, 2001; Rainville, Carrier, Hofbauer, Bushnell, & Duncan, 1999; Rainville et al., 2002; Rainville & Price, 2003; Roder, Michal, Overbeck, van de Ven, & Linden, 2007; Vanhaudenhuyse, Laureys, & Faymonville, 2014).

Despite clear evidence that hypnosis may yield specific brain changes, these results are dyshomogeneous, because hypnosis is far from being a single monomorphic activity. The wide range of patterns of activation and deactivation depend on both hypnotic tasks and a subject's hypnotic ability, making the interpretation of results a difficult job. This is especially true when the EEG is used, given its high variability and the problems related to the solution of the so-called inverse problem. Despite these limitations, the EEG remains a valuable tool, given its high temporal resolution and, thus, the capacity to track ongoing brain activity changes from induction through the posthypnotic phase, as well as their distribution on the scalp.

Methods

Participants

Fifteen healthy adult volunteers, 10 females and 5 males (age range: 21–59; mean: 28; *SD* = 10.02), were included in the study. They were recruited from the pool of high hypnotizable subjects known by the authors. Their number was predefined by a statistical power analysis related to a paired *t*-test with an estimated effect size of 1, alpha = .05, and statistical power = .95, computed by using the software G-Power (Faul, Erdfelder, Lang, & Buchner, 2007). The estimated effect size was derived from the pilot study of Pederzoli et al. (2016). The preregistration of the study is available at https://osf.io/9x65m/register/565fb3678c5e4a66b5582f67

The inclusion criteria were the following: (a) absence of any medical and psychiatric conditions and use of any psychotropic drug; (b) high hypnotizability, defined by an induction score of 7.5 or more, according to the 0–10-point scale of the Hypnotic Induction Profile (HIP; Spiegel, 1977; Spiegel & Spiegel, 2004); (c) a strong motivation toward this study; and (d) no signs of worry or fear at the prospect of undergoing an OBE.

The participants were reimbursed €10 for their participation in each of the two sessions. The study was approved by the Ethics Committee of the School of Psychology of the University of Padua (id. protocol 2058) and was conducted according to the principles of the Declaration of Helsinki for Human Research. Each participant was previously and individually informed in an appropriate place about the purpose and methods of the procedure and each was free to ask questions for a full comprehension of the procedure. All participants gave their informed consent.

Procedure

In the first session, participants were first informally interviewed by the last author (P.T.) regarding their knowledge of OBEs and the sources of their information, and were asked to sign the informed consent. Then, their hypnotizability was assessed by the first author (E.F.). High hypnotizable subjects were randomly assigned to the first experimental session (I-OBE or H-OBE session, as described below); the second session was performed at least a week later.

At the end of the first session, participants were asked to fill in the Italian version of the Dissociative Experience Scale (DES; Carlson & Putnam, 1993) and the Cardiff Anomalous Perceptions Scale (CAPS; Bell, Halligan, & Ellis, 2006) for assessment of exclusionary clinical conditions. At the end of each of the two experimental sessions, they were also requested to fill in the Phenomenology of Consciousness Inventory (PCI) to check their phenomenological experience of the just-completed H-OBE or I-OBE session. The PCI—including 53 questions requiring answers based on a 7-point Likert scale—has shown a good psychometric reliability and validity and has been widely used to check cognitive and emotional aspects of different nonordinary states of consciousness (Pekala, 2013, chaps. 5 and 6; Pekala et al., 2010). The questionnaire was individually filled out after an explanation of its items.

I-OBE. Following the montage of a 32-channel cap (see details in the EEG recording and analysis section), a 2-minute EEG baseline with closed eyes was recorded, at the end of which each participant was reminded that a good level of imagination was an important requisite for this task. This information was delivered to prevent the so-called "hold-back" effect, leading to participants deeming the H-OBE condition as the privileged one and hence restraining from fully applying their cognitive capacities in the I-OBE condition. Then, the participants were asked to imagine having an OBE with the following instructions:

> Close your eyes and relax. … Now you can start to exit from your body from the top of your head … and now you can reach the ceiling of this room and see your body from there…. Now you can move around, wherever you like and without constraints … and enjoy the experience of the lack of gravity … and the capacity of moving and rolling like an astronaut in orbit. … You may even pass through walls without any resistance and look at what you want. Pay attention to your emotions and sensations, because you will be interviewed about them.

After 4 minutes, when still in the I-OBE condition, they were interviewed about their experience using an adaptation of the Greyson Near-Death Experience Scale (Greyson, 1983), available in the Appendix. Then, at the end of the session, they were asked to fill out the PCI.

H-OBE. Hypnosis was induced starting with the eye-roll (the same procedure used for HIP administration), followed by verbal suggestions with cues of relaxation and well-being. Through the voice of an expert hypnotist (E.F. or E.C.), each participant was guided toward focusing his or her attention on a single idea, excluding any other external or internal stimuli. The participants were invited to concentrate on their own bodies from head to foot, while a feeling of muscular relaxation was being suggested. Verification of hypnosis was based on some signals, such as the easing of facial tension, eyelid flickering, dropped lower jaw with a slight opening of the mouth, and slowing down of breathing rate.

Then hypnotic suggestions of OBE were delivered with the same instructions used for I-OBE. After 4 minutes, when still in the H-OBE, participants were interviewed about their experience using the same adapted version of the Greyson Near-Death Experience Scale used in I-OBE. Following deinduction of hypnosis, they were asked to fill out the PCI.

EEG Recording and Analysis

The EEG activity was continuously recorded from baseline (2-minute closed-eyes, resting condition) through both the I-OBE and H-OBE with a Micromed SD MRI 64 system (Micromed/Treviso, Italy), amplified and digitized with sampling frequency of 512 Hz. A 32-channel Electro-Cap International montage was employed, in accordance with 10–20 international system referenced to the bilateral linked mastoids, using Ag/AgCl electrodes. All electrode impedances were kept below 10 KΩ. Horizontal eye movements were recorded by two electrodes placed at the outer canthus of each eye. All EEG recordings were processed offline using the MATLAB toolbox EEGLAB (Delorme & Makeig, 2004) and the Brainstorm software (Tadel, Baillet, Mosher, Pantazis, & Leahy, 2011).

The data were first band-pass filtered between .1 and 45 Hz and then visually inspected to interpolate bad channels. Bad-channels-free data were then processed with the independent component analysis (ICA; Stone & Stone, 2002). The main purpose of ICA in this case was not to correct eye blinks or saccades, given that participants performed the experimental procedure with closed eyes, but to identify and correct artifacts like muscle contractions, usually easily identifiable by ICA in the electrodes placed around the temples.

Welch's power spectrum density (PSD) and imaginary coherence were estimated by using the routines implemented in the Brainstorm software (Tadel et al., 2011). Welch's PSD, computed for each electrode, was obtained splitting the signals in overlapping windows calculating the Fourier transform (FFT) of each of these epochs and averaging the power of the FFT coefficients for all the overlapping windows. Coherence (Coh) was calculated at the level of the sensor space. Sensor-level coherence may be biased by the volume conduction, leading to the activity of a single generator being recorded by different derivations and electrodes close to each other presenting a high level of coherence. This reflects a volume conduction artifact of a same brain source recorded by different channels instead of a reflection of an underlying interacting brain (Nunez et al., 1997). A possible solution is to reconstruct the brain source, solving the forward and the inverse problem, and then calculate the coherence at the source level instead at the sensor level, as suggested by Baillet et al. (2001). Although this solution from a methodological point of view is the most accurate, our experimental apparatus does not present all the requirements for a reliable source reconstruction. In fact, as shown by Lantz, De Peralta, Spinelli, Seeck, and Michel (2003), the algorithm brain source identification capacity—for example, in the case of epileptic foci of epileptic spikes—increases with the number of sensors, supporting the insufficiency of 30 electrodes EEG-cup for an accurate localization. Furthermore, to generate a more precise source reconstruction, the structural MRI of each participant is necessary to create an individualized forward model and then solve the inverse model for each participant (Michel & Murray, 2012). Considering the limitations of the present experimental apparatus—that is, 32-channel EEG-cup and no MRI—a source reconstruction and connectivity might lead to inaccurate results, skewing the interpretation of results.

A more affordable way to ford the volume conduction problems, at the sensor-space level, has been proposed by Nolte et al. (2004) and defined as *imaginary coherence* (iCoh). The assumption behind iCoh is that it is basically the concept of quasistatic approximation of EEG: It means that the observed scalp potential has no time lag to the underlying source activity (Stinstra & Peters, 1998) and "if volume conduction does not cause a time-lag, the imaginary part of coherency is hence insensitive to artifactual 'self-interaction'" (Nolte et al., 2004, p. 2293). Therefore, taking into account they used 32-EEG channel cup, coherence was computed at the sensor-space level, using the iCOH.

Definition of Coherence. Coherency between two EEG channels is a cross-correlation of the two at a specific frequency. Let *x(f)* and *y(f)* be the (complex) Fourier transforms of the time series *x(t)* and *y(t)* and of channel *x* and *y*, respectively. Then the cross-spectrum is defined as:

$$G_{xy}(f) \equiv \langle x(f) y * (f) \rangle$$

where * means the complex conjugate, $\langle \ \rangle \langle \phi |$ means the expectation value.

Coherency is basically a measure of how the phases of the signals at the channel x and y are correlated, and it is defined as the normalized cross-spectrum:

$$C_{xy} \equiv G_{xy}(f) / \left(G_{xx}(f) G_{yy}(f) \right)^{1/2}$$

Coherence is defined as the absolute value of coherency:

$$Coh_{xy}(f) \equiv \left|C_{xy}(f)\right|$$

Imagniary coherence is then calculated as:

$$iCoh_{xy} = imag\left(Coh_{xy}\right)^2 / \left(1 - real(Coh)^2\right)$$

iCoh was calculated for each pair of electrodes for each participant, with a maximum frequency resolution of 2Hz along the continuous frequency spectrum, and then grouped in five frequency bands that represent the mean of the indicated frequency interval: delta (2–4hz), theta (5–7), alpha (8–12), beta (15–29), and gamma (30–45; see http://it.mathworks.com/help/signal/ref/pwelch.html?requestedDomain=www.mathworks.com).

The algorithm of iCoh, which was calculated at the level of the channel space, allowed us to partial out the effect of volume conduction on electrode activity. In fact, when activity of a single generator is recorded in different derivations, it may result in their strong correlation, due to volume conduction artifact rather than an underlying interaction in the brain (Nunez et al., 1997). This artifact, which has no time lag to the underlying source activity (Stinstra & Peters, 1998), can be filtered out by iCoh—that is, reconstructing the brain source, calculating the coherence at the source level, and solving both the forward and inverse problems (Baillet et al., 2001). Then, the difference between OBEs and baseline of PSD and imaginary coherence (iCoh; Nolte et al., 2004) were calculated for each participant.

Statistical Analysis

All inferential analyses were preregistered as monodirectional because higher scores were expected in the altered experience, positive affective, self-awareness, rationality, and memory subdimensions of the PCI. The free responses to the adapted Greyson Near-Death Experence Scale were analyzed by a content analysis (Vaismoradi, Turunen, & Bondas, 2013).

Results

The scores of both DES and CAPS were below the clinical cut-off in all cases. The DES scores ranged from 4.64 to 27.5 (according to the authors of the tests, a score above 30 can be used as the basis for a clinical interview). In the CAPS, the number of "Yes" responses ranged from 3 to 17 (nonclinical scores range from 0 to 26).

Two subjects did not return the PCI, one belonging to the I-OBE and the other one to the H-OBE session, and the EEG of one participant was excluded from the analyses due to the presence of too many artifacts. Therefore, the PCI data are based on 13 participants (the raw data are available at https://figshare.com/account/articles/5350135) and those of EEG on 14 participants.

A marked difference between I-OBE and the H-OBE conditions was observed in the following four subdimensions of PCI (see Figure 1).

1. Altered state (AS; e.g., "I felt in an extremely different and unusual state of consciousness"; "I felt in an extraordinarily unusual and nonordinary state of awareness");
2. Positive affect (PA; e.g., "I felt feelings of ecstasy and extreme happiness"; "I felt intense feelings of loving-kindness");
3. Altered experience (AE; e.g., "I felt my body greatly expanded beyond the boundaries of my skin"; "Time stood still; there was no movement of time at all"; "Objects in the world around me changed in size, shape, or perspective"; "I had an experience I would label as very religious, spiritual, or transcendental");
4. Attention (Att; e.g., "My attention was completely inner-directed"; "I was able to concentrate quite well and was not distracted").

Quantitatively, the standardized effect size with the corresponding 95% high density intervals of these differences were the following: altered state: .7 (.07 to 1.37); positive affect: .69 (.05 to 1.35); altered experience: .58 (−.04 to 1.21); attention: .81 (.11 to 1.5).

The main differences in the responses to the adapted Greyson's Near-Death Experience Scale regarded the following four questions:

1. Do you feel time flowing more slowly or quickly than normal? (For example, "I had the feeling of lack of time." "On earth time is longer, while for me only a few seconds pass.")
2. Do you sense harmony or unity with the universe? (For example, "I'm flying, I feel in harmony with the universe.")
3. Do you feel separated from your body? (For example,, "I have a third eye…. The part that is separate is a soul. I feel separated from my body.")
4. In this state of consciousness, do you perceive yourself with borders as in your physical body? (For example, "There is no body, there is no boundary." "I was like water, I did not feel bounded.")

The scores of these four responses were higher in H-OBE than in I-OBE, with the feeling of being separated from the body being statistically significant (see Table 1).

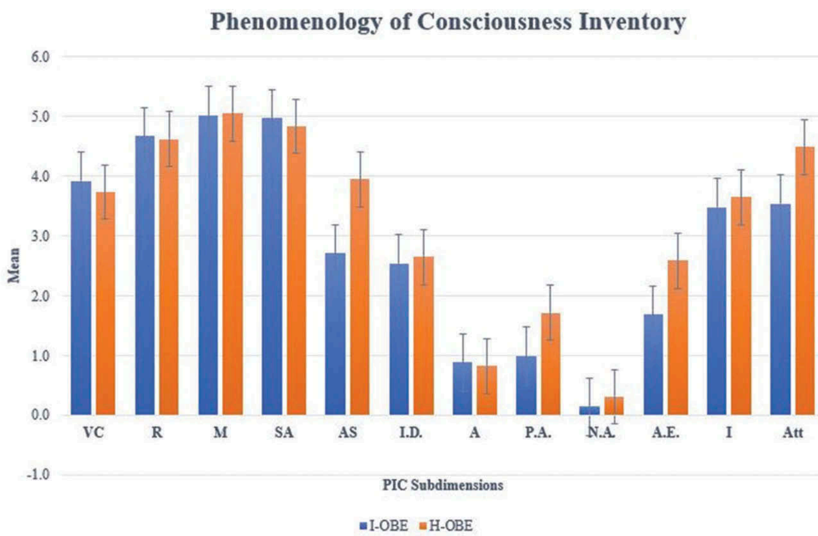

Figure 1. **Mean values with corresponding standard deviations of the 12 subdimensions of the PIC in the I-OBE and H-OBE conditions (VC = voluntary control, R = rationality, M = memory, SA = self-awareness, AE = altered experience, AS = altered state of awareness, ID = internal dialogue, A = arousal, PA = positive affective, NA = negative affective, I = mmagery, Att = attention).**

Table 1
Percentages of Positive Responses in the I-OBE and H-OBE Conditions

	I-OBE	H-OBE	*p*
Time speed change	.40	.53	.48
Unity with the universe	.40	.60	.28
Feel body separate	.20	.60	.02
Body without borders	.46	.66	.16

A significant decreased power in the beta and gamma bands was found in the right hemisphere from baseline to H-OBE condition (see Figure 2).

The H-OBE EEG changes were located mainly in the right parieto-temporal areas and spread to the frontal areas in the gamma band. A significant power decrease of the same frequency bands was found in the I-OBE condition as well but was mainly confined to the left temporal derivations. No significant power spectra differences were found when the H-OBE was contrasted with I-OBE, and no significant

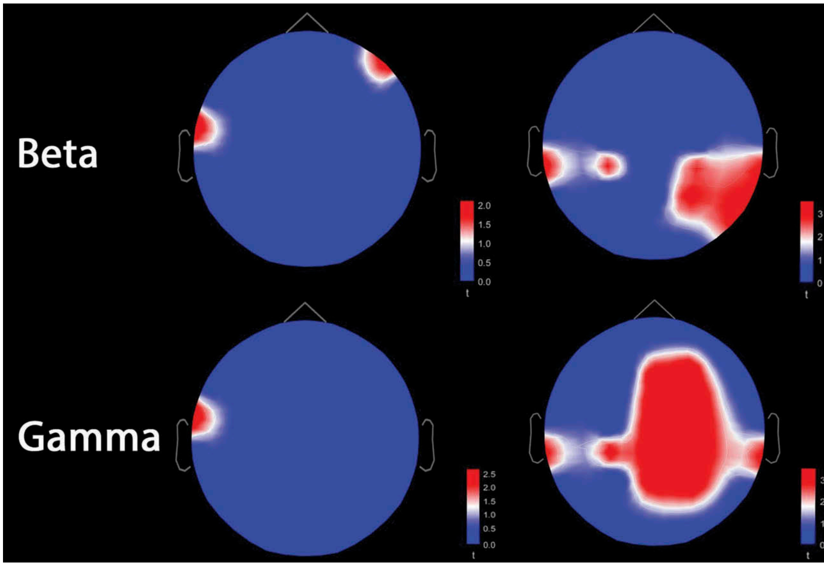

Figure 2. **EEG probability maps in H-OBE and I-OBE: differences in beta and gamma band activities between OBE condition and baseline recording. A significant reduction of power spectrum density in right fronto-parieto-temporal areas is present in H-OBE only.**

changes of iCoh were found in any frequency band between the H-OBE and I-OBE conditions. In the H-OBE group, eight out of 14 subjects answered "Yes" to the question: "Do you feel separated from your body?" in the Greyson questionnaire. Despite the small number of cases, the EEGs of these eight subjects disclosed a further significant decrease in the beta and gamma band activity (see Figure 3), whereas no difference was found in the I-OBE condition.

Discussion

A wealth of data has been published on the neurophysiological markers of hypnosis. The majority of articles have compared the EEG activity in high vs. low hypnotizable subjects (hereinafter defined as highs and lows, respectively), in the attempt to seek an objective classification of hypnotic susceptibility, to check the features of highs and/or the relationship between EEG, attention shifts, and hypnotic tasks. The available data are quite heterogeneous due to the variability of the EEG and the wide range of hypnotic tasks and study designs. Thus, discordant or even contradictory results have sometimes been

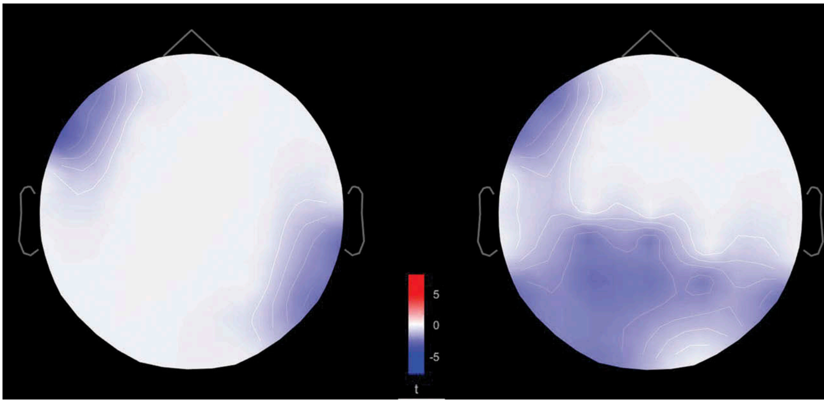

Figure 3. **EEG probability maps in the beta and gamma bands showing the differences between subjects reporting the feeling of being out of their body and the remaining ones in H-OBE condition. A significant decrease of power is present in the former.**

obtained. For example, an increased power in the theta band has been found both in highs (Cardeña et al., 2012; Graffin, Ray, & Lundy, 1995; Sabourin, Cutcomb, Crawford, & Pribram, 1990) and in lows (Williams & Gruzelier, 2001). Likewise, alpha power has been reported to be both related (Williams & Gruzelier, 2001) and unrelated to hypnotizability (Sabourin et al., 1990).

As far as beta and gamma activities are concerned, a significant correlation with the depth of hypnosis has been reported in highs (Cardeña et al., 2013, 2012), whereas gamma band activity and its coherence have been related to highs' ability to recall emotional memories as well (De Pascalis, 1999; De Pascalis, Marucci, & Penna, 1989). Furthermore, Jamieson and Burgess (2014) reported a decreased beta-1 iCoh with a focus on fronto-central and posterior hub in highs compared to lows.

In the chaotic sea of results reported in the literature, it is difficult, if even possible, to identify single, clear-cut, reliable EEG correlates of hypnosis. According to Kihlstrom (2013, p. 366):

> Many of these studies were "fishing expeditions," conducted in the hopes that they would yield interesting results, rather than tests of specific hypothesis about the nature or locus of electrocortical changes associated with hypnosis. Still, they were not always without some theoretical rationale, however weak.

On the other hand, the neurophysiology of hypnosis is a hard job pervaded by a strong uncertainty, as hypnosis is far from being a single monomorphic activity. As a result, the entire hypnotic state (defined in terms of relaxation and absorption) and the wide range of possible hypnotic tasks may specifically affect brain activity in different, even opposite ways, and may in turn be affected by different levels of hypnotic ability. For example, opposite changes of auditory mismatch negativity during hypnosis have been reported, depending on different hypnotic tasks (Facco et al., 2014; Jamieson, Dwivedi, & Gruzelier, 2005; Kallio, Revonsuo, Lauerma, Hamalainen, & Lang, 1999).

Indeed, the wide range of possibilities offered by hypnosis makes it an appealing and valuable model to manipulate subjective experience and gain insight into both the physiology and pathophysiology of mind–brain functioning—that is, its functional and organic disorders. According to Oakley and Halligan (2009), hypnosis is an appealing tool for the following reasons: (a) to study consciousness and create clinically informed analogues of functional and structural neuropsychological disorders and (b) to check the capacity of the mind to intentionally manipulate the activity of unconscious brain areas. The latter is a factor of paramount importance, responsible for relevant clinical results such as hypnotic analgesia (Facco, 2016; Facco et al., 2011, 2013).

The aim of this study was to investigate the neurophenomenological correlates of H-OBEs by comparing them to I-OBEs. Our primary purpose was not the mechanist-reductionist approach, only aimed to check the neuro-correlates of hypnosis; rather, it was to exploit hypnosis in the attempt of better understanding OBE neurophenomenology. Here, the neurophysiological investigations may help joining subjective experience and their neuro-correlates in a whole, as the two inescapable sides of the so-called and still unsolved "hard problem"—a neglected topic by the monist materialist approach, despite its crucial relevance for the understanding of consciousness (Facco & Fracas, 2018; Facco et al., 2017; Tressoldi, Facco, & Lucangeli, 2017).

It has been hypothesized that OBEs may depend on an altered multisensory integration at the level of right temporo-parietal junction, impairing both vestibular and somatosensory (proprioceptive) information processing (Blanke et al., 2004, 2005; Lopez et al., 2008) and thus yielding autoscopic hallucinations. On the other hand, despite the fact that spontaneous OBEs occurring during NDE may resemble autoscopies at first glance, they differ from autoscopies in many respects (e.g., the localization of the consciousness is clearly perceived as out of the real body) and have been included in the classification of autoscopies as a distinct form (Brugger et al., 1997).

OBEs in nonclinical populations have been linked with impaired fronto-parietal attentional networks, which may depend on several factors, including personality features, proneness to synesthesia, and the use of cannabis (Easton, Blanke, & Mohr, 2009; Overney, Arzy, & Blanke, 2009; Terhune, 2009). In this regard, it is worth recalling that the right parietal cortex is involved in the integration of multisensory information (Kanayama, Sato, & Ohira, 2007, 2009), an activity involved in both OBEs and synaesthesia—the latter engendering a sensory–visual crossmodal processing.

Gamma-band synchronization is a fundamental operation mode of activated cortical networks, which is essential for cortical computation (Fries, 2009). It also seems to be related to motor preparation and execution as well as multisensory integration; here, beta and gamma bands both may be involved in different steps of processing as well as in aberrant multisensory perception of schizophrenics (Balz et al., 2016; Moisa, Polania, Grueschow, & Ruff, 2016; Senkowski, Molholm, Gomez-Ramirez, & Foxe, 2005). If this is the case, OBEs and their related changes of multisensory integration might be reflected by changes of beta and gamma synchronization, in which a decreased power might be related to a parallel decrease of cross-modal integration and motor inhibition. Indeed, a study on rubber hand illusion has reported an increased synchronization of gamma band activity following congruent but not incongruent stimulation, reflecting both top-down and bottom-up processing (Kanayama et al., 2007). The authors concluded that their results did not support the hypothesis of an inhibition of multimodal processing as the cause of OBEs and suggested an increased gamma band synchrony (only following spatially congruent multimodal stimulation). On the other hand, the rubber hand illusion is far from being comparable to OBEs as described in NDEs and those elicited in our study. Here, the change of 1PP and the feeling of separation from the physical body might arguably be related to the decreased beta and gamma band activities as a result of crossmodal sensory lack of integration.

A further aspect of our study is the comparison of H-OBE to I-OBE, which may help in understanding whether they yield both qualitatively and quantitatively different kind of experiences. Smith and Messier (2014) reported on an uncommon case able to elicit OBEs at will without hypnosis, in which the fMRI showed activations mainly confined to the left hemisphere, involving the supplementary motor area and supramarginal and posterior superior temporal gyri, a fact interpreted by the authors as expression of kinetic imagery. This imagined OBE seems totally different from the available data on OBE illusions, the main neurophysiological markers of which are located in the right hemisphere, especially the temporo-parietal junction (the neurocorrelates of OBEs and autoscopies are summarized in Figure 4; see Lopez et al., 2008, for further details).

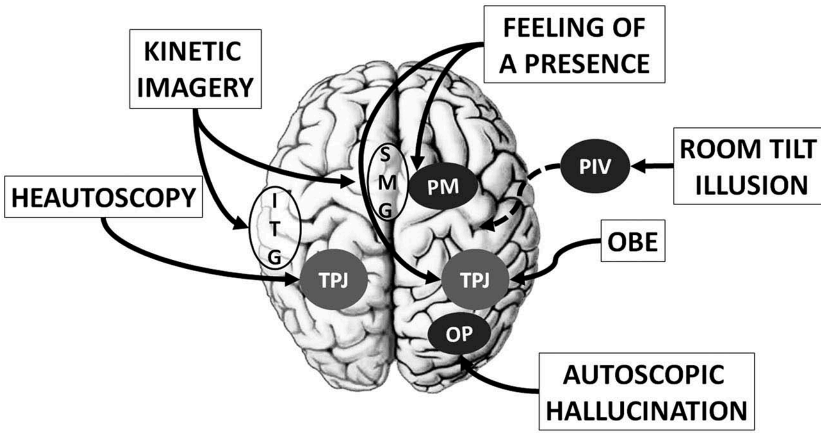

Figure 4. **Schematic representation of the main areas involved in OBEs and other autoscopies. Data drawn from Lopez et al. (2008) and Smith and Messier (2014).**

Our results show both quantitative and qualitative subjective differences between the H-OBE and I-OBE condition, despite being obtained with exactly the same instructions in the same subjects and thus showing the specific role of hypnosis as the cause of their features. Quantitative changes were observed in the PCI, including differences in the perception of the time flow, in the feeling of being separate from the physical body with fading borders, and in feeling a sense of unity with the universe, the first of which was statistically significant. Despite this, these findings do not allow us to state that the H-OBEs are the same as spontaneous OBEs—that is, those occurring in NDEs, NDE-like experiences, or, unpredictably, in nonclinical subjects. Our data support at least a partial overlapping of these two kinds of OBEs for the following reasons:

1. Both H-OBEs and I-OBEs are not illusions yielded by sensory and vestibular stimulation but, rather, depend on an intentional, introspective mental process, in which hypnosis yields different and more meaningful results with respect to I-OBE, including significantly higher scores in the altered state, altered experience, positive affect, and attention subdimensions of the PCI.
2. Nine out of 15 participants (60%) in H-OBE vs. only three (20%) in the I-OBE condition reported feeling themselves as being clearly separated from their body (p = .02); this also is in line with the higher rate of sense of harmony or unity with the universe and the perception of fading borders of the physical body, all features well described in OBEs during NDEs.

It is worth emphasizing that in the first interview the subjects declared themselves neither to be informed about OBE phenomenology nor to have been previously trained in the induction of OBEs. Therefore, they experienced the H-OBE for the first time, with two possible implications: (a) The H-OBE might result in deeper and provide better results following a specific training; (b) their novelty might have engendered uncertainty or misgiving when actually facing the separation from one's own physical body, decreasing their intensity. Such an event clearly occurred in a subject who reported she had remained halfway between feeling fully embodied and separated from her physical body. On the other hand, we purposefully avoided any training in order to check the differences between H-OBE and I-OBE in this least experienced condition, which is closer to spontaneously occurring, unpredictable OBEs; further study on H-OBE in well-trained subjects may provide further insight on the maximal intensity of the experiences intentionally elicited in hypnosis.

Our EEG data—that is, the decreased power in the beta and gamma bands in right parieto-temporal regions—agree with the key role the temporo-parietal junction (TPJ) seems to play in OBEs (Lenggenhager, Smith, S. T., & Blanke, 2006; Lopez et al., 2008). Despite no data on spontaneous OBEs being available (perhaps they will never be available), it is reasonable to argue that they may share similar neurocorrelates. If this is the case, our results suggest that H-OBEs, with their neurophenomenological changes, may be a good model of spontaneous OBE or, at any rate, be closer to them than I-OBE or those obtained by sensory and vestibular illusions.

Despite the significant EEG changes from baseline to the H-OBE condition, we did not find significant differences between H-OBE and I-OBE, a fact depending on two possible factors: (a) the small sample enrolled in this study with respect to the observed effect size, which was approximately .30, as well as the intrinsic variability of EEG signals; and (b) the possibility of a partial overlapping in the mechanisms of H-OBE and I-OBE—that is, the intentional introspective imaginative activity—in which H-OBEs might yield stronger EEG changes in the right hemisphere. Further study is required to check this provisional interpretation and better define the neurocorrelates of both I-OBEs and H-OBEs.

OBEs are a still ill-known, ostensibly odd, nonpathological phenomenon sharing some common phenomenological features with other NOMEs, such as those engendered by meditation and mystic experiences (Facco, 2012, 2017, 2018; Facco et al., 2015), unintentionally triggered by injuries (i.e., NDEs), psychological stress (NDE-like experiences; Facco & Agrillo, 2012a), or spontaneously occurring in a nonclinical population. Therefore, a method able to induce them may allow for better insight into this intriguing phenomenon.

Some partial OBE-like elements have been induced by vestibular stimulations, own-body transformation tasks, or spontaneously occurring in microgravity conditions and in room-tilt illusion (Lopez et al., 2008). Nevertheless, room-tilt illusion and inversion illusion in microgravity mainly yield a reversal of the visual field (e.g., upside-down reversal) without the experience of separating consciousness from one's body, whereas galvanic or caloric vestibular stimulation seem to yield partial dissociation between body and self and symptoms of depersonalization and derealization at best. In this regard, it is worth stressing that in OBEs occurring during an NDE, consciousness is reported to be perfectly clear or even brighter than normal, just the opposite of depersonalization and derealization.

Unlike the above-mentioned illusions, in H-OBE subjects have clearly reported leaving their body on the chair and floating close to the roof of the room, with their consciousness being located there—showing several phenomenological features of spontaneous OBEs. Furthermore, H-OBEs were associated with EEG changes compatible with a complex task altering the crossmodal sensory integration in the right hemisphere, according to their neurophysiological interpretation.

A key point of the phenomenology of OBEs remains their meaning, which does not imply that consciousness actually leaves the body. OBEs have been mainly interpreted in terms of dysfunction and disruption of multisensory integration by the ruling mechanistic approach. On the other hand, H-OBEs depend on an introspective activity intentionally performed by the subject, a fact hardly compatible with the idea of neurological dysfunction. Likewise, synesthesias were considered in the past decades as a deficit of separation of perceptual modalities due to a developmental failure, brain lesions, or the use of hallucinogens; instead, they may depend on a higher-than-normal brain connectivity related to better-than-normal activity, such as creativity (Chun & Hupe, 2016; Grossenbacher & Lovelace, 2001; Mroczko-Wasowicz & Werning, 2012; Safran & Sanda, 2015).

Despite the fact that OBEs, as well as NOMEs, may look odd from an unyielding physicalist perspective (the limits and pitfalls of which have been discussed in detail elsewhere; see Facco & Fracas, 2018; Facco et al., 2017), they may be endowed with a relevant cognitive and metacognitive potential, leading to resilience being enhanced and the fear of death being overcome. If this is the case, they may reveal unexpected relevant therapeutic implications. In this regard, it is worth mentioning that the meditation on one's own death in supine position (especially used in Tantric and Tibetan Buddhism) allows for experiences similar to NDEs, including the life review and the understanding of the meaning of life (Facco, 2014; Van Gordon et al., 2018). Furthermore, there is a meaningful link between hypnosis and meditation (Facco, 2014, 2017), as well as between NDEs and hypnosis (Facco, 2012, 2018), whereas NDE-like experiences permissively suggested in hypnosis might help to improve second-order changes and resilience (Schenk, 1999).

The same might be true for other NOMEs such as NDEs and OBEs, besides hypnosis and meditation, given their transformational power. In fact, their ostensible peculiarity with respect to ordinary features of consciousness and experience is conventional in nature, depending on statistical criteria of normality and on the adopted metaphysicis (i.e., accepted axioms and theories) at a given time; they do not imply *a priori* any dysfunction but only their diversity with the adopted *Weltanshaaung* (the view of the world) and *zeitgeist* (the spirit of times), suggesting the need for shifting their interpretation from only the field of physical disorders to their epistemological implications (as emphasized by the very concept of NOMEs). The link between hypnosis, meditation, and other NOMEs—such as mysticial experiences, NDEs, OBEs, and synesthesias—also involves art, poetry, music, and science itself, as well as psychiatric disorders (Facco, 2012, 2018, Facco & Agrillo, 2012a, 2012b). Their meaning looks hardly understandable by a reductive physicalist approach focused on brain circuitry only and unable to properly tell nonpathological or even better-than-normal NOMEs from psychiatric disorders, a problem already well defined by Plato in the *Phaedrus* (265a) as follows: "[Socrates] And of madness there were two kinds; one produced by human infirmity, the other was a divine release of the soul from the yoke of custom and convention." Plato's statement wisely emphasizes the epistemological implications of NOMEs and points out the need to properly understand them, avoding simple judgments based on custom and conventions and/or restricted to the axioms of reductive physicalism: Without this *divine release*, no cultural progress would be possible, not even Einstein's great intuitions on relativity and the revolution of classic thought introduced by quantum physics, well meeting Kuhn's concept of scientific revolutions (Kuhn, 1962).

Conclusions and Future Studies

Our data suggest that H-OBEs may be a useful experimental model of at least some aspects of spontaneous OBEs, as shown by the whole of their phenomenological and neurophysiological features. The lack of significant EEG differences between I-OBE and H-OBE may depend on the small sample size, EEG variability, as well as the fact that H-OBEs and I-OBEs might partly depend on common mechanisms—that is, intentional imagination, in which hypnosis may allow for much deeper experiences. Further study is required to define the similarities and differences between them.

Our study is based on a limited sample, and its results should not be overestimated; the findings are to be considered as hints rather than facts, to be confirmed by further studies on larger samples able to provide more accurate and statistically reliable results. They would allow better checking of the neurophenomenological aspects of H-OBEs and their specific features with respect to the same imaginary task without hypnosis (I-OBEs). Further studies should also compare highs to medium-lows and, within highs, check the correlation between EEG changes and the intensity of the experience of feeling out of body, in which a specific training in H-OBEs might probably provide stronger effects. Furthermore, EEG montages with higher electrode spatial frequency (e.g., a 64 or 128 channel montage) might strongly improve the localization of EEG changes yielded by H-OBEs and allow for their source analysis.

Despite all these limitations, our results show that OBEs can be easily inducible in hypnosis, and that their features are at least partially different from those yielded by the same imaginary task performed without hypnosis. This is in line with the concept of experimental hypnosis as a valuable model to manipulate subjective experience and gain insight into mind–brain physiology and pathophysiology. The observed EEG changes in H-OBEs are also in line with the available neuropsychological data on the mechanisms of OBEs illusions and autoscopies. The intensity of subjects' experience, as defined by the PCI and the Greyson modified scale, suggests an intriguing link between feeling out of one's body and positive emotions, a still poorly understood phenomenon common to NDEs and other NOMEs. Despite looking odd, this phenomenological aspect is of paramount importance to properly understanding the meaning of these experiences, given their metacognitive and transformational potential, which, once understood, might also disclose possible unforeseen therapeutic implications.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

Interview

1. Do you feel time flowing more slowly or quickly than normal?
2. Do you feel your thoughts accelerate/go faster than normal?
3. Do you see scenes from your past?
4. Do you suddenly seem to understand everything?
5. Do you feel peace or pleasantness?
6. Do you feel joy?
7. Do you sense harmony or unity with the universe?
8. Do you see or feel surrounded by a brilliant light?
9. Are your senses more vivid than usual?
   9a. How can you describe this state of consciousness? Are there differences with respect to a dream?
10. Are you aware of things going on elsewhere, as if by extrasensory perception?
11. Do you see scenes from the future?
12. Do you feel separated from your body?

12a. In this state of consciousness, do you perceive yourself with borders as in your physical body?
13. Do you feel you have entered in some other, unearthly world?
14. Do you feel the presence of a mystical being or hear an unidentifiable voice?
15. Do you see dead people or spiritual beings?

Die Neurophänomenologie von außerkörperlichen Erfahrungen mittels hypnotischer Suggestionen

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Abstract: Die Induktion von außerkörperlichen Erfahrungen in Hypnose (H-OBEs) bietet eine beinahe einmalige Gelegenheit, diese unter kontrollierten Bedingungen zu untersuchen. OBEs wurden als eine imaginative Aufgabe im Ruhezustand (I-OBE) oder in Hypnose (H-OBE) in einer Gruppe von 15 hoch hypnotisierbaren Teilnehmer induziert. Es wurde ein 32-Kanal-EEG aufgenommen und die spektrale Kraft und imaginative Kohärenz jedes einzelnen Frequenzbandes und jedes Elektrodenpaares ausgerechnet. Am Ende jeder Sitzung wurde der Phenomenology of Consciousness Inventory (PCI) angewandt, um die phänomenologischen Aspekte der Teilnehmererfahrungen aufzunehmen. Es wurde von signifikant höheren Zahlen im veränderten Bewußtseinszustand, dem positiven Affekt, der veränderten Erfahrung und der Aufmerksamkeitsuntergruppe des PCI in H-OBE als in I-OBE berichtet, die mit einer deutlichen Abnahme der Kraft innerhalb der Beta- und Gamma-Band-Aktivität in rechten parieto-temporalen Ableitungen assoziiert waren. Diese Ergebnisse legen nahe, daß die H-OBE ein nützliches experimentelles Modell spontaner OBEs darstellen könnte.

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La neurophénoménologie des expériences extracorporelles induites par des suggestions hypnotiques

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Résumé: L'induction d'expériences extracorporelles par hypnose (EEC-H) offre une occasion quasi unique d'étudier ces expériences dans des conditions contrôlées. Des EEC ont été induites en tant que tâches d'imagination en état de repos (EEC-I) ou en état d'hypnose (EEC-H) à un groupe de quinze sujets très susceptibles à l'hypnose. Un électroencéphalographe (EEG) à 32 canaux a enregistré les ondes du cerveau des sujets, et la puissance spectrale et la cohérence imaginaire de chaque bande de fréquences et de chaque couple d'électrodes ont été calculées. À la fin de chaque séance, l'Inventaire

de la phénoménologie de la conscience (IPC) a été administré aux participants afin d'évaluer les aspects phénoménologiques de leur expérience. Les scores de l'état altéré, de l'affect positif, de l'expérience altérée et des sous-dimensions d'attention de l'IPC ont été significativement plus élevés au sein du groupe EEC-H que dans le groupe EEC-I, lequel a été associé à une diminution significative de la puissance de l'activité des bandes bêta et gamma des dérivations pariéto-temporelles droites. Ces résultats laissent présager que les EEC-H peuvent offrir un modèle expérimental utile d'EEC spontanées.

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La neurofenomenología de experiencias extracorporales inducidas por sugerencias hipnóticas

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Resumen: Inducir experiencias extracorporales en hipnosis (EEC-H) ofrece una oportunidad casi única para investigarlas bajo condiciones controladas. Las EEC se indujeron como una actividad imaginativa durante la condición de descanso (EEC-I) o durante hipnosis (EEC-H) en un grupo de 15 sujetos altamente hipnotizables. Se grabó un EEG de 32 canales y se calculó el poder espectral y la coherencia en la imagen de cada banda de frecuencia y de cada par de electrodos. Después de cada sesión, se administró el Inventario Fenomenológico de Conciencia (PCI por sus siglas en inglés) para evaluar los aspectos fenomenológicos de la experiencia de los sujetos. Se reportaron puntuaciones significativamente más altas en las subdimensiones de estado alterado, afecto positivo, experiencia alterada, y atención en el grupo EEC-H comparado con EEC-I, que estuvieron asociados con un decremento significativo en el poder de las bandas beta y gamma en las derivaciones parieto-temporales diestras. Estos resultados sugieren que EEC-H pudiera ofrecer un modelo experimental útil de EECs espontáneas.

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