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Cognitive Correlates of the Spontaneous Out-of-Body-Experience (OBE) Occurring in the Psychologically Normal Population: Evidence for a Role of Temporal-lobe Instability and Body-distortion Processing

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(Running Head: OBE)

Abstract

Recent evidence from studies of epileptic patients and samples showing elevated scores on measures of schizotypy have implicated disruptions in multi-sensory integration as an important factor underlying predisposition to Out-of-Body Experiences (OBEs: Blanke et al., 2004; Mohr et al., 2006). It has been argued that these disruptions lead to a breakdown in own-body processing and embodiment. Here we present two studies which provide the first investigation of predisposition to OBEs in the normal population as measured primarily by the recently devised Cardiff Anomalous Perception Scale (CAPS; Bell et al, 2006). The Launay-Slade Hallucination scale (LSHS) was also employed to provide a measure of hallucinatory proneness. In Study 1, sixty-three University students participated in the study, seventeen of whom (26%) claimed to have experienced at least one OBE in their lifetime. OBEers reported significantly more perceptually anomalies (elevated CAPS scores) but these were primarily associated with measures of temporal-lobe instability and body distortion processing. The OBEers also scored significantly higher on the LSHS measure of hallucination proneness relative to controls. Study 2 demonstrated that OBEers and those scoring high on measures of temporal-lobe instability / body-distortion processing were significantly impaired, relative to controls, at a task requiring mental Own-Body-Transformations (Blanke et al. 2005). These results are consistent with an account positing both a disruption in temporal-lobe and body-based processing underlying OBE-type experiences. Theoretical implications of the findings are also discussed.

Introduction

Recent research from the cognitive neurosciences suggests that hallucinations are not necessarily indicative of, or restricted to, an underlying psychopathology (see Bentall, 1990, 2004; Brugger, 2002; Slade & Bentall, 1988). The emerging picture is one where proneness to both sensory anomalies and hallucination is seen more as a continuum along which we can all be placed (Bentall, 1990; Claridge, 1997; Lopez Rodrigo, Paino Pineiro, Martinez Suarez, Inda Caro, & Giraldez, 1997; Meehl, 1962; Mohr & Blanke, 2005; Strauss, 1969; Verdoux & van Os, 2002; van Os, Hanssen, Bijl, Ravelli, 2000). In addition, studying hallucinations in the normal population can greatly aid theoretical models of brain function by comparing instances when such 'positive' experiences occur, to the more traditional deficits approach of Cognitive Neuropsychology (see ffytche, 2000; ffytche & Howard, 1999; Frith, 2004; for examples and discussion). When viewed in concert, both the traditional neuropsychological 'deficit' approach, and this more recent 'positive' approach can lead to valuable insights in brain function and make important contributions to theories of consciousness, embodiment and the 'self'.

One important form of hallucination that has received considerable attention in recent years is that of the Out-of-Body Experience (OBE: see; Blanke & Metzinger, 2008; Brugger, 2002; for reviews). Blackmore (1982) defined the OBE *as "…an experience in which a person seems to perceive the world from a location outside his physical body"* (Blackmore, 1982, p1). Thus, in an OBE the observer experiences a form of dissociation between the perceiving 'self' and its typical physical moorings. Although some recent authors have tried to foster definitions which include the perception of a 'self' or some form of autoscopic body-image during the OBE (see Blanke, Mohr, Michel, Pascual-Leone, Brugger, Seeck, Landis, Thut, 2005; Ehrsson, 2007 for examples), seeing a representation of the physical self in an OBE is not a necessary condition for the experience. Indeed, some have suggested that actual reports of seeing some form of body representation during an OBE are quite rare (Gabbard & Twemlow, 1984; Irwin, 1985; Murray & Fox, 2005) and others have suggested treating experiences where people do see a double and when they do not see a double separately (see Cheyne & Girard, 2009; Terhune, 2009; for similar observations). Nevertheless, central to any definition of the OBE is a shift in the perspective of the experiencing self coupled to a disruption in the feelings of embodiment (Alvarado, 2000; Blackmore, 1982; Green, 1968; Irwin, 1981; 1985; Palmer, 1978).

Phenomenologically, the OBE can be fleeting and transient, though in rarer circumstances it can be more sustained and prolonged. A typical feature is that it is experienced as being extremely real at the time of the experience – with all the experiential qualities of three-dimensional veridical perception (Blackmore, 1982; 1987; Blanke & Mohr, 2005; Blanke et al., 2004; Brugger, 2002; Mohr, Blanke & Brugger, 2006). The effect on the observer can be quite striking. Understanding the neural and cognitive correlates of the OBE (and kindred hallucinations of the 'self') is important as current estimates suggest they also occur in around 10% - 15% of the psychologically normal population (~ 25% in undergraduate populations) where there is no evidence of any underlying psychosis or psychopathology (Alvarado, 2001; Blackmore, 1982; 1986; Irwin, 1985) as well as being well documented with a legion of clinical disorders, psychoses and underlying psychopathologies (see Brugger, 2002; Bychowski, 1943: Critchley, 1950; Gabbard & Twemlow, 1984; Gabbard, Twemlow & Jones, 1982; Twemlow, Gabbard & Jones, 1982).

Conducive contexts for the occurrence of OBEs are wide and varied. They can occur as part of the Near-Death Experience (NDE), as a result of taking hallucinogenic drugs, and can occur in response to life-threatening stressful situations, though they are more common during relaxed yet wakeful states (Alvarado, 2000; Appleby. 1989; Blackmore, 1982; Braithwaite, 2008a; 1998; Green, 1968; Noyes & Kletti, 1976, 1977; Siegel, 1977; 1980). They can occur as part of migraine aura (Comfort, 1982; Lippman, 1952; 1953; Sacks, 1995; Todd & Dewhurst,

1955) though are more commonly associated with complex partial seizures of the temporal lobe and limbic system – which are also associated with other forms of anomalous cognition such as dissociation, sensed presences, autoscopy, and déjà vu, etc (Devinsky & Lai, 2008; Fauget, 1979; Gloor, 1986; Gloor, Olivier, Quesney, Andermann, Horowitz, 1982; Bear, 1979; Halgren, Walter, Cherlow, Crandall, 1978; Penfield, 1955; Penfield & Perot, 1963; Sacks, 1995; Siegel, 1980, 1977; Tadokoro, Oshima, Kanemoto, 2006).

More recently, a growing number of studies have shown that the OBE is linked to a disruption in multisensory integration processes which typically sub-serve the processing of embodiment and supports a coherent unified perception of the 'self' (Blanke, Ortigue, Landis, Seeck, 2002; Blanke et al., 2004; Blanke, Perrig, Thut, Landis, & Seeck, 2000; Blanke & Metzinger, 2009). For example, direct cortical stimulation of the epileptic brain can artificially induce distortions in vestibular processing resulting in feelings of falling or floating (Blanke et al., 2000), can induce 'sensed presence' experiences (Arzy, Seeck, Ortigue, Spinelli, & Blanke, 2006) and can also elicit vivid OBEs (Blanke, et al., 2002; 2004). These experiences typically mimic those reported by the patient as part of their spontaneous pre-seizure aura - but can also be induced in epileptics that have never reported OBE-type hallucinations before (Blanke et al. 2002; see Tong, 2003). Independent studies that have electrically induced OBEs and kindred experiences have identified the temporal-parietal junction (TPJ), the angular gyrus, and the junction of the intraparietal sulcus as neurological regions potentially involved in generating or mediating such experiences (Blanke et al., 2002; 2004; Blanke & Thut, 2007; DeRidder, Van Laere, Dupont, Menovsky, & Van de Heyning, 2007).

In a functional sense, one central theme has been that the brain processes involved in the mental transformation of ones own body may recruit similar neural systems as those implicated in the computation of the somewhat de-centred OBE (Blanke et al., 2005; Brugger, 2002; Mohr et al., 2006). For example, findings from electrophysiological (ERP) and Transcranial Magnetic Stimulation investigations of performance at an own-body transformation task where participants have to adopt a perspective akin to that adopted in the OBE have implicated the selective involvement of the right TPJ in the mental transformation of ones own body (Blanke et al., 2005). In addition, this study also showed that an epileptic patient who had seizure activity associated with OBE-aura originating in the TPJ, displayed partial activation in the region of the seizure during mental transformations of their own body. Similar impairments at mental own-body transformation tasks have also been shown for male participants who scored positively on a measure of schizotypy-related perceptual aberration (Mohr et al., 2006; see also Mohr & Blanke, 2005).

The emerging view argues that the altered perspective reported in a typical OBE may result from a simultaneous breakdown in parietal networks sub-serving multi-sensory egocentric processing (Blanke et al., 2005) and / or medial temporal lobe structures involved in exocentric perspective taking (Lambrey, Amorim, Samson, Noulhiane, Hasboun, Dupont, Baulac, & Berthoz, 2008; Rudy & Decety, 2001; Saxe, Jamal & Powell, 2005). More recently, others have extended these ideas beyond the TPJ and highlighted an impaired connectivity between frontal and parietal attentional networks as being potentially involved in OBEs and kindred experiences (Easton, Blanke, & Mohr, 2009). Irrespective of the neurological underpinnings, a breakdown in integration between visual and proprioceptive / vestibular feedback may be the trigger for the feeling of spatial separation from the physical self and relocation of the perceiving 'self' into extra-personal space. Such de-coupling effects between visual and proprioceptive feedback are not unprecedented and have been induced in the laboratory resulting in body distortions for either specific limbs or body parts (i.e., the rubber-hand illusion: Botvinick & Cohen, 1998; Ehrsson, Wiech, Weiskopf, Dolan, & Passingham, 2007) or for the whole body (Ehrsson, 2007).

As a consequence of these recent investigations, it appears as if the OBE may result, at least in part, from a disruption in the brain regions underlying multi-sensory integration processes (visual / proprioceptive / tactile / vestibular) which are collectively important for the representation of the body, self and feelings of embodiment (Blanke & Arzy, 2005; Blanke et al., 2002; 2004; 2005; Blanke & Metzinger, 2008; Brugger et al., 1997; Bunning & Blanke, 2005; Mohr et al., 2006). By this account then, such anomalous experiences result from a failure to successfully integrate multi-sensory information due to some form of conflicting information between these senses, which in turn leads to a form of perverse integration of the 'self' and its relationship to its immediate environment (Blanke et al., 2004; Bunning & Blanke, 2005; Mohr & Blanke, 2005).

Although the studies involving epileptic and clinical patients show that the OBE can occur as a result of an underlying pathology, other observations have shown that anomalous experiences can and do occur in the psychologically normal population. For example Persinger and colleagues have shown that propensity to report paranormal / mystical experiences (and related aura sensations) is related to increased signs of temporal-lobe disturbance in the normal, non-epileptic brain (Neppe, 1983; Makarec & Persinger, 1985; 1987; 1990; Persinger, 2001; Persinger & Makarec, 1987; 1993; Persinger & Koren, 2001). These individuals are described as showing epileptic-like signs in electroencephalographic recordings which in turn are thought to reflect the presence of transient micro-seizures in the temporal lobe and limbic system of non-epileptic brains (Persinger, 2001). In addition, these researchers have also provided evidence that OBEs and other anomalous experiences can be induced artificially in normals by the application of weak (< 10,000nanoTesla) complex magnetic fields to the temporal lobes (see Persinger, 2001; for a review). Although this method is controversial (see Braithwaite 2008b; for a critique) the implication is that individuals who show elevated signs of temporal lobe instability have brains which are more vulnerable and susceptible to being stimulated in this manner (presumably due to a lack of inhibitory regulation in localized neuronal assemblies: Persinger, 2001; Persinger & Koren, 2001).

To summarise, there is growing evidence that a breakdown in proprioceptive feedback and body-based processing sub-serving a coherent sense of 'embodiment' are crucial for understanding the OBE (see Blanke & Metzinger, 2008; Brugger, 2002; for recent review). This evidence is based principally on observations from the clinical literature, from epileptic patients, and patterns of performance for individuals who score high on measures of schizotypal perceptual aberrations (Blanke et al., 2002; 2004; 2005; Brugger et al., 1997; Brugger, 2002; Bunning & Blanke, 2005; Mohr et al., 2006). In addition, disruptions in temporal-lobe processing also appear to be related to aura-like experiences including, though not restricted to, the OBE (Neppe, 1983; Persinger, 2001).

However, while the studies demonstrating the artificial induction of such experiences in epileptic patients provide an important comparative model for the non-epileptic brain, it is not a clear or direct demonstration that similar forms of temporal instability exists within the non-epileptic population. Indeed, in the study of Blanke et al. (2002) the epileptic patient being described did not experience an OBE as part of their general aura or at lower amplitudes of pre-surgical electrical stimulation (see also Tong, 2003). Such experiences only occurred during higher levels of electrical stimulation (approx 3.5mA) – which arguably may not have a natural homologue in the non-epileptic brain. Furthermore, the studies which do show elevated signs of temporal-lobe instability in non-epileptics, have done so more in relation to general paranormal experiences and spiritual belief (which includes experiences of déjà vu, sensed presences, generic aura experiences, hyper-religiosity, etc) and have not typically been directed to specific instances of OBE. Therefore, while such studies certainly imply and are consistent with the notion that aura-like experiences are associated with signs of temporal-lobe dysfunction in the normal population, these previous investigations do not necessarily demonstrate this association in the specific generation or maintenance of the OBE in the normal population. It should also be noted that in the study of Blanke et al (2005) which provided an excellent investigation of performance at own-body transformations in both a patient and normal controls, none of the normal participants were actual OBEers. As a consequence, few, if any studies to date have demonstrated that, as a perceptual anomaly, naturally occurring spontaneous OBEs reported by the psychologically normal population are related to associated signs of disturbances in temporal-lobe processing and / or disruptions in body-based representations or processing.

Of the studies which have examined the OBE in the normal population, these have typically been carried out in conjunction with the clinically and psychiatric inspired notion of schizotypy or the 'healthy schizotype'. For example, McCreery and Claridge (2002) demonstrated that OBEers scored significantly higher than nonOBEer controls but only on the measures associated with aberrant perceptions and beliefs (see also McCreery & Claridge, 1995). All other schizotypal measures did not reveal reliable differences between OBEers and the nonOBEer control group. Similarly, Murray & Fox (2005) employed a host of questionnaire measures to investigate factors associated with propensity to report OBEs in relation to different aspects of body-experience. They found that OBEers produced significantly elevated scores on measures of somatoform dissociation, self-consciousness, and body dissatisfaction - suggesting potentially important differences between the body-experiences of OBEers relative to nonOBEers These studies are consistent with a multi-dimensional view of both the OBE and schizotypy. However, none of these previous studies employed measures designed specifically to indicate the presence of temporal lobe dysfunction – a factor more recently implicated as being important.

Mohr et al. (2006) provide perhaps the study closest to establishing a link to body-based perceptual aberration and predisposition to have OBEs in the normal population. However, these researchers also employed a measure of bodily perceptual aberration from a schizotypy questionnaire (Chapman, Chapman & Raulin, 1978), and did not directly delineate between self-claimed OBEers and nonOBEers. As such, there was no direct comparison between OBE and nonOBE groups (this was inferred indirectly via high scores on the perceptual aberration subscale). While it is perfectly reasonable to assume that OBEers would score higher on measures of body-based perceptual-aberration (as suggested by McCreery & Claridge, 2002) it is conceivable that one may score high on such a scale and not necessarily have had an OBE. Not all dimensions of dissociation directly implicate a propensity to have an OBE and may pertain more to other forms of body-distortion experience such as autoscopy and / or sensed presence experiences (Blanke et al., 2004; Brugger, 2002; Brugger, Regard & Landis, 1996). While all these phenomenological experiences may be related at some level (as variants from disruptions in the body-image and multi-sensory integration) it remains an open question as to how distinct they are as well.

Crucially, as Bell, Halligan, and Ellis (2006) note, many previous measures of hallucination, delusion and perceptual distortion, derive both their content and language from clinical psychiatry which may not ideally map onto the rate and range of sensory anomalies in the normal population. These issues can be compounded further by the fact that many of these clinical measures can make it difficult to separate perceptual and cognitive distortions, or underlying sensory anomalies from resultant delusional beliefs (Bell et al. 2006). Therefore, although it is a central theme running through current neuroscientific accounts of the OBE, a clear empirical demonstration that self-claimed OBEers (specifically) may well display signs of temporal-lobe instability / dysfunction and suffer from body-based distortion processing remains to be demonstrated. The current study sought to address this omission.

Study 1 employed two parametrically validated measures; one measuring specific perceptual anomalies across a variety of modalities (the Cardiff Anomalous Perception Scale: CAPS: Bell et al., 2006) and the other measuring general hallucination proneness (a revised version of the Launay-Slade Hallucination Scale, Launay & Slade, 1981; see also Morrison, Wells, & Nothard, 2000; 2002) on a psychologically normal undergraduate population. Study 2 employed only the subscales from the CAPS measures which significantly distinguished OBEers from nonOBEers in Study 1, as a factor which may be related to performance on a behavioural task associated with carrying out mental own-body-transformations (the OBT task: Blanke et al. 2005; Mohr et al., 2006).

Overview of the present study

The present study investigated the cognitive correlates of hallucinatory proneness with regard to a specific form of anomalous experience reported by a sizable minority of the psychologically healthy general population – namely the OBE. In addition, the present study is directed at investigating naturally occurring spontaneous OBEs that occur in the absence of known situational and artificial agonists (i.e., recreational drugs, anaesthesia, etc)[1]. Study 1 sought to provide an independent questionnaire-based investigation of two important components identified as being involved in the triggering and phenomenological content of, the OBE in the normal population. These were (i) signs of temporal-lobe instability and disturbances in temporal-lobe processing (using a psychometrically verified measure); and (ii) disruptions and distortions in body-based processing, proprioceptive integration processes. Study 2 provided additional behavioural evidence from the own-body-transformation task (OBT) devised and employed in previous studies (Blanke et al., 2005, Mohr et al., 2006).

We employed the recently devised Cardiff Anomalous Perception Scale (CAPS: Bell et al., 2006) as a measure of individual propensity to experience anomalous perceptions. To our knowledge, we provide the first empirical investigation of an OBE sample group using the recently devised Cardiff Anomalous Perception Scale (CAPS: Bell et al., 2006). Coupled to this we also administered a revised Launay-Slade Hallucination Scale (LSHS: Launay & Slade, 1981) as a measure of hallucination proneness in our sample.

The CAPS measure is highly appropriate for the present study. Firstly, it is a measure of predisposition to anomalous perceptual experience and not one of delusional belief per-se – a distinction that can be confounded in some measures of hallucination proneness (Bell et al.,

[1] We fully acknowledge that OBEs have been associated with other situational factors such as drugs, anesthesia, sleep-paralysis etc, but these broaden the scope beyond that of the current study where factors associated with the occurrence of spontaneous OBEs are more pertinent and are arguably far more frequent.

2006). The items on the measure are directed more towards the nature of anomalous perceptual experience, rather than include dimensions directed more toward general schizotypy or psychosis and the language employed is somewhat liberated from that of previous clinical and psychiatric measures. In addition, when constructing the measure Bell et al. (2006) removed items from previous questionnaire measures that did not occur in clear waking consciousness (i.e., dreaming) from the CAPS measure – thus eliminating nebulous experiences from dreams and related states which can be problematic to assess and interpret (see Bell et al., 2006 for a discussion and justification).

Secondly, the CAPS measures predisposition to anomalous experience across a variety of sensory modalities including measures for temporal-lobe instability and body-distortion processing – factors that have been identified as being important for both hallucinatory proneness in general, and specifically to the OBE (Bell et al., 2006; Blanke et al., 2002; 2004; 2005; Blank & Metzinger, 2008; Ehrsson, 2007; Makarec & Persinger, 1985; 1990; Persinger & Makarec, 1987; 1993; Mohr et al. 2006). The temporal-lobe instability subscale of the CAPS contains items that are common in pre-seizure aura-type experiences reported by temporal-lobe epileptic patients (either spontaneously or via direct electrical stimulation; Gloor, 986; Gloor, et al., 1982; Halgren, et al., 1978; Penfield, 1955; Penfield & Perot, 1963), and in attenuated form by the normal population (Makarec & Persinger, 1985; 1987; 1990; Persinger & Makarec, 1987; 1993; Persinger, 2001). As such, these items / experiences are known to be associated with varying forms of temporal-lobe dysfunction and can form part of pre-surgical evaluation. Indeed, based on the prior work reviewed in the Introduction, it was predicted here that OBEers would produce elevated scores specifically on measures of temporal-lobe instability and body-distortion while they may well remain indistinguishable on other dimensions not directly implicated in the cognitive processes underlying and contributing to an OBE. This in turn would suggest some specificity in the underlying cognitive processes mediating this particular form of anomalous experience. The CAPS is also useful as it provides a measure of how frequently such instances occur, how distressing they are, and how distracting they are.

The use of the CAPS was coupled to the use of a revised Launay-Slade Hallucination Scale (LSHS: Launay & Slade, 1981; see also Morrison, Wells, & Nothard, 2000; 2002). The LSHS is a measure of general hallucination proneness rather than just one of propensity to experience sensory anomalies. Employing this scale also makes the present findings (using psychologically normal individuals) comparable to a large previous literature which has employed the LSHS to explore hallucination proneness in both the patient and general population (see Bentall, 2004; Bentall & Slade, 1988) as well as to previous studies of the OBE (McCreery & Claridge, 1995, 2002). Previous research has shown that responses to the CAPS and the LSHS were correlated – suggesting a possible relationship between the existence of anomalous perceptions and predisposition to hallucinations (Bell et al. 2006). As such, a general pattern of agreement between the CAPS and LSHS would be expected with the present sample here.

Study 2 coupled the significant subscales identified from the CAPS measure from Study 1, to performance at a mental own-body transformation task (OBT). Task of this nature are thought to measure similar perspective-taking mechanisms to that implicated in the out-of-body perspective reported by OBEers (Blanke et al., 2005; Mohr et al., 2006; Easton et al., 2009). In the OBT task observers are presented with a schematic manikin type figure which is either facing the observer or facing away from the observer. Participants are instructed to try to adopt the perspective of the manikin and hence – engage perspective taking processes and decide on what hand (left / right) is the figure wearing a distinctive glove / bracelet. Collectively, evidence from both epileptic patient studies and those reporting an association with high scores on measures of perceptual aberration / schizotypy, suggests that these individuals have more difficulty with taking the perspective of the figure when it differs from their own – consistent with the notion that anomalies in such processes may be related to OBEs (Blanke et al., 2005; Mohr et al., 2006).

Finally, for the present study it is important to be clear on what counted as an OBE and thus, qualified as inclusion criteria to the OBEer group. The present study employed Blackmore's (1982) definition for OBEs but with some additional a-priori constraints. An a-priori pre-screen was devised to exclude any OBEs that occurred as the result of recreational drug use, alcohol, anaesthesia, or as a direct result of prescription medication. Only one OBEer from Study 2 failed to satisfy this criterion and was removed from the analysis. In addition, although we noted whether the OBEer experienced a representation of the self during the OBE or not – we did not use that information as exclusion criteria. Both visual experiences (i.e., seeing the environment from another vantage point) and bodily experiences of displacement (feeling as if one is no longer in ones body and is now experiencing the environment from outside of oneself) were counted as an OBE in the present study.

Method

All questionnaire measures were administered in person in the laboratory under the supervision of an experimenter.

Participants

Sixty-three participants took part in the study between September 2005 and May 2008. Forty-eight participants (76%) were female and 56 (88%) self-reported that they were right handed. None reported any personal medical history of seizure, epilepsy or were diagnosed with having migraine. All participants were undergraduate or postgraduate students (MSc / PhD) from the School of Psychology at the University of Birmingham, UK. Participants ranged in age from 19 – 35 years, with a mean average age of 21 years (OBE group mean age 21.4, nonOBE group mean age = 20.8). All received course credit or a small financial payment for taking part in the study.

Questionnaire measures

The revised Launay-Slade-Hallucination-Scale (LSHS:) a revised Launay-Slade Hallucination Scale was employed (Launay & Slade, 1981). The LSHS consisted of a 12-item questionnaire (see Table 1). The present version incorporated the revised method of scoring the responses which allowed for items to be rated using a 5-point scale to measure agreement with statements pertaining to hallucinatory episodes (0 = certainly does not apply to me; 1 = possibly does not apply to me, 2 = unsure, 3= possibly applies to me, 4 = certainly applies to me: see Morrison, Wells, & Nothard, 2000; 2002). These scores were summed for each participant and an overall score of hallucinatory proneness was ascertained.

Table 1. The revised Launay-Slade-Hallucination-Scale (LSHS) used in the present study. Participants provided an agreement score on a scale of 0 to 4 (0 = certainly does not apply to me / 4 = certainly applies to me) in response to each item.

Q. No	Statement
1	No matter how hard I try to concentrate, unrelated thoughts always creep into my mind
2	In my daydreams I can hear the sound of a tune almost as clearly as if I were actually listening to it
3	Sometimes my thoughts seem real as actual event in my life
4	Sometimes a passing thought will seem so real that it frightens me
5	The sounds I hear in my daydreams are usually clear and distinct
6	The people in my daydreams seem so true to life that sometimes I think they are
7	I often hear a voice speaking my thoughts aloud
8	In the past I have had the experience of hearing a person's voice and then found that no one was there
9	On occasions I have seen a person's face in front of me when no one was in fact there
10	I have heard the voice of the devil
11	In the past I have heard the voice of God speaking to me.
12	I have been troubled by hearing voices in my head

Cardiff Anomalous Perception Scale (CAPS:): The CAPS is a recently developed 32-item measure of perceptual anomalies which also includes dimensions of levels of distress, distraction and frequency of anomalous experience (Bell, Halligan, & Ellis, 2006). More importantly, the CAPS contains nine subscales which seek to measure; (1) temporal lobe instability; (2) body distortion / proprioceptive processing; (3) experiences of unexplained source; (4) non-shared sensory experience; (5) distorted sensory experience; (6) changes in sensory intensity; (7) verbal hallucinations; (8) sensory flooding; and (9) hearing thoughts out loud / thought echo. The questions contributing to each subscale range from two to six. The CAPS measure was specifically designed for use with both the clinical and non-clinical, psychologically normal populations, it has a high level of reliability and correlates strongly with other measures of hallucinatory proneness like the revised LSHS (see Bell et al., 2006; 2008).

For example, an illustrative question from the temporal-lobe instability subscale is *"Do you ever have the feeling of being uplifted, as if driving or rolling over a road while sitting quietly"* or *"Do you ever sense the presence of another being, despite being unable to see any evidence?"* An example question from the body-distortion subscale is *"Do you ever have the sensation that your body, or part of it, is changing or has changed shape?"* Participants respond initially to each question with a yes / no response (scored 1 / 0 respectively). Thus the maximum overall CAPS score for any participant was 32. For questions where a 'yes' response was given, there were three additional subscales that needed to be answered which asked how distracting, how distressing and how frequent such experiences were (each one of these additional subscales was scored on a Likert scale of 1 – 5).

<u>OBE vs nonOBE grouping</u>

In conjunction with the pre-screen (described above) participants were assigned to the OBE group on the basis of their answer to the question *"Have you ever had an experience where you have perceived / experienced the world from a vantage point outside of the physical body?"* which was an additional question we added to the end of the CAPS questionnaire. In addition to this question participants were given further qualifying information that (i) such an experience can feel totally real at the time of the experience with all the phenomenological qualities of veridical perception and (ii) that such experiences can be fleeting and transient or more sustained. If a response of "yes" was provided then additional contextual and situational information about the experience(s) was also ascertained such as their physical / emotional state at the time of the experience (i.e., relaxed, borderline sleep, dreaming, awake)[2] how often they had experienced an OBE (only once / more than once / regularly), whether the experience was visual in nature, and whether they saw their physical self during the experience. Associated phenomenology was also documented (i.e. feelings of dizziness, floating sensations, disorientation, dissociation, duality of consciousness, other sensory experiences etc).

Results

Of the 63 participants who took part in this study, seventeen of these (26%) claimed to have experienced at least one out-of-body experience at some point in their life. Of the OBEer group, four (24%) claimed to have experienced multiple (more than one) vivid OBE and continued to do so. The vast majority of OBEs were reported as occurring during a relaxed / borderline sleeping state – though two are of note as they occurred during (i) a ski jump accident, and (ii) a charity parachute jump. Of the OBE group, only six (35%) reported seeing their own body or some form of body representation of the physical self during the OBE, with all the others reporting only the shift in perspective (either visually, as a bodily sensation, or both).

The mean average LSHS score for the whole sample was 11.6 (SD=7.3). The OBE group had an elevated LSHS score (mean=17.5, SD=7.0) relative to the nonOBE control group (mean=9.4, SD=6.1) – this difference was significant ($t(61) = 4.469$, $p<.001$). According to the scores gleaned from the LSHS, OBEers were significantly more hallucinatory-prone than nonOBEers. Of the four individuals (24%) that reported having had more than one previous OBE, their average LSHS score was elevated relative to the rest of the OBE group at, 22.3.

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[2] As noted earlier, an a-priori decision not to include experiences reported as part of dreams was made (to be consistent with the criteria of how the CAPS was constructed).

Only six (13%) of the nonOBE group scored higher than the mean for the whole OBE group. Figure 1 shows the mean responses for both groups across all questions from the LSHS. As can be seen, OBEers showed a general trend and bias to produce elevated responses across the questions from the LSHS. These data suggest that OBEers are generally more hallucinatory prone relative to nonOBEers and this was consistent across most questions contained in this measure.

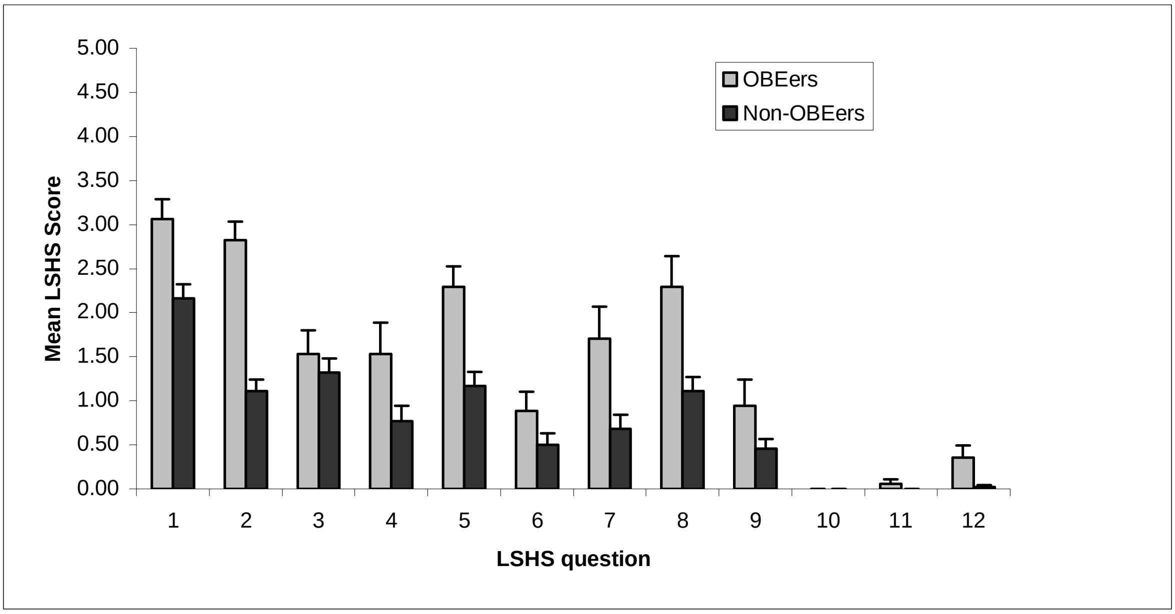

Figure 1. Mean LSHS scores for each question from both OBE and nonOBE groups (error bars = 1 SE).

The overall total CAPS score for the combined sample was 9.90 (SD=5.05). Scores were severely non-normally distributed – as would be expected for a questionnaire which measures a host of psychological dimensions and where most psychologically healthy people score very lowly. As a consequence of this, these CAPS data were analyzed using non-parametric Mann-Whitney tests. Again, the OBEers scored significantly higher (mean=13.53, SD=6.52) relative to the nonOBEer scores (mean=8.57, SD=3.63) in terms of their overall total scores – this difference was significant (Mann-Whitney U = 217, z = 2.71, p<.006). The difference was less in magnitude than that seen for the LSHS – which might suggest that OBEers were not significantly elevated in terms of their scores for all nine of the subscales (explored and discussed below). In addition, only three (6.5%) people from the nonOBE group scored higher than the mean value for the OBEgroup The highest CAPS score from the OBE group was 23 (out of a possible highest score of 32) with scores ranging from 4 to 23 (range = 19). The highest CAPS score reported from the nonOBE group was 18 with scores ranging from 1 to 18 (range = 17).

The difference between the groups was also explored in terms of the dimensions of (i) distress, (ii) distraction and (iii) frequency of the anomalous perceptions via a series of separate between-subjects Mann-Whitney U-tests (in line with the procedure of Bell, 2008). This revealed that the OBE group scored significantly higher on all three dimensions with Distress, ($U=153.5$, $z = 3.68$, $p<.001$); Distraction, ($U=153$, $z = 3.69$, $p<.001$); and Frequency, ($U=134$, $z = 3.99$, $p<.001$); respectively (see Figure 2). The largest difference between the groups was in terms of the frequency of occurrence of perceptual anomalies – with such anomalies being significantly more frequent within the OBE group.

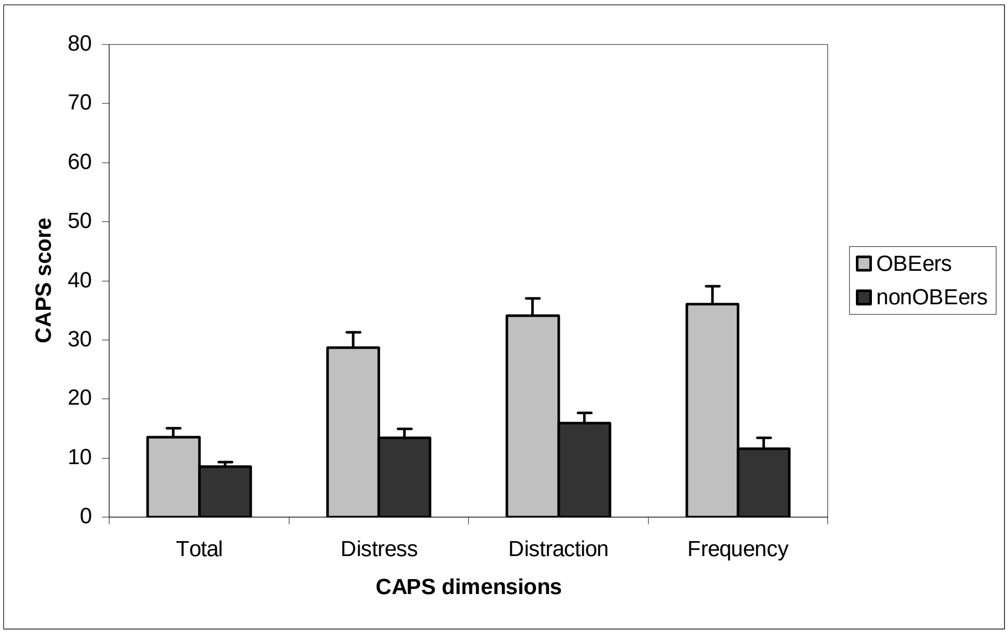

Figure 2. CAPS scores for the OBE and nonOBE groups (error bars = 1SE).

Although OBEers tended to score higher on all dimensions of the CAPS, importantly, OBEers only displayed statistically significant elevated scores for some of the nine subscales which indicated an important and heightened role for some cognitive processes relative to others. Scores from the OBEer and nonOBEer groups were directly compared across these nine subscales where the p-values were corrected for multiple comparisons via the False Discovery Rate procedure (Benjamini & Hochberg, 1995). For pairwise contrasts, this entails ordering the contrasts by descending *p*-value. The first contrast is tested against α=.05, subsequent values are compared against $\alpha=(i/k)*.05$, where k is the total number of contrasts tested (here, k=9) and i is the rank-order of the contrast. For the largest p-value, i=9 and for the smallest p-value i=1. As soon as $p< \alpha$, this contrast and all subsequent ones are considered significant (Benjamini & Hochberg, 1995; also see Howell, 2009). As can be seen in Table 2, the OBEers were statistically distinguishable only in terms of (i) temporal lobe instability, (ii) body distortion / proprioception distortion, and a smaller effect for (iii) thought echo. All other subscales failed to be reliable between the two groups.

Table 2. Mean CAPS scores for both the nonOBE and OBE group across the nine subscales. Note these are mean values and not summed values due to uneven sample sizes. Note also, they are ranked in terms of the degree of difference between the groups with the subscale revealing the largest difference at the top. An asterisk (*) indicates that the difference is significant after correction for the False Discovery Rate (Benjamini & Hochberg, 1995).

Subscale	nonOBEer	OBEer	Difference (d)	Mann-Whitney
Temporal lobe instability	1.33	2.88	1.56	$p<.001^*$
Body distortion	0.85	2.00	1.15	$p<.001^*$
Thought echo / out loud	0.24	0.76	0.52	$p<.002^*$
Sensory flooding	0.11	0.29	0.18	$p=.052$
Non-shared sensory experience	1.07	1.65	0.58	$p=.074$
Unexplained source	1.70	2.59	0.89	$p=.091$
Verbal hallucinations	0.33	0.59	0.26	$p=.227$
Sensory intensity	2.20	2.71	0.51	$p=.273$
Distorted sensory experience	1.24	1.47	0.23	$p=.500$

The average CAPS score for those OBEers reporting having had more than one previous OBE was 19 (SD=4.3) relative to a score of 12.4 (SD=6.9) for OBEers who only reported one experience and 8.6 (SD=3.6) for the nonOBEers. This is in line with the pattern of results from the LSHS where, in both cases, the mean average for observers reporting more than one OBE was marginally elevated relative to the mean of the rest of the OBE group (and both are elevated relative to nonOBEers). Finally, Table 3 provides additional contextual information as well as individual scores of the temporal-lobe and body-distortion subscales of the CAPS for the OBEer group from Study 1.

Table 3. The experiential context and state of the OBEer, whether they saw an image of themselves during their OBE(s), the number of OBEs they have experienced, and CAPS score for measures of neural instability and body distortion.

OBEer	Context / state	Vision of self	No of OBEs	Neural instability	Body / Dist
1	Borderline sleep	No	One	1	1
2	Parachute jump	Yes	One	4	2
3	Relaxed / resting	No	One	1	0
4	Relaxed / resting	Yes	More than one	4	3
5	Relaxed / resting	No	One	1	1
6	Relaxed / resting	Yes	One	2	1
7	Relaxed / resting	No	One	4	2
8	Ski jump accident	Yes	One	2	1
9	Borderline sleep	No	One	4	4
10	Borderline sleep	No	One	4	3
11	Relaxed / resting	No	One	4	2
12	Relaxed / resting	No	More than one	3	2
13	Borderline sleep	Yes	One	4	3
14	Relaxed / resting	Yes	One	4	4
15	Relaxed / resting	No	More than one	2	2
16	Borderline sleep	No	One	2	1
17	Relaxed / resting	No	More than one	3	2

Note: The highest possible score per participant for both the temporal lobe instability subscale and the body distortion subscale is 4.

Discussion

Twenty-six percent of the present sample reported at least one OBE during their lifetime. This is consistent with previous studies which have examined the occurrence of OBEs in university student populations (see Alvarado, 2000; for a review). None of our OBEers reported any medical history of seizure, of being diagnosed with epilepsy, or migraine (with or without aura). Despite this, the present findings clearly show that OBEers reported significantly more perceptual anomalies (as measured by the CAPS) relative to the nonOBEers. In addition to this, the revised LSHS also revealed that OBEers had a tendency to be more hallucinatory-prone (generally) compared to nonOBEers. The increased scores for both the CAPS and the revised LSHS suggest a relationship between the propensity to have anomalous sensory experiences and a bias towards hallucinatory proneness in general – at least for the OBEers sampled here. This is in line with the findings from previous studies examining anomalous perceptions in psychosis, schizophrenia and schizotypy which also observed a similar relationship (Bell et al., 2006, 2008; Bentall, 2004; McCreery & Claridge, 2002; Mohr et al., 2006; Easton et al., 2009). Importantly, although there was a small trend for OBEers to score higher on all CAPS subscales, only two of these subscales were reliable and noteworthy (discussed more fully below). None of the other subscales produced reliable or meaningful differences between the OBEers and nonOBEers. Such a finding suggests that certain factors may be more directly related to, and be more important for, the OBE relative to other factors. In addition, these findings suggest that the CAPS was well suited not only for examining anomalous sensations in the normal population, but also, crucial factors specifically pertaining to the OBE. These results considerably extend those of previous studies which have typically employed basic measures of schizotypy as a general indicator of propensity to report perceptual aberration (McCreery & Claridge, 1995, 2002; Mohr et al., 2006; Easton et al., 2009)

Based on the prior research reviewed in the Introduction, it was predicted that OBEers should show elevated scores specifically on dimensions of (i) temporal-lobe disturbances / instability, and (ii) body-based distortion experiences (which may reflect errors in proprioceptive integration). Both these predictions were confirmed. The nature of the perceptual anomalies reported by OBEers were largely limited to those items directed at measuring disturbances in temporal lobe function, and those related to a distortion in body processing. These particular findings are consistent with recent accounts positing that the OBE may occur due to a disturbance of multi-sensory integration in the temporal-parietal junction, and may underlie an impairment in the brains ability to constantly integrate multi-sensory information about the self, and ones own body in peripersonal space (Blanke et al., 2000; 2002; 2004; Blanke & Metzinger, 2009; Blanke & Thut, 2007; DeRidder et al., 2007; Mohr & Blanke, 2005; Mohr et al., 2006). The present findings are also consistent with accounts which have shown elevated signs of temporal-lobe disturbance in relation to general paranormal / mystical experience – though here we relate it specifically to the OBE in the psychologically normal population (cf. Neppe, 1983; Makarec & Persinger, 1987; Persinger, 1993, 1988; Persinger & Makarec, 1993; Persinger & Koren, 2001; see Persinger 2001).

Further to the pattern seen across the subscales, OBEers also showed significantly elevated measures of distress, distraction, and frequency for the reported experiences relevant to nonOBEers (see also Bell et al., 2008; for similar results within a schizophrenic sample). By far the largest statistical effect was that of the frequency with which anomalous perceptions occurred between the OBEer and nonOBEer group. The OBEers not only reported having more perceptually anomalous experiences, but also that they tend to have them more frequently. The finding that OBEers report increased levels of distress may appear to be at odds with the commonly reported view that OBEs themselves are typically reported as being pleasant (Alvarado, 2000; Blackmore, 1982; Irwin, 1985). However, it may not be the case that OBEers are being distressed specifically by the occurrence of their OBE per-se. Indeed, the individual items on both the CAPS and the revised LSHS suggest that OBEers may also be predisposed to a number of other associated experiential phenomena as well (perhaps as a function of diffuse temporal-lobe dysfunction). That is to say, the measures of distress, distraction and frequency, while elevated for the OBE group in general, might not directly relate to the OBE itself.

In addition to elevated scores on measures of temporal-lobe and body-distortion, the data provided in Table 2 seem to also suggest a significant effect for thought-echo experiences and a borderline (though non-significant) effect of sensory-flooding. However, we suggest that these two effects are most likely best explained as artefacts, based on the simple fact that these dimensions are practically at floor level in both groups. This means that even the slightest change in one group might manifest itself as an apparently significant difference – when in fact there are no meaningful differences here. This can be seen in Table 2 as the lowest scores for any dimension measured in the nonOBEer group were for thought-echo (0.24) and sensory-flooding (0.11). In real terms, only four participants from the nonOBEer replied 'yes' to an item on the sensory-flooding subscale, which compares to five people in the OBEer group (a difference of just one person). For thought-echo experiences, the same number of people (11) in both groups replied 'yes' to an item on this subscale. However, the OBEer groups provided an overall score of 13 compared to 11 from the nonOBEers. Moreover, both the sensory-flooding and thought-echo subscales of the CAPS are the only ones to have only two questions representing that subscale, thus potentially reducing their reliability. All other subscales have between three and six items contributing to their relative dimension. As a consequence, we are not convinced that these latter two effects reflect any real psychological differences between the groups and a closer look at the overall levels provided by both groups, and the difference necessary to produce a significant effect, supports this interpretation.

The findings from the CAPS measure also considerably challenge the notion that significantly elevated scores on measures of hallucination-proneness merely reflect a generic response bias in certain groups. This in turn can lead to some circularity in the underlying reasoning of what such measures show and how such findings can be used to guide theory. By this argument, the fact that hallucinatory-prone groups score higher on measures of hallucinatory-proneness (hence the circularity) is not that informative.

However, such concerns are more pertinent perhaps to measures like the LSHS rather than the multi-dimensional CAPS – which is a further reason for why the CAPS is an attractive tool for studies of this nature. While it was certainly the case that responses on the LSHS were significantly elevated for the OBE group (and on the vast majority of items on that measure) relative to the nonOBE group – only two dimensions (from a total of nine) on the CAPS were highly significant. As such, while generic response biases may well be present in hallucinatory groups (and indeed this is a central tenet of some accounts of hallucination: see Bentall, 1990; 2004) – the CAPS was capable here of selectively identifying components associated with propensity to report OBEs. Such selective findings cannot merely be explained by a sole generic response bias in the OBE sample. We return to these issues in the General Discussion.

Study 2:
Temporal-lobe / body distortion factors and performance at mental own-body transformation tasks

The findings from Study 1 are in line with accounts positing both an increased temporal-lobe dysfunction and body-based distortion experiences in OBEer groups. In a follow-up investigation, Study 2 here expanded on these novel findings by employing a behavioural task which measures participants abilities to carry out mental own-body transformations (cf. Blanke et al., 2005; Mohr et al., 2006). In contrast to previous studies we now investigate performance on this OBT task as a direct function of (i) whether or not participants had experienced a previous OBE or not, and in relation to (ii) high or low scores on a both the temporal-lobe instability and body-distortion processing subscales of the CAPS measure. .

Method

The general method followed that of Study 1 with the following exceptions. Firstly, the CAPS subscale measures for (i) temporal-lobe instability and (ii) body-distortion were employed as these were the only reliable subscales identified in Study 1. Secondly, all participants took part in the OBT manikin task outlined in previous studies (Blanke et al. 2005)

Participants

Thirty nine new participants took part in the study (none of these had taken part in Study 1). Thirty-two participants (82%) were female and 34 (87%) self-reported that they were right handed. None reported any personal medical history of seizure, epilepsy or were diagnosed with having migraine. All participants were undergraduate or postgraduate students (MSc / PhD) from the School of Psychology at the University of Birmingham, UK. Participants ranged in age from 19 – 28 years, with a mean average age of 21 years (OBE group mean age 19; nonOBE group mean age = 22). All received course credit or a small financial payment for taking part in the study.

Questionnaire measures

Each participant completed both the temporal-lobe and body-distortion subscales of the CAPS. (Bell et al., 2006). The order of presentation of these subscales was randomized across participants. The responses from both these subscales were pooled (summed) to provide a combined temporal-lobe / body-distortion score (TL-BDs). As each scale had four items contributing to it – the maximum possible pooled score was 8. This was used to carry out a median-split analysis to generate a new grouping factor (high / low TL-BDs) to complement the OBE versus nonOBE grouping.

Behavioural Task

All participants took part in a version of the own-body-transformation task (OBT: Blanke et al., 2005; Mohr et al., 2006).

Stimuli & Procedure

All stimuli were taken from previous studies testing mental own-body transformations (Blanke et al., 2005; see Figure 3). The manikin could be presented either facing toward the participant (with a different perspective to the participant) or facing away from the participant (sharing the same egocentric perspective as the participant). Front-facing and Away-facing figures were drawn in a black font presented on a white background. Both Front and Away-facing figures had the same general outline and differed only in that the clothing of the schematic figure (which contained added cues to signify whether to figure was facing forward or away) and the presence of a face (Facing) or the back of a head (Away).The figure wore a distinctive gray glove and black bracelet which could occur on either the right or left hand (See Figure 3).

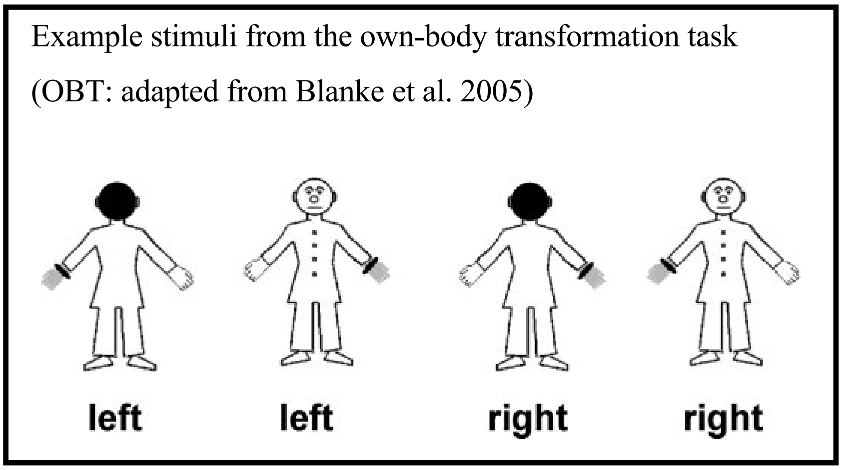

Figure 3. An illustration of the OBT stimuli employed in Study 2 (adapted from Blanke et al. 2005). The correct responses are given below each figure.

The experiment was programmed in E-prime© software v1.2 (Psychology Software Tools) and run on a Pentium PC fitted with a 17-inch Samsung SyncMaster monitor. The stimuli were presented centrally and viewed at an unfixed but general distance of 60cm. Each trial began with the presentation of a black central fixation cross on a white background. The fixation cross was presented for 1000ms and then followed by the presentation of the schematic manikin which remained on the screen until response or 5000ms had elapsed. There was an inter-stimulus interval of 1000ms between trials. There were four exemplars of the manikin (see Figure 3). One block of trials was the ‘baseline’ condition where, following the protocol of

Blanke et al. (2005), participants were instructed to respond to what visual field (LVF – up-arrow / RVF – down-arrow) the distinctive glove was in as they viewed the computer screen (from their own perspective). This lateralization version of the task employed the identical stimuli, but participants indicated which visual-field contained the distinctive glove / bracelet. This condition did not involve an imagined change in own-body position or visuospatial perspective[3]. This was also to ensure that participants had no general problems in making left / right judgements. In the crucial 'experimental' block the instructions changed and now participants were told they had to imagine themselves to be in the figures body position and to adopt the appropriate perspective of the figure. The task now required participants to respond to whether the glove / bracelet were on the left hand (up-arrow keyboard response) or right hand (down-arrow keyboard response) of the figure. Both blocks consisted of 96 trials (24 trials per manikin for each block). The order of the blocks was randomised across participants and trial type (Facing / Away) within each block was also fully randomised. The experiment began with a separate block of 36 practice trials which were not analysed. Participants were instructed to respond as fast and as accurately as they could. The experiment lasted about 45mins (including the administration of the questionnaire). The questionnaire was always completed after the OBT task.

Results:

Questionnaire responses

Of the forty participants who took part in this study, twelve of these (30%) claimed to have experienced at least one out-of-body experience at some point in their life. One of these OBEers was removed as the experience occurred under anesthetic during a dental operation and

[3] Blanke et al (2005) also note that running this condition as a comparison also helps to identify and dissociate the central mechanisms of the OBT from those associated with the mere perception of the human body (as well as assessing the participants ability to make effective left / right decisions).

thus did not satisfy our pre-screen restrictions of 'spontaneous' OBEs occurring in the absence of drugs / anesthesia etc. . The analysis was based on the remaining eleven OBEers (28%) and 28 nonOBEErs. Of the OBEer group, four (36%) claimed to have experienced more than one vivid OBE and five (45%) reported seeing a representation of their physical self during the OBE. The average TL-BD score for the combined sample was 2.74 (SD=2.05). For the OBEers the average of the TL-BD scores was 4.36 (SD=1.91) relative to a score of 2.11 (SD = 1.75) for the nonOBEers. This difference was significant (Mann-Whitney U = 60.00, z = 2.97, p<.004). The highest TL-BD score from both groups was the same – at a score of 6 (from a possible maximum of 8). However, only one nonOBEer provided this score in comparison to four separate OBEers providing the same result. These findings replicate those from Study 1 in that OBEers display significantly elevated signs of both temporal-lobe disturbances and body-distortion experiences relative to nonOBEers.

Table 4. The experiential context and state of the OBEer, whether they saw an image of themselves during their OBE(s), the number of OBEs they have experienced, and combined temporal-lobe and body distortion scores (TL-BD) from Study 2.

OBEer	Context / state	Vision of self	No of OBEs	Comb TL-BD score
1	Borderline sleep	Yes	More than one	3
2	Borderline sleep	Yes	One	5
3	Borderline sleep	No	One	1
4	Relaxed / resting	No	More than one	6
5	Relaxed / resting	Yes	One	6
6	Borderline sleep	No	More than one	5
7	Relaxed / resting	Yes	One	5
8	Borderline sleep	No	One	4
9	Borderline sleep	Yes	One	1
10	Borderline sleep	No	More than one	6
11	Relaxed / resting	No	One	6

Results:

Behavioural OBT task

Reaction times (RTs) faster than 200ms, more than 2.5 standard deviations above the mean, time-outs (trials not responded to within 5000ms), and incorrect responses were all removed from the analysis. The analysis was carried out on the remaining mean correct RTs. Any participant generating more than 15% errors in any one cell was considered too error prone and removed from the sample.

Participants took longer to perform the OBT task (974ms; SD = 276ms) than the visual-field lateralization baseline task (535ms; SD = 96ms). This difference was significant, $F(1, 38) = 94.286$, $p<.001$ with the lateralization task being significantly faster than the OBT task. For the main OBT task the overall RT performance (collapsed across perspectives) for the OBEers was 996ms (SD = 301ms) relative to 965ms (SD = 272ms) for the nonOBEers. For both groups, trials which contained a ‘Facing’ perspective were slower relative to those containing an ‘Away’ perspective. This difference was much larger for OBEers (236ms; SD=166ms) relative to nonOBEers (73ms: SD = 119ms; see Figure 4). A 2x2 (Group: OBEer / nonOBEer) x Perspective (Facing / Away) mixed ANOVA revealed a significant main effect of Perspective $F(1, 37) = 42.341$, $p<.001$. Facing figures were significantly slower than ‘Away’ figures. There was a significant interaction between Perspective and Group, $F(1, 37) = 11.758$, $p<.003$. OBEers were significantly slower, relative to the nonOBEers, at responding to Facing relative to Away trials. The main effect of Group was not significant, $F(1, 37) = .098$, $p=.756$. Interestingly, Figure 4 suggests that the failure to find a significant effect of Group may be due, in part, to the large interaction effect itself and that this interaction appears to reflect opposite effects across the groups from Facing and Away perspectives. OBEers showed an RT cost for processing ‘Facing’ figures and a slight benefit for processing ‘Away’ figures relative to the nonOBEer controls.

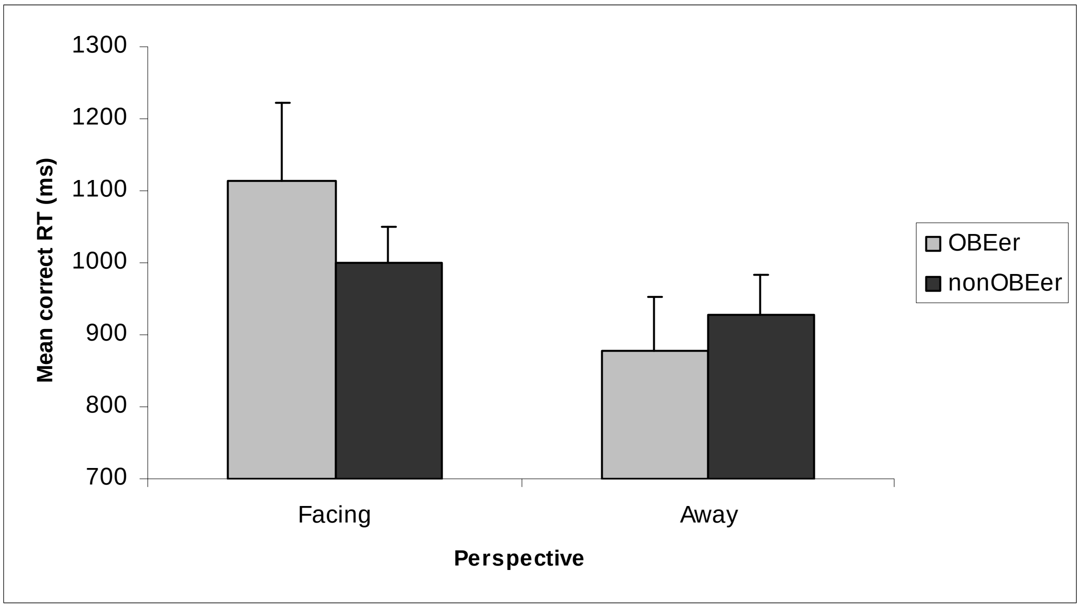

Figure 4. Mean correct RTs (in ms) plotted for both 'Facing' and 'Away' perspective trials across both OBEer and nonOBEer groups (error bars = 1 SE).

We repeated the above analysis but now generated two groups based on a median-spilt procedure to create both a low scoring TL-BD (N=28) and high scoring TL-BD (N = 11) group as the between-subjects factor. This procedure led to four OBEers to be classed in the low TL-BD group and four nonOBEers to be classed in the high TL-BD group. So although this grouping factor did not alter the relative size of the groups, a number of participants were now assigned to different groups on the specific basis of their questionnaire responses alone. For the OBT task the overall RT performance (collapsed across perspectives) for the high TL-BD group was 1044ms (SD = 344ms) relative to 946ms (SD = 247ms) for the Low TL-BD group. For both groups, trials which contained a 'Facing' perspective were slower relative to those containing an 'Away' perspective and this difference was much larger for the high TL-BDs group (197ms; SD = 169ms) relative to low TLBDs group (88ms: SD= 135ms; see Figure 5).

A 2x2 (Group: High TLBDs / Low TLBDs) x Perspective (Facing / Away) mixed ANOVA revealed a significant main effect of Perspective $F(1, 37) = 30.612$, $p<.001$; and a significant interaction between Perspective and Group, $F(1, 37) = 4.399$, $p<.05$. The main effect of Group was not significant, F(1, 37) = .981, p=.328. Again, reaction times for 'Facing' trials were still significantly slowed relative to 'Away' trials. In addition, this difference was greater for the high TL-BD group with this group showing significantly slowed RTs relative to the low TL-BD group specifically for 'Facing' figures (though the effect is smaller in this comparison: see Figure 5).

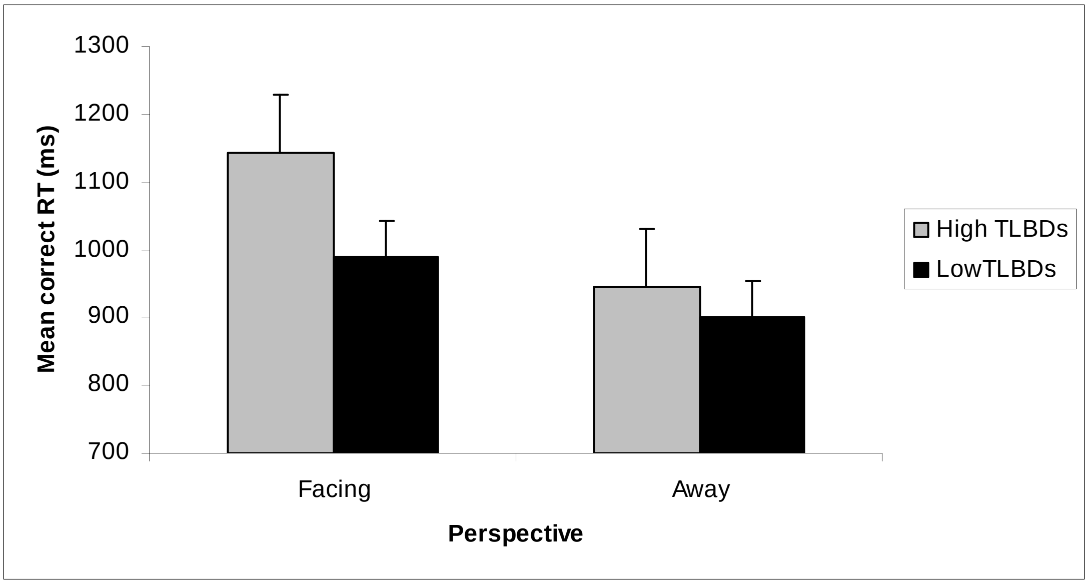

Figure 5. Mean correct RTs (in ms) plotted for both 'Facing' and 'Away' perspective trials across both high TLBDs and low TLBDs groups (error bars = 1 SE).

Errors OBT task

For the lateralization baseline task the overall proportion correct was 98% (SD=1.07%). The overall proportion correct responses for the OBT task was 93% (SD = 3.05%). Responses for the lateralization task were significantly more accurate relative to the OBT task, F(1, 38) = 91.44, p<.001. This follows the pattern described earlier for RTs and suggests that performance for the lateralization task is both faster and more accurate relative to the OBT task.

Accuracy at the OBT task for OBEers was 93.0% (SD = 3.31%) and for nonOBEers it was, 92.5% (SD = 2.98%). The Error analyses for the OBT task followed that of the RT analysis described above. For the OBEer versus nonOBEer grouping, only the main effect of

Perspective approached significance, $F(1, 37) = 3.240$, $p=.08$, with a trend for fewer correct responses for Facing trials relative to Away trials. This is in line with the pattern seen for reaction times. All other differences (main effects and interactions) between the groups were not reliable {all Fs< 2 all Ps>.210}. As such, there was no evidence of a speed-accuracy trade off (see Table 5).

Table 5. Proportion correct (as a percentage) for the OBT task as a function of group.

Group	Facing	Away
NonOBEer	92.3	93.3
OBEer	92.1	94.3
Low TLBDs	92.3	94.0
High TLBDs	92.0	93.0

Discussion

The results from study 2 are clear. Firstly, OBEers scored significantly higher on CAPS measures of combined temporal-lobe disturbance and body distortion processing. This is consistent with the findings from Study 1 and suggests that such results are a robust indicator of important differences between these groups. Secondly, OBEers were significantly slower than the nonOBEer controls at carrying out mental own-body transformations for stimuli that did not share the same perspective as themselves (i.e., Facing stimuli). A similar pattern emerged when the sample was divided up in terms of their high / low scores on the CAPS subscales. These findings are both novel and noteworthy.

To our knowledge, this is the first study to show that psychologically normal individuals who provide elevated scores on a non-clinical measure of anomalous perception are selectively slowed at mental own-body transformations. These findings mesh well with and considerably extend those from previous studies which have investigated case studies of epileptic patients and / or employed clinically inspired measures of perceptual aberration and schizotypy in the normal population (cf. Blanke et al., 2000; 2002; 2004; 2005; Easton et al., 2009; Mohr et al., 2006). In addition, the current behavioural findings considerably extend those of Study 1 and provide further support that questionnaire measures like the CAPS are capable of indexing, at least in part; underlying differences in certain forms of cognitive processing associated with OBEs and kindred hallucinations of the self. The present findings are consistent with the notion suggesting that the OBEers are a selective subgroup of the population who may display a bias or disturbance in temporal-lobe function, the representation and transformation of ones own body, and multi-sensory integration processes – all of which are thought to contribute to feelings of embodiment and a sense of 'self' (Blanke et al., 2000; 2002; 2004; Blanke & Metzinger, 2009; Blanke & Thut, 2007; DeRidder et al., 2007; Makarec & Persinger, 1987; Mohr & Blanke, 2005; Mohr et al., 2006; Persinger, 1993, 1988; Persinger & Makarec, 1993; Persinger & Koren, 2001; see Persinger 2001).

General Discussion

The present study reports the first empirical investigation of the cognitive correlates of the OBE in the psychologically normal population, as assessed by the recently devised Cardiff Anomalous Perception Scale (CAPS: Bell et al., 2006). An additional standard measure of hallucination proneness (the revised LSHS) was also employed. Study 1 showed that despite the OBEers having no known history of epilepsy, seizure or migraine, they reported significantly more perceptual anomalies (as measured by the CAPS) relative to the nonOBEers. In addition to this, the revised LSHS also revealed that OBEers had a tendency to be more hallucinatory-prone (generally) compared to nonOBEers. This is in line with the findings from previous studies examining anomalous perceptions in psychosis, schizophrenia and schizotypy (Bell et al., 2006, 2008; Bentall, 2004; McCreery & Claridge, 2002; Mohr et al., 2006; Easton et al., 2009). Study 1 is also the first study to our knowledge that OBEers (specifically) do provide reliably elevated scores on questionnaire measures of both temporal-lobe instability and body-distortion experiences / processing – while other measures of sensory anomalies remained statistically indistinguishable from the nonOBEer baseline group.

A central prediction of the present study was that OBEers should provide elevated scores specifically on dimensions of (i) temporal-lobe disturbances / instability, and (ii) body-based distortion experiences and both these predictions were confirmed in Study 1. This is consistent with a growing body of evidence positing that the OBE occurs due to, at least in part, a disturbance in temporal-lobe processing which may in turn underlie impairments in multi-sensory integration crucial for the constant processing of embodiment and the 'self '(Blanke et al., 2000; 2002; 2004; Blanke & Metzinger, 2009; Blanke & Thut, 2007; DeRidder et al., 2007; Mohr & Blanke, 2005; Mohr et al., 2006) and like other forms of aura and instances of anomalous cognition is associated with elevated signs of temporal-lobe disturbance (Neppe, 1983; Makarec & Persinger, 1987; Persinger, 1993, 1988; Persinger & Makarec, 1993; Persinger & Koren, 2001; see Persinger 2001).

As noted earlier, the findings from the CAPS measure also considerably challenge the notion that significantly elevated scores on measures of hallucination-proneness merely reflect a generic response bias in certain groups. This in turn can lead to some circularity in the underlying reasoning of what such measures show and how such findings can be used to guide theory. According to this argument, it is an important though somewhat circular position to demonstrate that hallucinatory-prone groups score higher on measures of hallucinatory-proneness. As a consequence, such demonstrations might not be that informative. This argument could certainly be directed towards questionnaire measures which provide a basic measure of ‘proneness’ in one group relative to the other and in the present context this could be applied to some degree to the findings from the revised LSHS. However, such basic notions of a response bias are not convincing arguments against measures that are more multi-dimensional in nature and show selective effects on only some of those select dimensions. In terms of the present study, while it was certainly the case that responses on the LSHS were significantly elevated for the OBE group (and on the vast majority of items on that measure) relative to the nonOBE group – only two dimensions (from a total of nine) on the CAPS were highly significant. As such, while response biases may well be present in hallucinatory groups (and indeed this is a central tenet of some accounts of hallucination: see Bentall, 1990; 2004) – the CAPS was capable here of selectively identifying the prime factors associated with propensity to report OBEs. As such, the present findings cannot merely be satisfactorily explained by a sole generic response bias in the OBE sample as arguably this should impact across subscales to a comparable magnitude or at least to a level reliably distinguishable to the nonOBEers. Instead, we suggest the present findings show that certain perceptual anomalies which are known to be associated with temporal-lobe disturbances and biases in body representation appear more prevalent in OBEers. This appears not to be a coincidence.

The findings from Study 2 show that OBEers and participants with high combined scores on the temporal-lobe / body-distortion subscales of the CAPS were significantly impaired, relative to controls, at carrying out mental own-body transformations for stimuli that did not share the same perspective as themselves. These findings are consistent with the notion that OBEers display a bias or disturbance in temporal-lobe function and / or body-based representations that are typically involved in processing a coherent sense of embodiment and sense of ‘self’ (see Blanke & Metzinger, 2009; and Persinger 2001; for reviews).

Finally, it is also important to note that these findings complement and extend those reported in Study 1 and the presence of significant interactions between perspective and group (both OBE and TL-BD scores) go against the notion that the present findings can be explained as a simple response bias from hallucinatory prone individuals.

Temporal-lobe instability, body-distortion and multi-sensory integration.

The present findings from psychologically normal individuals are consistent with prior studies of temporal-lobe epileptics and those showing a relationship between temporal-lobe signs and more general anomalous experiences in the normal population (Blanke et al., 2000; 2002; 2004; Mohr & Blanke, 2005; Makarec & Persinger, 1987; Neppe, 1983; Persinger, 1993, 1988; Persinger & Makarec, 1993; see Persinger 2001). Elevated scores on measures of body-distortion for the OBE group are also consistent with studies suggesting that OBEs may be related to disturbances in multi-sensory integration processes that are crucial for supporting the concept of embodiment and the 'self' (see Blanke & Metzinger, 2008; Blanke & Thut, 2007; Mohr & Blanke, 2005). However, the current findings now considerable extend this notion to the incidence of OBEs specifically, occurring in the psychologically normal population. As a consequence, the present study helps to bridge the explanatory gap between the comparative models of patient studies and those of normal populations. In addition, the present findings are based on a recently devised parametric measure (i.e., the CAPS) which is somewhat liberated from the language and concepts of psychiatry / schizoptypy. Importantly, the finding that only a minority of the subscales produced significant differences between the groups suggest that the underlying cognitive processes associated specifically with the propensity to experience an OBE are not wide and varied – at least as measured here by the CAPS.

In addition, it is important to point out that the presence of temporal-lobe disturbance and body-distortion may not be functionally unrelated. For example, if the increased signs of neural instability occur in brain regions which support body processing, proprioceptive feedback, multi-sensory integration, and the mechanisms crucial for the processing of embodiment – then these mechanisms may suffer transient impairments, which may themselves trigger OBEs and / or be responsible for the phenomenological content of them. This is in line with recent behavioural and neuropsychological evidence which also implicates the temporal-parietal junction as being important for multi-sensory integration (Blanke et al., 2002; 2004; Blanke & Thut, 2007; Mohr & Blanke, 2005; Mohr et al., 2006). The behavioural findings from Study 2 also support this idea. Findings from Study 2 showed that OBEers, and those that scored high on measures of temporal-lobe instability and body-distortion processing are impaired at carrying out own-body transformations when the perspective of the manikin differs from that of the observer. Although previous research has shown similar findings for an epileptic case study (Blanke et al., 2005) and individuals which produce elevate scores on measures of schizotypy (Easton et al., 2009; Mohr et al., 2006), the present findings now extend this to OBEers specifically, and individuals grouped on the basis of non-clinical predisposition to anomalous perceptions.

Limitations & future research

The current study demonstrates that the CAPS, as a measure of anomalous perceptions in the normal population, is well suited for use with investigating OBE samples. Indeed, the CAPS may be more helpful than previous measures which have been typically cast within the context and language of clinical / psychiatric frameworks (Bell et al., 2006). To our view, assessing predisposition to anomalous perception in the normal population via a measure specifically designed for the normal population (as opposed to relying on measures and assumptions of schizotypy etc) is an important development. However, there are some limitations worth noting. Although the present study provides validated questionnaire evidence for specific factors (i.e., temporal-lobe instability / body-distortion processing) being associated with the occurrence of the OBE – questionnaire measures are perhaps not the most direct demonstrations of underlying anomalies in neural function. As such, the intermediate link between specific forms of anomalous experience and underlying signs of temporal lobe instability would be empirical demonstrations of anomalies in the underlying neurophysiology. Modern methods in exploring the time-varying properties of quantatitative electroencephalography (QEEG), measured over prolonged periods of time, could offer the potential to reveal either (i) constant though subtle anomalies that are prevalent in the general background EEG of OBEers, or (ii) more transient and fleeting anomalies akin to microseizures that, for whatever reason, do not propagate through enough neural landscape, with enough intensity, to present themselves as fully apparent seizure. Nonetheless, such microseizures may well be sufficient to destabilize or at least temporarily challenge the current internal mental model of coherent embodiment.

As noted in the Introduction, Persinger and colleagues have entertained the notion of microseizures (i.e., seizure in the absence of epilepsy) underlying instances of anomalous cognition in the normal population and have recruited some EEG and questionnaire evidence in support of their contention (Makarec & Persinger, 1985; 1987; 1990; Persinger, 2001; Persinger & Makarec, 1987; 1993). Although this work has not received the attention it perhaps deserves – developments in modern techniques coupled to the advancements in statistical analyses may now prove to be revealing and it may well be appropriate to revisit these issues. However, it should be noted that it is currently unclear how to statistically define such anomalies in the EEG profiles of psychologically normal individuals. Nevertheless, the potential of this area of research is fast becoming a tantalizing possibility.

An additional interesting aspect for further investigation would be to investigate differences in processing between OBEers that report seeing visual representations of themselves in the hallucination relative to those that do not. This has been suggested previously as being an important aspect of the experience – though it has received little empirical investigation (see Cheyne & Girard, 2009; Gabbard & Twemlow, 1984; Murray & Fox, 2005; Terhune, 2009; for a similar discussion). Evidence from Study 1 here suggests marginally increased scores on measures of body distortion (see Table 3) for those that do see representations of themselves relative to those that do not which is nothing if not suggestive (a mean score of 2.33 relative to a score of 1.81 respectively). In addition, it would also seem important to further explore those individuals that report having multiple or even regular OBEs to those who only report having one or a few. One prediction might be that the former group would show increased signs of temporal-lobe disturbance relative to the latter. Again, tentative suggestions from Study 1 show a small bias in this expected direction (3.0 for those who report multiple OBEs compared to a score of 2.85 for those who reported only one OBE) – though such differences here are very small and caution should be expressed with their interpretation. Low numbers of these sub divisions within the OBE group leading to low power, and the high variability within the groups, are two factors that prevent a formal assessment of these issues here (even via a single case methodology: see Crawford & Howell, 1998). In addition, such differences were not part of our original investigation and thus lie outside the scope of the current study (though they remain fascinating possibilities for future research).

Conclusion

The present study is the first to employ a recently devised measure of perceptual anomalies to investigate spontaneous OBEs occurring in the psychologically normal population. The use of the CAPS questionnaire is unique in this regard as all previous investigations have employed measures which employ the assumptions and language of clinical psychiatry – which might not always be appropriate for use on normal populations. As instances of anomalous cognition in the psychologically normal population become more generally recognised and accepted – the need for such measures increases greatly. The present findings show that OBEers display elevated signs of temporal-lobe instability and provide increased scores on measures of body-distortion. Such selective effects on only certain subscales cannot be explained merely by the present of a response bias from hallucinatory prone individuals. In addition, OBEers also showed a selective impairment for carrying out a mental own-body transformation task – when the stimuli did not share the same perspective as the observer. Collectively these results are consistent with the notion that OBEers may display an impairment in temporal-lobe function and the processes underlying perspective-taking and multi-sensory integration which may, in turn, be important factors for predisposition to temporary breakdowns in embodiment and hallucinations of the self.

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