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# The body unbound: Vestibular–motor hallucinations and out-of-body experiences

J. Allan Cheyne<sup>a,\*</sup> and Todd A. Girard<sup>b,c</sup>

<sup>a</sup>Department of Psychology, University of Waterloo, Waterloo, ON, N2L 3G1, Canada

<sup>b</sup>Department of Psychology, Ryerson University, Toronto, ON, M5B 2K3, Canada

<sup>c</sup>Centre for Addiction and Mental Health, Toronto, ON, M5T 1R8, Canada

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## ABSTRACT

Among the varied hallucinations associated with sleep paralysis (SP), out-of-body experiences (OBEs) and vestibular–motor (V–M) sensations represent a distinct factor. Recent studies of direct stimulation of vestibular cortex report a virtually identical set of bodily-self hallucinations. Both programs of research agree on numerous details of OBEs and V–M experiences and suggest similar hypotheses concerning their association. In the present study, self-report data from two on-line surveys of SP-related experiences were employed to assess hypotheses concerning the causal structure of relations among V–M experiences and OBEs during SP episodes. The results complement neurophysiological evidence and are consistent with the hypothesis that OBEs represent a breakdown in the normal binding of bodily-self sensations and suggest that out-of-body feelings (OBFs) are consequences of anomalous V–M experiences and precursors to a particular form of autoscopic experience, out-of-body autoscopia (OBA). An additional finding was that vestibular and motor experiences make relatively independent contributions to OBE variance. Although OBEs are superficially consistent with universal dualistic and supernatural intuitions about the nature of the soul and its relation to the body, recent research increasingly offers plausible alternative naturalistic explanations of the relevant phenomenology.

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## 1. Introduction

Sleep paralysis (SP) refers to a brief period at sleep onset or offset during which a person is unable to move or speak while remaining awake and aware of the immediate environment (ICSD, 2001; Hishikawa, 1976). Consistent with the hypothesis that SP represents an intrusion of a rapid eye movement (REM) state into waking consciousness caused by defective coordination of sleep–wake and REM–nonREM transitions (e.g., Hishikawa and Shimizu, 1995), polysomnographic studies report

mixed REM and waking electroencephalographic components during SP episodes (Takeuchi et al., 1992). SP is widely reported in the general population (Arikawa et al., 1999; Awadalla et al., 2004; Cheyne et al., 1999a, 1999b; Fukuda et al., 1998; Kotorii et al., 2001; Ohayon et al., 1999; Spanos et al., 1995) and is frequently accompanied by diverse and often vivid hallucinations (e.g., Hishikawa, 1976; Hufford, 1982). SP-related hallucinations are likely important contributors to a variety of paranormal beliefs and supernatural traditions (Hufford, 1982; French and Santomauro, 2007).

\* Corresponding author. Department of Psychology, University of Waterloo, 200 University Avenue, Waterloo, Ontario, N2L 3G1, Canada.  
E-mail address: [acheyne@watarts.uwaterloo.ca](mailto:acheyne@watarts.uwaterloo.ca) (J.A. Cheyne).

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In a series of studies, we have found that SP-related experiences can be reliably sorted into three factors (Cheyne, 2003, 2005; Cheyne et al., 1999b; Cheyne and Girard, 2004, 2007a). One factor consists of a feeling of an unseen “felt presence” (FP) nearby, along with visual, auditory, and tactile hallucinations. When sufficiently elaborated these are frequently interpreted as evidence of a threatening intruder and hence we have labeled this factor “intruder.” A second factor comprises breathing difficulties, feelings of suffocation or choking, pressure on the chest or other body parts, pain, and thoughts of immanent death. The foregoing experiences form the *incubus* factor and, when sufficiently elaborate, are interpreted as physical and sometimes sexual assault. Intruder and incubus factors are positively correlated with one another as well as with intense fear and may combine to produce nightmare scenarios of threat leading to physical and sexual assault. Intruder and Incubus experiences have received some theoretical attention regarding their possible origin in REM activation of the extended amygdala and associative sensory cortex (Cheyne, 2003, 2005; Cheyne et al., 1999b; Cheyne and Girard, 2007a, 2007b; Fukuda, 2005; Simard and Nielsen, 2005) or of social imagery (Nielsen, 2007; Solomonova et al., 2008).

### 1.1. V–M hallucinations during SP

The third factor, and focus of the present study, comprises a distinctive set of experiences that include a variety of illusory (bodily-self) movement experiences (IMEs) as well as out-of-body experiences (OBEs). IMEs encompass vestibular experiences (floating, flying, falling, spinning, and elevator sensations) and motor hallucinations (illusory limb movement, sitting, standing, and locomotion). An OBE conventionally refers to (1) a feeling of separation from one’s body and (2) viewing one’s own body (i.e., autoscopia) from an outside, (3) typically elevated, viewing station (Blackmore, 1982; Blanke and Arzy, 2005; Blanke et al., 2004; Blanke and Mohr, 2005; Denning and Berrios, 1994; Devinsky et al., 1989; Green, 1968), the core of which is the “feeling of spatial separation of the observing self from the body” (Brugger, 2002). It remains a plausible empirical question, however, whether people sometimes (1) experience feelings of separateness from, or taking leave of, their corporeal bodies (disembodiment) without ever seeing their bodies from an external viewing station (cf. “depersonalization” in Devinsky et al., 1989); (2) see what they take to be their own body as seen from an external viewing station, without feelings of leaving, or separation from, their corporeal bodies or; (3) experience both. Hence, we formally distinguish between (1) out-of-body *feelings* (OBFs) being based on bodily sensations and (2) out-of-body *autoscopia* (OBA) based on visual perspective as subtypes of OBEs during SP. Our previous research supports the general hypothesis that both subtypes of OBEs are, in the context of SP, closely associated with one another and with IMEs (Cheyne, 2003, 2005; Cheyne et al., 1999b; Cheyne and Girard, 2007a).

It is notable that many of the references cited for OBEs in the literature are to parapsychology journals. Interestingly, accounts of paranormal “astral travels” often describe contexts and experiences suggestive of SP episodes. That is,

individuals claiming the ability to intentionally leave their bodies and visit remote locations often report techniques that involve lying quietly in a supine position, typically during transitions between waking and sleeping, as well as during “dream control” (e.g., Fox, 1962; Monroe, 1971; Muldoon and Carrington, 1969; Taylor, 2000). Oliver Fox describes one of his techniques as a method “to send the *body* to sleep while the *mind* is kept *awake*” (Fox, 1962; italics in original). Moreover, such adepts frequently mention feelings of paralysis preceding or accompanying OBEs (Fox, 1962; Monroe, 1971; Muldoon and Carrington, 1969; Taylor, 2000).

Whereas intruder and incubus factors focus on a frightening and alien other, V–M experiences are clearly focused on one’s own body. We have hypothesized that the latter experiences result from false and conflicting interoceptive information about the position, attitude, and motion of one’s body or body parts and, specifically, that OBFs and OBA arise as consequences of salient V–M sensations that conflict with one another or with associated background somatosensory sources of information or their absence (Cheyne, 2003; Cheyne et al., 1999b). Neuroimaging studies of REM states report decreases in regional cerebral blood flow (rCBF) in parietal (e.g., angular gyrus) and prefrontal cortex (Braun et al., 1997; Maquet et al., 1996), sites long associated with body schemes and vestibular functioning (e.g., Adrian, 1947; Head and Holmes, 1911; Lobel et al., 1998). Consistent with the results of these studies and with Melzack’s notion of a *neuromatrix* (Berlucchi and Aglioti, 1997; Melzack, 1990, 1992, 1999), OBEs may, in common with phantom-limb experiences, reflect a failure of integration or binding of tactile, proprioceptive, vestibular, motor, and visual experiences of the bodily-self, likely implicating relevant regions within parietal, temporal, and frontal cortices (Cheyne, 2003; Cheyne and Girard, 2007b; for a parallel argument for Doppelgänger experiences see Brugger et al., 1997). The neuromatrix is postulated to be a widely distributed neo-Hebbian cell assembly including thalamic, somatosensory, limbic, and parietal areas. In essence, we argue that OBEs represent a failure of the neurosignature, the pattern of activation of the neuromatrix that signals that the body is intact.

### 1.2. Parallels between induced and SP-related experiences

Direct cortical stimulation via subdural electrodes elicit patient reports of vestibular sensations of rolling, falling, and sliding (Blanke et al., 2000), and OBEs (Blanke et al., 2002), as well as the experience of an illusory “shadow” body (Arzy et al., 2006a). Cortical sites producing these effects include areas around the temporo-parietal junction (TPJ), the angular gyrus, and the junction of the intraparietal sulcus and postcentral gyrus (Blanke and Thut, 2007). Consistent with these effects, temporal and parietal lobe lesions are frequently implicated in OBEs of apparent neurological origin (Blanke et al., 2002, 2004; Brugger et al., 1997; Denning and Berrios, 1994; Devinsky et al., 1989; Grüsser and Landis, 1991; Hécaen and Ajuriaguerra, 1952; Lunn, 1970; Todd and Dewhurst, 1955). Consistent with such observations, it has been argued in these contexts as well that OBEs reflect a failure to integrate vestibular, proprioceptive, tactile, and visual information

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