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

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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 *autoscopy* (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.

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).

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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 amygdalar 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., autoscopy) from an outside, (3) typically elevated, viewing station (Blackmore, 1982; Blanke and Arzy, 2005; Blanke et al., 2004; Blanke and Mohr, 2005; Dening 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 *autoscopy* (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; Dening 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 relevant to the body (Blanke and Arzy, 2005; Blanke et al., 2004, 2005; Overney et al., this issue, 2009).

The parallels between stimulation-induced vestibular sensations and many hallucinations during SP are quite striking. In studies of induced experiences, OBEs have been accompanied or preceded by floating, flying, falling, or rolling (Blanke et al., 2000, 2002, 2004) consistent with the reliable associations among vestibular sensations during SP that include floating, flying, falling, spinning, and elevator sensations with OBEs (Cheyne, 2003, 2005; Cheyne and Girard, 2004, 2007a; Cheyne et al., 1999b).

Interestingly, apparent excursion distances from initial positions also appear to be very similar in the two contexts. Blanke et al. (2002, 2004) report distances of two to three meters for two patients and somewhat greater distances for a third patient. In comparison, the average distance for both simple floating and for OBEs in a large SP sample was approximately two meters, though some were beyond the room (Cheyne and Girard, 2004; Girard et al., 2007). Also of interest, given that SP hallucinations typically occur in the supine position (Cheyne, 2002; Dahmen and Kasten, 2001; Dahmen et al., 2002; Fukuda et al., 1998), Blanke et al. (2004) reported that all three neurological patients reporting OBEs were in the supine position whereas other forms of autoscopic phenomena not associated with OBEs were more likely to be experienced in sitting or standing positions (Blanke and Mohr, 2005).

It is rather clear that SP and neurological studies are discussing the same set of experiences. Of course, even when the types of hallucinations are superficially highly similar they can have diverse neurophysiological concomitants (Brugger et al., 1996). Nonetheless, these striking similarities in the phenomena reported and the independent implication of parietal involvement seem worth pursuing.

2. Hypotheses

The relatively common occurrence of the V–M experiences in the general population affords an opportunity to assess their structural relations employing large samples. Although there have been many studies of OBEs in non-clinical samples (for reviews see: Alvarado, 2000; Blackmore, 1982; Gabbard and Twemlow, 1984; Green, 1968; Irwin, 1985), they tend to represent disparate contexts and reporting methods. Moreover, they often neither probe for specific experiences nor provide a common metric of intensity or vividness of the experiences. In the present study all experiences reported occurred in a common context of SP and we employed a common metric for rating intensity/vividness across experiences enabling us to use relatively powerful parametric analytic tools to test hypotheses.

Based on the foregoing empirical and theoretical observations, three plausible hypotheses about the associations among IMEs, OBFs, and OBA seem worthy of consideration. One possibility is that when anomalous IMEs occur and as they increase in intensity they (1) give rise to feelings of disembodiment (OBFs) and (2) the resulting feelings of separateness then create the conditions for visual corroboration via OBA (see Fig. 1). That is, OBFs mediate the association between IMEs and OBA. The first part of this hypothesis is consistent with the findings of induction studies (Blanke et al., 2002), in which less intense stimulation produced IMEs and higher intensities produced OBEs, as well as with conceptual and neurological arguments relating vestibular and proprioceptive activity to OBEs (Blanke et al., 2002, 2004; Brugger et al., 1996). The second part is consistent with the claim of Devinsky et al. (1989) that "nonvisual depersonalization phenomena are transition states preceding autoscopy" (p. 1080). This seems to us to be the strongest candidate hypothesis to explain the associations within the V–M factor.

It is also possible, however, that the order of OBA and OBFs might be reversed. For example, Blanke and colleagues (Blanke et al., 2002) report observations consistent with an OBA preceding OBFs during their induction study. Initial stimulations ($n = 3$, 2.0–3.0 mA, right angular g.) induced vestibular responses. The patient reported "sinking into the bed" and "falling from a height." Increasing stimulation amplitude to 3.5 mA produced OBA, "I see myself lying in bed, from above, but I only see my legs and lower trunk." It appears that the patient might have initially experienced an OBA without OBFs, which were, however, present during subsequent experiences.

A third hypothesis is that increasing intensity of IMEs directly produces both OBFs and OBA as simultaneous and parallel consequences. Here, the association of OBFs and OBA is explained by their common cause, IMEs.

A fourth hypothesis states that it is the interaction between IMEs and OBA that produces the feeling of disembodiment. That is, simultaneous and parallel disruption of bodily-self processing and activation of body and body-part imagery might combine in an overadditive fashion to produce OBFs. This hypothesis is consistent with recent speculations regarding the joint roles of TPJ and the extrastriate body area (EBA) as the neural basis for embodiment (Arzy et al., 2005, 2006b). The second part of this hypothesis might also be seen to be consistent with the notion of "visual capture" in which visual information influences felt body-part location and/or movement (Botvinick and Cohen, 1998; Hay et al., 1965; Neilson, 1963; Ramachandran et al., 1995). Given our major hypothesis that it is the OBF that leads to the OBA, we also tested the interaction of IMEs and OBFs as giving rise to OBA.

Next we test a pair of related hypotheses implicating FP, a core feature of intruder hallucinations (Cheyne and Girard, 2007a, 2007b). The first of the pair was proposed by Frith (2004) and incorporates a causal role for FP experiences. More specifically, the Frith hypothesis predicts that the combination of FP and OBA give rise to OBFs. Finally, we tested one further related hypothesis, namely, that the interaction of FP and the OBF might produce OBA.

3. Method

Two participant samples comprised individuals reporting (1) a general survey of SP experiences and (2) single-episode reports of SP experiences. These projects received ethics clearance from the Office of Human Research at the University of Waterloo.

3.1. Sample 1

The first sample employed the Waterloo unusual sleep experiences scale (Cheyne et al., 1999a,b) that assesses frequency of SP episodes on a four-point scale (never, once, 2–5 times, and more than 5 times) and vividness or intensity of each type of hallucination accompanying SP on a seven-point Likert scale (from a vague impression to a vivid and lifelike experience). Text boxes were also provided for further elaboration. The relevant V–M hallucinations for this sample were floating, flying, falling, elevator sensations, spinning, motor hallucinations (e.g., sitting up, walking around), OBFs, and OBA. The original HTML version of the scale was placed on the World Wide Web in September 1997. The scale can be accessed through a variety of search engines and related links.

The data reported here were collected over a period of 15 months from July 1, 2005 to September 1, 2006. During that time 12,505 reports were received. Data were screened for invalid and duplicate responses. A primary inclusion criterion was positive endorsement of SP, "Sometimes when falling asleep or when waking from sleep, I experience a brief period during which I am unable to move, even though I am awake and conscious of my surroundings." Only complete and consistent reports were retained. Data screening also revealed obvious errors for textbox entries regarding age (e.g., 501 years) and thus, only data for participants reporting ages between 12–100 years are included here. Typical duplicated entries occurred within seconds (or less), seemingly reflecting double-clicking on the submit icon, although some were months apart. A conservative approach was taken to keep only the most recent entry among those with duplicated email addresses. Further duplicate respondents were identified and eliminated based on an initial search for shared IP addresses, followed by assessment of reported demographics and other survey data (sex, age, occupation, nationality, etc.).

The final sample comprised 11,385 respondents (63% females; mean age = 29.21 years, SD = 10.07), world-wide (>65 nations; but predominately USA, 64%; UK, 13%; and Canada, 9%).

3.2. Sample 2

A second, prospective sample was recruited to report on single episodes as they occurred in order to supplement and extend the retrospective general survey (see Girard and Cheyne, 2006). Although smaller, this sample was used to assess more precisely the mediation and moderation analyses as prospective studies of individual episodes reduce the conflation of experiences from different episodes and the incidence of forgetting following the episode (Cheyne and Girard, 2007a). Participants were recruited from among those who had previously completed an earlier survey (i.e., there is no overlap with Sample 1) and had indicated a willingness to be contacted for further study. The main purpose of the research was explained in the email request for participation; namely, that our interest was to obtain detailed reports of individual episodes of SP as soon as possible following their occurrence. Participants were assigned personal identification numbers (PINs) to be used for each report and instructed to log on to fill out a modified and slightly abbreviated episodic survey form at http://watarts.uwaterloo.ca/~acheyne/epi/spqepi.html as soon as possible following an episode to answer questions about the episode on-line. Again, occurrence and ratings were collected for each hallucination type. Of 1876 valid addresses, 1040 previous participants responded to our request by filling out a sleep survey, a response rate of 55%. During the study, 314 participants submitted at least one valid SP report. The mean delay in reporting was 27:34 h (range: <1 min to 6 d). For each episode, participants provided a PIN, the time and date for the episode, bedtime, the time of reporting and rated vividness of hallucinations experienced. The relevant experiences for the present study were floating, flying, falling, and motor hallucinations, as well as OBFs and OBA. Text boxes were provided for respondents to provide further details. The sample was mostly female (71%) with an average age of 31.05 (range: 16–69) years. The majority were citizens of the USA (65%), UK (15%) and Canada (13%), but also with representation from 15 other nations world-wide. For test-retest consistency, see Cheyne and Girard (2007a).

3.3. Data analyses

All analyses were conducted on intensity measures. Absence of an experience was coded as '0' intensity to create an 8-point scale. We have previously found virtually identical results when we include non-occurrence as zeros or exclude them as missing. Similarly, frequency and intensity measures produce comparable results (Cheyne, 2003). To address potential attenuation of relations among variables because of distributional non-normality, we employed bootstrapping procedures in AMOS 7.0 (2000 samples; Arbuckle, 2006a). Bootstrapping is a form of resampling that provides less biased estimates for non-normal distributions than conventional techniques (Bollen and Stine, 1993). Given that sample sizes for both Samples 1 and 2 result in even trivial effects yielding "significant" results, we focus on effect sizes using Cohen's (1988) terminology. Small effects involve r or $\beta \geq .10$ (i.e., accounting for $\geq$1% variance). Medium and large effects refer to coefficients greater than .30 and .50, respectively. All hypotheses were assessed using structural equation modeling (SEM: AMOS 7.0; Arbuckle, 2006a).

We first assessed the hypothesis that OBFs mediate the association between IMEs and OBA via a series of step-wise multiple regression analyses (Baron and Kenny, 1986) predicting that OBFs, but not OBA, were directly associated with IMEs. We also tested the alternative hypothesis that the visual experience of OBA mediated the associations between IMEs and OBFs. These analyses also allowed us to assess the independent contributions of different IMEs to OBFs and OBA.

The regression analyses provided a foundation for additional tests of the hypotheses outlined in Section 1. Model 1 assessed the major hypothesis of mediation of the association between IME intensity and OBA via OBFs, modeling IMEs as a latent factor with key indicators identified by the regression analyses and common to both samples: floating, flying, and motor hallucinations. In Model 2, IMEs were modeled as direct predictors of both OBA and OBFs (i.e., no mediation) accounting for their mutual association. For Model 3, IMEs were modeled as an exogenous manifest variable (the mean-centered total of the intensity measures for floating, flying, and motor hallucinations). OBA and OBFs were also mean centered. Model 3A, included IME-total, OBA, and their interaction term all as direct predictors of OBFs. Model 3B tested a model with reversal of the roles of OBA and OBFs. Frith's (2004) hypothesis was assessed by Model 4A, which essentially replaced the IME-total variable from Model 3B with the intensity measure of FP. Model 4B reversed the roles of OBA and OBFs to test an alternative more consonant with the main hypothesis (Model 1) by reversing the roles of OBA and OBFs.

Multiple goodness-of-fit indices were used to achieve broad conceptual and statistical coverage in evaluating model fit. Specifically, five aspects of fit were tested using a total of eight indices: (a) chi-square (χ^2) and the ratio of the chi-square to degrees of freedom (χ^2/df) assessed absolute fit; (b) CFI (Bentler comparative fit index) and NNFI (non-normed fit index) assessed incremental fit; (c) PCFI (parsimonious CFI); (d) RMSEA (root mean square error of approximation) was the non-centrality based estimate of error; and (e) the information-theoretic measures AIC and BIC (Akaike and Bayes information criteria, respectively) (Arbuckle, 2006b; Hoyle, 1995; Kline, 1998). Given the non-hierarchical (non-nested) nature of the alternative models, direct statistical comparisons among the competing models are inappropriate. Moreover, our purpose was not to determine the absolute fit of any of the models, but rather to rank the relative fit of the alternatives. The AIC and BIC measures are most appropriate for this purpose; lower values on these measures reflect a well-fitting and parsimonious model.

4. Results

4.1. Rates of occurrence of SP experiences

IMEs were reported for 69% of Sample 1 and 38% of Sample 2 (note: the lower frequency for Sample 2 is to be expected given the lifetime retrospective nature of Sample 1 and that single-episode reports were used for Sample 2). The most frequent individual IME experience was motor hallucinations (44% Sample 1, 22% Sample 2) and the least was flying (15% Sample 1, 3.5% Sample 2); it was rare that a single respondent endorsed experiencing all of the IME variables (2.8% Sample 1, .3% Sample 2). OBEs were reported by 39% of Sample 1 and in 25% of Sample 2 episodes. Consistent with the main hypothesis, 90% of those experiencing OBEs also reported IMEs, whereas only 51% of reported IMEs were accompanied by OBEs in Sample 1, Odds ratio (OR) = 7.50, χ^2 (1, $N = 11{,}385$) = 1546.21, $p < .001$. Similarly, OBEs were more often in the context of IMEs (74%) than the reverse (48%) for Sample 2, OR = 8.14, χ^2 (1, $N = 314$) = 57.42, $p < .001$. Moreover, OBFs occurred more often without OBA (51% of OBFs) than OBA without OBFs (18% of OBA) in Sample 1, OR = 15.36, χ^2 (1, $N = 11{,}385$) = 2908.88, $p < .001$. The values for Sample 2 were 64% and 31%, respectively, OR = 11.98, χ^2 (1, $N = 314$) = 52.36, $p < .001$.

In summary, these results are consistent with the hypothesis of a continuum of experience such that IMEs → OBF → OBA.

4.2. Regression analyses

OBFs and OBA were positively associated with all IME variables (Table 1). The multiple regression analyses addressed the associations among IMEs, OBF, and OBA variables.

Subsequent analyses attempted to detail the structure of these associations. The first regression analysis examined predictors of OBA. In step (a), all IME variables were entered simultaneously as predictors of OBA. The analysis of Sample 1 data yielded a robust overall multiple correlation, $R = .41$. Floating, flying, and motor hallucinations were the primary contributors to this relation, whereas falling, elevator, and spinning revealed minimal independent predictive ability (Table 2A: Sample 1). The additional contribution of OBF in step (a) produced a substantially larger multiple correlation, $R = .56$. Beta coefficients for all IME variables became small to trivial in magnitude in this model (b), though often still nominally significant. Thus, OBFs account for a considerable amount of the covariation between IMEs and OBA.

A parallel analysis was carried out with OBF as the dependent variable (Table 2B: Sample 1). In step (a), IME variables, floating, flying, and motor hallucinations again made major contributions to the prediction of OBF. In step (b), OBA made a major contribution into the prediction of OBF. The contribution of floating was, however, only modestly reduced. The association between IME variables with OBF was double that

Table 1 – Pearson product moment correlations for V–M hallucinations in Sample 1 (above diagonal, $N = 11{,}385$) and Sample 2 (below diagonal, $N = 314$)

	OBF	OBA	Floating	Flying	Falling	Motor	Elevator	Spinning
OBF	2.30\2.66	.55	.53	.43	.27	.29	.33	.25
OBA	.42	1.72\2.19	.35	.33	.19	.24	.22	.17
Floating	.55	.22	2.12\2.66	.52	.35	.24	.41	.33
Flying	.28	.14	.33	1.10\2.09	.37	.22	.39	.33
Falling	.12	.04	.13	.25	1.51\2.49	.21	.46	.31
Motor	.26	.30	.20	.07	.04	2.36\2.92	.22	.19
Elevator	–[a]	–[a]	–[a]	–[a]	–[a]	–[a]	–\2.46	.38
Spinning	–[a]	–[a]	–[a]	–[a]	–[a]	–[a]	–[a]	–/2.00

Standard deviations are shown on the major diagonal for Sample 2/Sample 1. Abbreviations: Motor = motor hallucinations; OBA = out-of-body autoscopy; OBF = out-of-body feelings; V–M = vestibular–motor.
a Not assessed in Sample 2.

Table 2 – Step-wise multiple regression assessing predictors of OBA and mediation of associations with IMEs by OBFs and OBA

	Step	β							R^2
		Floating	Flying	Falling	Elevator	Spinning	Motor	OBF	
OBFs[a]									
Sample 1	(a)	**.21**	**.17**	.01	.03	.01	**.14**	–	**.17**
	(b)	.03	.09	.01	−.01	<.01	.07	**.49**	**.31**
Sample 2	(a)	**.14**	.08	−.01	–	–	**.26**	–	**.12**
	(b)	−.04	.04	−.02	–	–	**.21**	**.38**	**.21**
OBA[a]									
Sample 1	(a)	**.37**	**.17**	.02	.07	.01	**.15**	–	**.34**
	(b)	**.30**	.10	.01	.06	.01	.09	**.37**	**.46**
Sample 2	(a)	**.49**	**.10**	.02	–	–	**.15**	–	**.34**
	(b)	**.45**	.08	.02	–	–	.08	**.28**	**.41**

a Sample 1: $N = 11{,}385$. Sample 2: $N = 314$. Cell values are standardized beta weights (β). R^2 is the squared multiple correlation. Bolded β and R^2 values are of at least a small effect size and those bolded and italicized represent medium and large effects (Cohen, 1988). Abbreviations: Motor = motor hallucinations; OBA = out-of-body autoscopy; OBF = out-of-body feelings.

with OBA ($R^2 = .34$ *vs* $R^2 = .17$). OBF accounted for over twice the variance in OBA as all IME variables combined, whereas OBA accounted for only about two-thirds the variance of OBF as the other IME variables. In general, the results are clearly more consistent with the hypothesis that OBFs mediate the association between IME variables and OBA than that OBA mediates the association of IME variables with OBF.

These two sets of regressions were repeated for Sample 2. Step (a) produced a multiple correlation of $R = .35$. Motor hallucinations accounted for the majority of the variance in OBA, followed by floating, then flying, with a negligible unique contribution of falling (Table 2A: Sample 2). Step (b), including OBFs, produced a substantially larger multiple correlation, $R = .46$. Most other beta coefficients for IME variables became small to trivial in magnitude, except motor hallucinations, which remained significant. OBF again accounted for a considerable amount of covariation between motor hallucinations and OBA. In step (a) of the parallel analysis with OBF as the dependent variable, particularly floating, as well as motor hallucinations and flying contributed to the prediction of OBF (Table 2B: Sample 2). In step (b), OBA made a significant contribution to the prediction of OBF, but less than that of floating. Moreover, the contribution of floating was only modestly reduced. The association between IME variables with OBF was almost three times greater than with OBA ($R^2 = .34$ *vs* $R^2 = .12$; see step (a) of Table 2A and B, Sample 2). Moreover, floating remained the dominant predictor of OBFs when OBA was added in step (b) (Table 2B), whereas OBF was the major predictor of OBA in the first analysis (Table 2A). Thus, the analysis of Sample 2 replicated in considerable detail the findings for Sample 1.

4.3. *Path analyses*

The results for the SEM path analyses are summarized in Table 3. The hypothesized Model 1, which is simply the IME → OBF → OBA mediation hypothesis cast as a path model with IMEs as a latent variable, was by far the best-fitting model

Table 3 – Assessment of model fit for path analyses based on the main hypotheses (Model 1) for mediation of OBA by OBFs and competing hypotheses for two samples[a]

Model	χ^2	*df*	χ^2/df	CFI/PCFI	NNFI	RMSEA	AIC	BIC
A: Sample 1								
1	394.76	5	78.95	.97/.49	.94	.08	414.76	488.16
2	900.72	5	180.14	.93/.47	.87	.13	920.72	994.12
3A	8636.21	3	2878.74	.33/.17	−.33	.50	8650.21	8701.59
3B	6886.06	3	2295.35	.49/.24	−.03	.45	6900.06	6951.44
4A	1460.75	3	486.92	.74/.37	.48	.21	1474.75	1526.14
4B	1103.93	3	367.98	.79/.39	.58	.18	1117.93	1169.31
B. Sample 2								
1	18.88	5	3.78	.94/.47	.89	.09	38.88	76.38
2	23.14	5	4.63	.93/.46	.85	.11	43.14	80.64
3A	313.13	3	104.38	.17/.09	−.66	.58	327.13	353.38
3B	161.77	3	53.92	.46/.23	−.08	.41	175.77	202.02
4A	93.69	3	31.23	.40/.20	.21	.31	107.69	133.94
4B	11.69	3	3.90	.91/.45	.81	.10	25.69	51.94

a Sample 1 $N = 11{,}385$ and Sample 2 $N = 314$. For all chi-square values, $p < .05$.

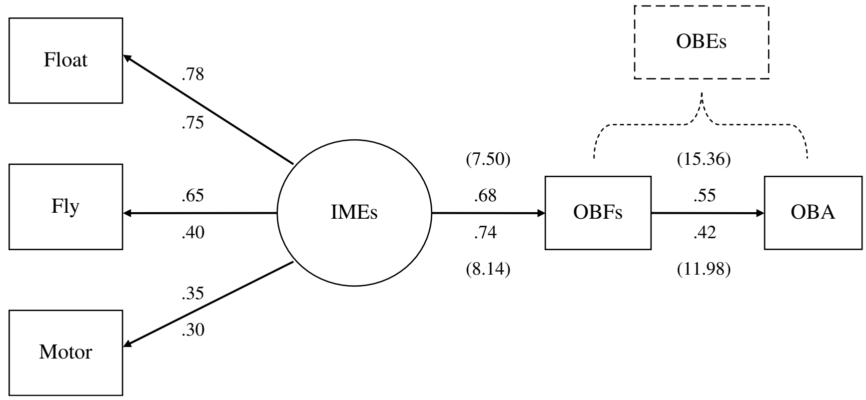

Fig. 1 – Path analysis of V–M experiences during SP. Path coefficients and Odds ratios (in parentheses) were derived from analyses of Sample 1 (N = 11,385, retrospective) and 2 data (N = 314, episodic) displayed above and below the path-diagram lines respectively. Note the absence of a direct path from IMEs to OBA. Abbreviations: Motor – motor hallucinations; OBEs – out-of-body experiences, a superordinate category comprising two conceptually independent experiences; OBF, a feeling of separateness from the corporeal body; OBA, seeing one's body from an external station point.

and, moreover, was the only reasonably well-fitting model according to recommended rules of thumb (Arbuckle, 2006b; Hoyle, 1995; Kline, 1998). Model 1, is detailed graphically in Fig. 1, with path coefficients from both samples.

Model 2, representing IMEs as a common direct source of OBFs and OBA, was a moderately well-fitting model, though with a consistently poorer fit than Model 1 for all indices. The overall fit for each of Models 3A, 3B, and 4A was poor; and the interaction terms for these models revealed negligible predictive power, all $\beta \leq |.09|$. Interestingly, however, Model 4B, which reversed the roles of OBA and OBF from Frith's (2004) hypothesis, was a reasonably well-fitting model, though for Sample 2 only (Table 3B, bottom). The association of OBF and OBA increased with increasing levels of FP. The information-theoretic measures were actually lower for Model 4B than for Model 1, at least for Sample 2. The interaction of FP and OBF intensity accounted for 5% of the variance in OBA; the contribution of FP alone was trivial (<2%), whereas OBF alone made the largest contribution (14%). Nonetheless, the parallel analysis for Sample 1 fared poorly.

4.4. *Age and sex effects*

Next, age and sex effects were considered. Although age was significantly associated with the intensity of several V–M variables, the magnitude of these correlations was trivial, all $rs < |.08|$. The association between sex and V–M experiences was similarly trivial, all $\varphi < |.07|$. For Sample 2 only the correlation between floating intensity and age reached significance, $r = -.14$, $p = .016$, and there were no significant associations between sex and any V–M variable, all $\varphi < |.20|$. Parallel analysis of frequency data revealed comparable results. The percentages of participants reporting each of the V–M experiences, as well as FP, are reported in Table 4, broken down by sex, and along with mean age by hallucination type.

Table 4 – Age means (SD) for, and percentages of males and females reporting, each FP experience and V–M hallucination type in Sample 1 and Sample 2[a]

	FP	OBF	OBA	Floating	Flying	Falling	Motor	Elevator	Spinning
Sample 1									
Mean (SD) years age	28.9 (10.2)	29.0 (10.0)	29.8 (10.7)	28.9 (10.0)	30.6 (10.4)	29.0 (10.2)	28.5 (9.8)	28.4 (9.7)	27.6 (9.2)
% of Total females	81.3	36.4	21.9	36.6	14.5	30.9	47.0	27.1	16.3
% of Total males	75.2	33.6	19.9	34.4	17.2	29.8	40.2	27.7	14.7
Sample 2									
Mean (SD) years age	31.3 (9.6)	29.7 (9.4)	34.1 (11.8)	28.1 (8.4)	32.3 (12.4)	33.8 (11.7)	32.0 (10.9)	–[b]	–[b]
% of Total females	60.5	21.5	12.1	18.4	2.7	6.7	22.0	–[b]	–[b]
% of Total males	51.6	20.9	8.8	25.3	5.5	9.9	23.1	–[b]	–[b]

a Sample 1 N = 11,385 (female n = 7183; male n = 4202); Sample 2 N = 314 (female n = 223; male n = 91). Note: the lower frequencies for Sample 2 than 1 are expected given the lifetime retrospective account of Sample 1 and single-episode reports for Sample 2. Abbreviations: FP = felt presence; Motor = motor hallucinations; OBA = out-of-body autoscopy; OBF = out-of-body feelings; SD = standard deviation; V–M = vestibular–motor.

b Not assessed for Sample 2.

A path analyses for Model 1 was subjected to moderator analyses based on (1) sex and (2) age (based on a median split: Sample 1 at 26 years old, Sample 2 at 27.85 years). That is, fully constrained models were tested that set all parameters (factor loadings, path coefficients, covariances, variances, and residuals) equal across the groups defined by sex or age. The fully constrained models fit the data well in general for Sample 1, reflecting negligible differences according to sex, $\chi^2(20) = 498.76$, $p < .001$, $\chi^2/df = 24.94$, NNFI = CFI = PCFI = .96 (Note: These values are equivalent under this condition in which the number of free parameters equals that of the independence/baseline model), RMSEA = .046, AIC = 518.76 (Note: BIC is not appropriate for multiple-group analyses), or age group, $\chi^2(20) = 693.27$, $p < .001$, $\chi^2/df = 34.66$, NNFI = .95, RMSEA = .054, AIC = 713.27. For Sample 2, constraining all parameters to equality produced moderately well-fitting models for sex, $\chi^2(20) = 65.53$, $p < .001$, $\chi^2/df = 3.28$, NNFI = .82, RMSEA = .085, AIC = 85.53, and age, $\chi^2(20) = 62.70$, $p < .001$, $\chi^2/df = 3.14$, NNFI = .83, RMSEA = .083, AIC = 82.70. Given the slight drop in fit for Sample 2, intermediate models constraining specifically the factor loadings and path coefficients, i.e., the parameters of most interest, were tested. Comparison to fully unconstrained models (comparable to Model 1 in Table 3) failed to indicate significant moderation by sex ($NNFI_\Delta < -.05$; $p = .071$) or age ($NNFI_\Delta < .01$; $p = .054$). The overall profiles of coefficients are consistent across both the sex and age groups and with the overall results for Model 1 (Fig. 1).

5. Discussion

The results are highly similar for both samples and generally consistent with the major hypothesis (Model 1). OBFs are most directly associated with IMEs, and especially floating, which appears to be a key variable partially mediating the associations between the other IMEs and OBFs. As predicted, OBFs largely mediate the associations between IMEs and OBA. In contrast, there was little evidence that OBA mediates the effects of IMEs on OBFs. The findings are particularly clear for Sample 2, consistent with the argument that data from prospective studies of recent individual episodes provide more valid and precise estimates of potential causal associations among variables (Cheyne and Girard, 2007a).

Interestingly, motor experiences continued to provide unique variance to OBA even when controlling for OBFs. Consistent with these regression results, inspection of modification indices from the SEM analyses suggested that an improvement in fit might be achieved by adding direct links between motor hallucinations and OBA. This observation is also consistent with participant reports of hallucinations of getting up and walking away from the bed and then unexpectedly seeing one's body lying in bed. In such cases, experients appear to have had no sense of disembodiment prior to seeing their own bodies in bed. This may occur because motor hallucinations are not inherently anomalous as are sensations of floating or flying. Examples of motor hallucinations as initial experiences have also been reported in the literature, where experients sometimes report motor hallucinations leading to sensations of floating, or directly to OBAs. For example, Gabbard and Twemlow (1984) open their study of OBEs with an example of someone who, getting up from bed and walking to the next room, suddenly felt weightless and joyful, turned around and saw himself. Motor movements are sometimes discussed among OBE adepts as well. Fox (1962), for example, describing one of his techniques, claims that at the end "the student... can now get out of bed in leisurely fashion and walk away, *leaving his entranced body behind him on the bed*" (p. 128, italics in the original). Nonetheless, the role of motor hallucinations has been less remarked on in the literature on neurological cases of OBEs and only infrequently mentioned in the SP literature. It would be an interesting topic for further research to examine more closely differences and similarities between OBEs associated primarily with vestibular sensations and those more specifically associated with motor hallucinations.

In contrast to floating, flying, and motor hallucinations, sensations of falling, elevator, and spinning were not strongly independently associated with either OBFs or OBA. That is, although the bivariate correlations of falling, elevator sensations, and spinning with OBFs and OBA are moderately positive (Table 1), beta coefficients from the regression analyses reveal that this is almost entirely accounted for by associated floating and flying hallucinations. Interestingly, floating, flying, and motor hallucinations (especially when initiated from a supine position) entail upward translational movement – in contrast to falling (downward), elevator sensations (directionally ambiguous), and spinning (no translational movement). Perhaps also relevant is the observation that the falling sensations are sometimes associated with reports of a return to the corporeal body.

The present results also indicate that OBEs need not involve individuals looking back and seeing their bodies left behind (cf. Dening and Berrios, 1994). Individuals reported OBFs to be accompanied by OBA only about half to two-thirds of the time (see also Cheyne, 2003; Cheyne and Girard, 2007a; Terhune, this issue, 2009). This finding is interesting in light of observations that visual elements sometimes play a minor role in OBE-related phenomena in other contexts (Brugger et al., 1996; Devinsky et al., 1989; Green, 1968; Grüsser and Landis, 1991).

5.1. *Neurological speculations for SP-related OBEs*

Both Blanke and colleagues (Blanke and Arzy, 2005; Blanke et al., 2004, 2005) and Cheyne and colleagues (Cheyne, 2003; Cheyne et al., 1999b) have proposed involvement of parietal cortex and Blanke and colleagues have particularly remarked on the role of the TPJ in V–M phenomena via disruption of the integration of vestibular, proprioceptive, tactile, and visual sensory information. The case for parietal involvement in V–M experiences during SP is less direct than for induction studies. Nonetheless, as noted in the introduction, SP is a well-established REM phenomenon and pontine vestibular centers are closely associated with REM on–off centers involving the raphe nuclei, locus coeruleus, and the pedunculopontine and laterodorsal tegmentum (Hishikawa and Shimizu, 1995; Hobson et al., 1998). Lesions of the parietal–temporal–occipital region have been reported to be associated with cessation of dreaming (Solms, 1997, 2000) and brain imaging (PET) studies report reduced rCBF in most parietal areas during REM (Braun et al., 1997, 1998; Maquet, 2000; Maquet et al., 1996). These associations are consistent also with the decreased activation of the intralaminar thalamus (Braun et al., 1998), which richly innervates frontal and parietal association areas. Also of interest is the finding that, despite a general cerebellar deactivation during REM, Braun et al. (1998) reported a selective activation of the cerebellar vermis, an important component of the vestibular system. This finding suggests the possibility that hypoactivation of cortical vestibular areas during SP may render these areas unable to cope with the conflicting information coming from different sensory sources as well as potentially increased activity of subcortical vestibular centers. In general, this evidence implicates parietal areas in the generation of vestibular dream imagery and, by extension, in V–M hallucinations during SP.

Another context for OBEs is that of the near death experience (NDE), which has recently been linked to REM intrusions (Nelson et al., 2006, 2007). Common features of NDEs and SP include immobilization, consciousness of one's surroundings, intense affect a sense of presence and a context (real or imagined) of immanent threat, as well as OBEs. Nelson et al. (2006) hypothesize that some people may have an arousal system (i.e., brainstem mechanisms affecting sleep-wake states, alertness, and attention) that predisposes them to NDEs as well as REM intrusions. Specifically, they predicted and found that people who report NDEs also report a high frequency of REM intrusions as indexed by SP and (visual and auditory) hypnagogic and hypnopompic hallucinations. Given that OBEs are relatively common during NDEs as well as during REM intrusions, Nelson et al. (2007) further predicted and found that people who have reported NDEs will also be more likely to report OBEs during REM intrusions. The NDE group was more than 8 times more likely to report OBEs during REM intrusions than the non-NDE group (45% *vs* 5%). Curiously, those reporting OBEs during NDEs were no more likely to report OBEs during REM intrusions (14/31) than people reporting NDEs without OBEs (11/24; i.e., 45% *vs* 46%). On the one hand, this equivalence argues against a response bias for reporting OBEs. On the other hand, one might have expected more consistency across contexts for OBEs.

The general features of an emerging neurological model of OBEs, incorporating the present findings, are summarized in Fig. 2. According to the model, disruption of the widely distributed neuromatrix can affect the processing of a variety of bodily senses involving vestibular, motor, and proprioceptive systems as discussed. This disruption may directly produce anomalous bodily experiences as well as contribute to the breakdown of the neurosignature, particularly when central integration is compromised. OBEs, experienced as OBFs and/or OBA are perhaps the most extreme phenomenological end products of these disruptions.

As to the role of illusory motor activity in OBEs observed in the present study, corollary discharge/efferent copy from motor neurons may play a direct role in generating bodily imagery leading to OBEs during SP, NDEs, insufficient anaesthesia, and other conditions involving somatosensory deficiency (cf. Bünning and Blanke, 2005; Overney et al., this issue, 2009). Motor activity normally affects sensory processing

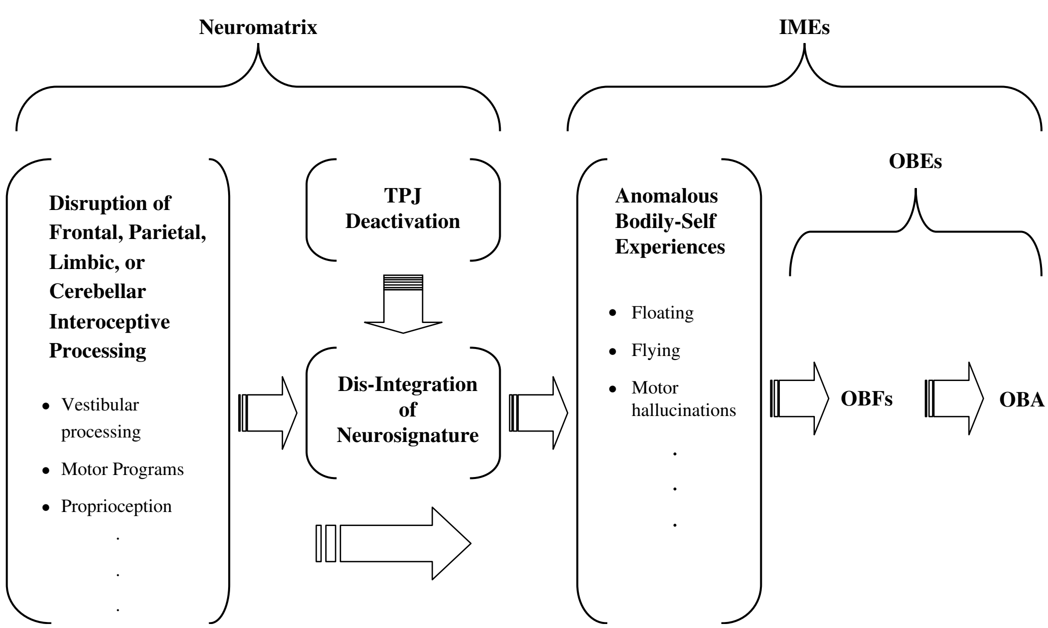

Fig. 2 – From the neuromatrix to OBEs: A hypothesis. The neuromatrix includes a distributed neural system processing and integrating bodily processes including vestibular sensations, motor plans, efference copy, and proprioception. Anomalous sensory experiences are bodily sensations postulated to arise from disruption of the components of the neuromatrix or their integration. The model proposes that, in the case of SP-related OBEs, REM state produces conflicting patterns of activation of different somatosensory centres and/or deactivation of areas important for the integration of somatosensory information (e.g., TPJ). Such disruptions could also arise via electrical stimulation of TPJ or lesions or other anomalies associated with critical components of the neuromatrix. Abbreviations: IME – illusory movement experiences; OBEs – out-of-body experiences; OBF, a feeling of separateness from the corporeal body (out-of-body feeling); OBA, seeing one's body from an external station point (out-of-body autoscopy); TPJ, temporo–parietal junction.

in several ways, including: (1) environmental change picked up by exteroceptors, (2) kinesthetic feedback from the body periphery, (3) direct enhancement or dampening of sensory areas via corollary discharge/efference copy, or (4) indirectly through the construction of a forward model (emulator). During SP, 1 is much attenuated and 2 is unavailable, whereas 3 and 4 are likely to continue functioning adequately. Anomalous outcomes involving such efference copy and forward models have been discussed for schizophrenic hallucinations (e.g., Feinberg, 1978; Heinks-Maldonado et al., 2007) and phantom-limb experiences (Blakemore et al., 2002; Frith et al., 2000).

5.2. *Self and other hallucinations: OBEs and FP experiences*

There are interesting parallels, as well as contrasts, between the OBE and that of another anomalous experience, FP (Brugger, 2006; Brugger et al., 1996; Cheyne, 2003; Cheyne and Girard, 2007a,b; Cheyne et al., 1999b; Hufford, 1982; Nielsen, 2007). FP has sometimes been included along with OBEs under the general rubric of autoscopic phenomena (Brugger et al., 1996, 1997; Grüsser and Landis, 1991; Nielsen, 2007). Both FP and OBE entail unmediated feelings of certainty. In the case of the OBA, there is a conviction that one's centre of awareness is spatially separate from one's body and that a body seen below is one's own, often despite lack of correspondence of physical appearance, mode of dress, age, hair style or color, and even when the body is viewed from behind (for reviews see Blanke et al., 2004; Blanke and Mohr, 2005; Brugger et al., 1997; Devinsky et al., 1989). Thus, self-image of the OBA is often less than completely veridical, suggesting that self-recognition during OBEs is both immediate and immune to falsification by visual anomalies. Similarly, SP experients have an unmediated certainty of the presence of an alien intruder in the absence of any sensory evidence (Cheyne, 2001; Cheyne and Girard, 2007a, 2007b; Hufford, 1982). Yet, at the most fundamental level the FP and OBEs are in stark contrast to one another (see also Hufford, 1982). Whereas FP is a disembodied and invisible alien agent, the OBA is the experience of the image of one's own "disensouled" body. Moreover, although the FP is a thorough alien, it is paradoxically, a somewhat psychically transparent agent, whose intentions seem clear, and typically, in the SP context, quite malevolent (Cheyne, 2001; Hufford, 1982). In contrast, as one's centre of awareness appears to have been removed, or to have removed itself, from its body during OBA, this body becomes a somewhat alien object as cognitively impenetrable as the body of another. That is there is, along with the certainty that the body below is one's own, a psychological alienation from that very body. In many cases, when "out-of-body," people often have a rather detached curiosity, sometimes bordering on complete indifference, to their abandoned corporeal bodies (Crookall, 1964; Devinsky et al., 1989; Lukianowicz, 1958). The body below is no longer "the body *as subject*, the body as locus of knowledge and of lived, conscious experience" (Metzinger, 2005, p. 67; 2003, p. 497, italics in originals).

Although the recent finding of an illusory shadow body following TPJ stimulation (Arzy et al., 2006a) has been taken to reflect a type of felt-presence experience (e.g., Nielsen, 2007), we have argued that a shadow body is more likely an epiphenomenon of anomalous V–M disintegration associated with OBEs (Cheyne and Girard, 2007b). Nonetheless, the partial success of Model 4B (Sample 2) suggests a possible role for FP in moderating the OBF → OBA relation. Intruder and V–M experiences, though loading on separate factors, are generally positively correlated and narrative reports indicate that various experiences across factors can be combined in some cases of, for example, violent assault scenarios (Cheyne, 2003). Nonetheless, as the interaction effect was observed in only one sample, it should be viewed with some caution at present.

5.3. *Sample characteristics and study limitations*

There was a significant preponderance of women in both samples. The percentage of women in Sample 1 is very similar to those reported for our earlier surveys. Other recent surveys on SP that provide a sex breakdown have also reported a greater percentage of women experients (Arikawa et al., 1999; Kotorii et al., 2001), though some do not find significant differences (Spanos et al., 1995). One study comparing Canadian and Japanese samples reported a percentage of women respondents among Canadians that was almost identical to that for Sample 1 (65%), yet reported virtual equivalence among male and female Japanese respondents (51% women: Fukuda et al., 1998). Two studies of Chinese in Hong Kong also reported no sex difference (Wing et al., 1994, 1999). These results suggest the possibility of a cultural difference either in the incidence of SP among women and men or possibly a reporting bias. Although our sample is world-wide, most were from North America, Europe, and Australia. The reporting bias hypothesis might be seen to be consistent with the even greater percentage of women participating in our prospective study. Surveys of more general OBE phenomena also frequently, but not invariably, report a preponderance of women, though, once again, reporting bias is a potential factor (Irwin, 1985). If a sex difference in reporting bias does exist, it does not seem to affect the pattern of results as all other sex differences found in the present study were minor.

In considering characteristics of our sample, it is important to bear in mind our sampling method. In contrast to most student samples, for example, there is no pressure (implicit or explicit) to participate in our web studies. Moreover, the Internet provided a unique opportunity to obtain both a large and diverse Sample 1 and to conduct a prospective naturalistic study of SP on-line with Sample 2 responding within relatively short delays. Nonetheless, web-based samples are typically self-selected rather than random. In addition, many of our web participants expressed considerable interest, motivation, commitment, and appreciation for our research. Our web sample likely included participants with more knowledge and experience of SP, as well as comparatively more intense and elaborate hallucinatory experiences, than student samples (Cheyne et al., 1999b). Nonetheless, consistent with reports on a variety of topics comparing web surveys with a variety of traditional methods (e.g., paper-and-pencil, phone, mail surveys: Huang, 2006; Kiernan et al., 2005; McCabe et al., 2006; Ross et al., 2005; but see Buchanan et al., 2005 for cautions), we previously replicated our initial findings from a conventional student-based sample using a paper-and-pencil survey with an online web sample (Cheyne et al., 1999b).

Despite the remarkable parallels among the different V–M phenomena, the contexts, including SP, subdural electric stimulation, lesions, and seizures of such experiences are very different. Indeed the only commonality among these particular contexts is that there are grounds for concluding that cortical and/or subcortical vestibular centers have been compromised in some manner. Thus, they all converge broadly on a common cause. Nonetheless, neither SP nor direct stimulation, nor any other condition, invariably leads to OBEs, or even vaguely anomalous vestibular experiences. Moreover, V–M experiences do not lead inevitably to OBFs, and OBFs do not always lead to OBA. The present findings are consistent with such effects being determined, at least in part, by intensity levels, though other factors will undoubtedly be involved. It is also possible, for example, that OBEs merely represent a higher level interpretation or over-interpretation (apophenia) of anomalous bodily sensations (Brugger and Graves, 1997; Brugger and Taylor, 2003; Fyfe et al., 2008; Leonhard and Brugger, 1998) possibility potentiated by suggestibility (French et al., in press; Granqvist et al., 2005) or related personality differences (Fleck et al., 2008). Nonetheless, it is very easy to underestimate the vividness of the SP experiences and it may rather require a fairly stolid imagination not to be moved by the more intense phasic REM-induced sensory anomalies.

The present research does not provide any insight into why some individuals are prone to IMEs and OBEs and others to intruder and incubus experiences. Such differences do seem to reflect stable individual differences (Cheyne and Girard, 2007a) and biases towards OBEs may reflect hypersensitivity in the selected modalities (Dubal and Viaud-Delmon, 2008) or cross-modal and possibly weakly synaesthetic connectivities (Brugger, 2000; Easton et al., this issue, 2009; Irwin, 2000; Terhune, this issue, 2009).

Finally, the implication of vestibular centers in the SP-related experiences is very indirect, based on neuroimaging studies of normal REM. Direct neuroimaging studies comparing chronic SP experients who report vestibular and OBE experiences with those who report other types of experiences, or none at all, are required to test more directly the hypotheses offered here. Also potentially fruitful would be a similar comparison among different groups of SP experients on the OBT and mirror tasks (Easton et al., this issue, 2009; Mohr, personal communication).

5.4. *What is it that is out-of-the-body? The phenomenology of the soul*

> We have both corporeal and noncorporeal aspects. We are embodied spirits and inspirited bodies (or, if you will, embodied minds and minded bodies).
>
> President's Council on Bioethics (US), December 2003

Common-sense dualism has recently become the subject of considerable theorizing and empirical research in cognitive science (Atran, 2002; Bering, 2006; Bloom, 2004; Humphrey, 2006). Common-sense dualism is probably much more like Thomistic substance dualism than Cartesian substance dualism. That is, the common-sense notion of the soul is that of a person in every respect rather than a simple rational mind (cf. Moreland and Rae, 2000). Such a soul is taken to be a formed organic whole complete unto itself, though normally "contained" within a corporeal body. Thus, for the common-sense dualist, as for the Thomistic dualist, "out-of-body survival is coherent and metaphysically possible" (Moreland and Rae, 2000, p. 45).

Metzinger (2003, 2005) is perhaps the latest to promote the strong hypothesis that "the particular phenomenal content of the OBEs led human beings to believe in a soul" (Metzinger, 2003, p. 80) and that, "taken as an ontological metaphor, the phenomenology of OBEs inevitably leads to dualism, and the concrete idea of an invisible, weightless, but spatially extended body" (Metzinger, 2003, p. 81). This general notion has been mooted before. For example, in his discussion of the origin of beliefs in "unseen or spirit agencies," Darwin (1879, p. 117), citing Tylor (1871), endorses the hypothesis that spirit beliefs arise from dreams when "the soul of the dreamer goes out on its travels, and comes home with remembrance of what it has seen" (Tylor, 1958, p. 6). Whether or not one endorses the strong form of this hypothesis, OBEs clearly provide a paradigm empirical (i.e., experiential) illustration of the common-sense notion of the relation of the body and soul. That is, the OBF consists of a compelling sense of separation of self and body, and the OBA provides a visual corroboration of a body spatially separate from the centre of awareness. That this is often accompanied by a sense of floating upward and of lightness and insubstantiality is also consistent with common-sense notions of the soul; that is, of an insubstantial ethereal spirit person inhabiting a corporeal body but not necessarily identified with it. Belief that a soul that can exist independently of "its" body is a small inferential step from the conclusion that it may even inhabit other bodies, either displacing another soul or sharing a single body with it, while retaining its personal identity. Such soul beliefs are virtually universal, appearing in diverse unrelated traditional cultures from the high Arctic to the tropics, and are frequently associated with night and dreams (e.g., Atran, 2002). Among the Inuit, for example, the soul (innua) is "the same shape as the body, but of a more airy composition... The soul of man is quite independent and can leave the body" (Nansen, 1894, p. 228). Early anthropologists deemed such beliefs the mark of "primitive" minds (Tylor, 1958), but they are clearly ubiquitous in modern societies as well. Indeed, literary tropes of soul-body independence are so wide-spread and intuitive that they are readily accepted without need of comment or explanation (viz. numerous popular movies such as "Freaky Friday," in which a pair of souls and bodies exchange places; "Heaven can Wait," in which a soul that loses its body is provided with first a temporary and then a more permanent substitute; "Ghost," in which a soul of a deceased body is able to take over gross living material bodies, with permission, in order to have physical contact with others; or "All of Me," in which two souls share, and compete for control of, a single body). In all these cases, the disembodied soul retains all features of its original personality as well as its sensory capacities irrespective of whether it is in or out of any body, all of which are consistent with common-sense notions of the soul. Not surprisingly, in light of the forgoing, OBEs are often referred to as "soul travel" in popular paranormal literature (e.g., Soul Travel Magazine; Taylor, 2000) and have been an integral part of quasi-religious supernatural cults from Swedenborgism through Theosophy to Eckankar (Blavatsky, 2005; Eckankar, 2007; Swedenborg, 1977).

OBEs also appear, to many people, to defy naturalistic accounts and to invite paranormal speculation. ''Based on knowledge from self-awareness, people know themselves to be centres of consciousness with the features that ground the modal argument, and that is why they can conceive of OBEs and of a disembodied afterlife. Surely the burden of proof is on the physicalist to show why these cases are not possible, and, in our view, that burden has not been met'' (Moreland and Rae, 2000, p. 176). Moreland and Rae commit a common fallacy here in requiring their opponents to argue for the impossibility of the unfalsifiable (cf. Russell's celestial tea-pot argument – Russell, 1952). Nonetheless, it is a fair challenge for a naturalistic theory to explain and predict features of any phenomenon claimed to be mysteriously beyond naturalistic explanation. One of the most wide-spread supernatural metaphysical beliefs is that of a soul consisting of an essential ''I'' and a fundamental ''me'' that transcends the corporeal body and naturalistic explanation. Whether or not it is the origin of the concept of the soul as suggested by Metzinger, the OBE is, on the face of it, the most straightforward empirical/experiential evidence of the independence of the soul and for substance dualism, namely, the position that the soul (I, self, mind) is an immaterial substance different from the body. This is not simply an abstract philosophical or theological point. Thomistic substance dualism is taken by Moreland and Rae to have implications for a diverse array of ethical issues, including abortion, cloning, reproductive technologies, and euthanasia.

Moreland and Rae (2000) enjoy influential company in this opinion. The opening quotation for this section, which also represents a version of substance dualism, is taken from a document with significant real-world political and scientific implications not only for the US but also for those of us living beyond US borders. It is the statement of a committee on *Bioethics*, that is, the ethics of *scientific* research. The chapter from which the quotation is drawn cites writers, philosophers, theologians, and poets – but no scientists – as authorities on what it means to be human and, in particular, on the relation of the self/soul and the body. Clearly, the matter of what it is to be human – and in particular the relation of the ''embodied spirit'' and the ''inspirited body'' – is taken to be an essential prerequisite to the consideration of the ethics of scientific research. Moreover, the issue is apparently taken to be closed, as the document states that it begins, not by inquiring, or even arguing, but by ''acknowledging'' (i.e., asserting) that we have both corporeal and noncorporeal aspects.'' As noted above, OBEs, taken at face value, appear, and are often taken, to provide evidence consistent with such a dualistic and supernatural position (e.g., Crookall, 1964; Fox, 1962; Monroe, 1971; Muldoon and Carrington, 1969; Taylor, 2000). Such interpretations are consistent with deep intuitions concerning agency and its relation to the body (Atran, 2002; Barrett, 2004; Barrett and Keil, 1996; Bering, 2006; Bloom, 2004; Cheyne and Girard, 2007b; Tremlin, 2006). The evidence brought to bear by recent scientific scrutiny, however, provides a rather different interpretation. Neurophysiological research such as that reviewed herein and reported elsewhere in this special section as well as the present empirical results provide a naturalistic alternative to substance dualism. Thus, the natural phenomenological progression from anomalous vestibular and motor sensations to OBFs and OBA and the obvious role of vestibular and motor neurophysiological responses provide compelling evidence that these are naturalistic events of the corporeal body should be offered as an alternative to dualistic and supernatural understandings. It would be naive to suggest that the findings reported in the articles of this special section, or even those of hundreds of articles published in science journals in recent years, would or should settle the matter for the authors of *Being Human*, or of *Body and Soul*. Yet, although Moreland and Rae (2000) ostensibly rely on theological–ontological modal arguments of conceivability and possibility rather than scientific evidence, the fact that they introduce empirical observations regarding OBEs reveals an implicit awareness that their modal arguments have little force without empirical consequences.

Available scientific research suggests that, contrary to the assumptions of the President's committee, all our experiences and our well-being rest on variations of normal bodily experiences and physiology. In our view, such scientific evidence is as relevant for consideration for debates on human nature and well-being as the quotations of writers and poets cited in the Bioethics document.

Appendix 1. Terms and definitions of SP-related V–M experiences

The experience term used in the text is in bold, followed by the definition offered to respondents in italics. Respondents were asked to indicate whether they had each experience, how often and how vivid or intense each was (see Section 3).

Sample 1

Floating: *During the experience I had the experience of floating.*
Flying: *During the experience I felt like I was flying.*
Falling: *During the experience I felt that I was falling.*
Spinning: *During the experience I felt my body was spinning or turning rapidly.*
Elevator: *During the experience I experienced 'elevator' feelings of moving rapidly up or down.*
Motor hallucinations *During the experience I had the illusion that I sat up, or moved an arm or leg, or walked around the room, only to discover later that I had not moved at all.*
Out-of body feelings (OBF): *During the experience I felt that I had temporarily left my body.*
Out-of-body autoscopy (OBA): *During the experience I was able to see my own body as if from an outside vantage point.*

Sample 2

Floating, flying, falling: *During the episode I had a sensation of floating, falling, or flying.* (Respondents were presented with check boxes to indicate which of floating, flying, and/or falling applied and to rate the experience(s) in the usual manner.)
Motor hallucinations: *During the episode I imagined that I had sat up, or got out of bed, or walked across the room or into another room.*

OBF: *During the episode I felt as if I had left my body.*
OBA: *During the episode I saw myself lying in bed from an outside vantage point.*

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