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Out-of-body experience in vestibular disorders – A prospective study of 210 patients with dizziness

Christophe Lopez [a,*] *and Maya Elzière* [b]

[a] *Aix Marseille Univ, CNRS, LNIA, FR3C, Marseille, France*
[b] *Centre des Vertiges, Hôpital Européen, Marseille, France*

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ABSTRACT

Out-of-body experiences (OBEs) are states during which people experience their centre of awareness as located outside of their physical body, along with the sensation of seeing the environment from an elevated viewpoint. OBE is encountered in epilepsy, migraine and depersonalization, and it is not an uncommon experience in the general population. Current neuroscientific models of bodily self-consciousness consider that OBE are related to a failure to integrate visual, somatosensory and vestibular signals. These models have highlighted the importance of visual-vestibular mismatch in OBE. Case reports from older clinical literature suggest that vestibular disorders may precipitate OBE, but we were lacking population-based evidence that OBE is related to vestibular disorders. The present observational, prospective study describes otoneurological, neuropsychological and phenomenological correlates of OBE in the largest sample of patients with dizziness to date ($n = 210$) compared to a group of age- and gender-matched controls with no history of dizziness ($n = 210$). We show a significantly higher occurrence of OBE in patients with dizziness (14%) than in healthy participants (5%). Most of the patients experienced OBE only after they started having dizziness for the first time. OBE in patients with dizziness were mainly related to peripheral vestibular disorders. We also identify depersonalization-derealization, depression and anxiety as the main predictors of OBE in patients with dizziness, as well as a contribution of migraine. Depersonalization-derealization was the only significant predictor of OBE in healthy controls. Altogether, our data indicate that OBE in patients with dizziness may arise from a combination of *perceptual incoherence* evoked by the vestibular dysfunction with psychological factors (depersonalization-derealization, depression and anxiety) and neurological factors (migraine).

* *Corresponding author*. Laboratoire de Neurosciences Intégratives et Adaptatives – UMR 7260, Aix Marseille Université, Centre National de la Recherche Scientifique (CNRS), Centre Saint-Charles, Fédération de Recherche 3C – Case B, 3, Place Victor Hugo, 13331 Marseille Cedex 03, France.
E-mail address: christophe.lopez@univ-amu.fr (C. Lopez).

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1. Introduction

Out-of-body experiences (OBEs) are states during which people experience their "self", "mind", or centre of awareness, as located outside of their physical body. During an OBE, people seem to be fully awake and often report a sensation of floating along with the impression of seeing the environment from an elevated position (Blackmore, 1982; Blanke & Dieguez, 2009; Brugger, 1997). OBE is not an uncommon experience in the general population and it is also encountered in conditions such as epilepsy, migraine and depersonalization (Blanke & Dieguez, 2009; Blanke & Mohr, 2005). This has resulted in a surge of interest from neurologists and neuroscientists over the past two decades to understand OBEs and provide a better comprehension of the sensorimotor and neurophysiological foundations of self-consciousness (Blanke, 2012; Brugger, 1997; Ionta et al., 2011; Kessler & Braithwaite, 2016; Metzinger, 2009).

Current neuroscientific models of bodily self-consciousness propose that accurate integration of visual, tactile, proprioceptive, interoceptive, motor and vestibular signals supports the experience of an embodied self (Blanke, 2012). OBEs are thus seen as a failure to coherently integrate these signals. A large body of evidence from neurology and research in healthy participants support this proposition. First, OBEs have been evoked in patients during electrical stimulations of the temporo-parietal junction, where they very likely interfere with multisensory processing (Blanke, Ortigue, Landis, & Seeck, 2002; Bos, Spoor, Smits, Schouten, & Vincent, 2016). Second, OBEs due to epilepsy or stroke are often associated with complex multisensory illusions, such as visual sensations (including autoscopy: the sensation of looking at one's own body), somesthetic sensations (the perceived shape and size of the body is distorted), and vestibular sensations (Blanke & Mohr, 2005; Blanke, Landis, Spinelli, & Seeck, 2004; Devinsky, Feldmann, Burrowes, & Bromfield, 1989; Lopez, Halje, & Blanke, 2008; Lopez, Heydrich, Seeck, & Blanke, 2010). Third, recent studies in neurologically normal participants show that the perceived location of the "self" is altered when conflicts are created between visual and tactile signals (Ehrsson, 2007; Ionta et al., 2011; Lenggenhager, Mouthon, & Blanke, 2009; Lenggenhager, Tadi, Metzinger, & Blanke, 2007). These paradigms can evoke the feeling that the participants' viewpoint is disembodied and that they self-identify with a distant avatar.

The vestibular contributions to the sense of self and embodiment have been poorly described when compared to the role of vision and touch, despite the crucial role of the vestibular system in the perception of self-motion and orientation (Blanke, 2012; Ferrè & Haggard, 2016; Lenggenhager & Lopez, 2015; Lopez et al., 2008). In a recent study, healthy participants who received low-intensity galvanic stimulation of the vestibular nerves were more likely to adopt an embodied perspective to perceive letters traced on their forehead (Ferrè, Lopez, & Haggard, 2014). The authors proposed that low-intensity vestibular stimulation increases the natural tendency of the vestibular system to anchor the self to the body, suggesting a vestibular contribution to embodied self-location. Another way to examine the vestibular contribution to embodiment would be to investigate patients with vestibular disorders. If vestibular signals are central for anchoring the self to the body (Ferrè et al., 2014), patients suffering from vestibular disorders may be more prone to OBE.

An older clinical literature review only found some cases of patients with dizziness reporting abnormal sense of embodiment, and extremely rare cases of full-blown OBE in vestibular disorders (reviewed in Lopez, 2013). In the 19th Century, Krishaber (1873) was probably the first to report abnormal self and bodily perceptions in patients with dizziness, followed by Bonnier (1905), who described apparent dissociations between the self and the body. One of Bonnier's patients reported *"he was divided into two persons, one who had not changed posture, and another new person on his right, looking somewhat outwardly. Then the two somatic individuals approached each other, merged, and the vertigo disappeared"*. Three decades later, Skworzoff (1931) established a link between vestibular disorders and illusory perceptions of doubles (autoscopic phenomena), as one of his patients suffering from dizziness reported seeing and feeling every day his own double. Schilder (1935) proposed that normal vestibular functions are required for a normal body schema and described several patients with dizziness who experienced abnormal perceptions of their body shape and size. Yet, these patients did not receive systematic otoneurological examinations. The sensations often reported by Krishaber (1873), Bonnier (1905) and Schilder (1935) that the self feels strange, unreal and disconnected from the body in patients with dizziness are reminiscent of symptoms of depersonalization. There is evidence that Menière's disease can evoke symptoms resembling depersonalization (*e.g.*, *"I feel like I'm outside of myself. I feel like I'm not in myself"*; Grigsby & Johnston, 1989) and that depersonalization is more frequent and severe in patients with dizziness (Jauregui-Renaud, Sang, Gresty, Green, & Bronstein, 2008; Tschan, Wiltink, Adler, Beutel, & Michal, 2013; Sang, Jauregui-Renaud, Green, Bronstein, & Gresty, 2006; reviewed in Jauregui-Renaud, 2015). Depersonalization is also often associated with anxiety and depression during dizziness (Tschan et al., 2013). Because of the lack of detailed phenomenology of disembodiment and the absence of systematic OBE questionnaires in older case reports (Bonnier, 1905; Grigsby & Johnston, 1989; Krishaber, 1873; Schilder, 1935; Skworzoff, 1931), the relation between vestibular disorders, OBE and depersonalization remains unclear. Finally, we note the recent description of one patient with a unilateral vestibular dysfunction who experienced OBEs (Kaliuzhna, Vibert, Grivaz, & Blanke, 2015). When tested in visuo-tactile conflicts known to evoke disembodied self-location (Lenggenhager et al., 2007), the patient reported a stronger feeling of elevated, disembodied self-location than control participants, suggesting a role of vestibular signals in OBE. In conclusion, despite anecdotal cases collected over more than a century, we lack convincing evidence of full-blown disembodiment related to vestibular disorders, as there has been to date no systematic neuropsychological and otoneurological investigations of OBE in a large population of patients with dizziness.

The present study describes otoneurological, neuropsychological and phenomenological correlates of OBE in the largest sample of patients with dizziness to date. We first

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