Consciousness and Cognition 21 (2012) 1037–1042

Contents lists available at SciVerse ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Short Communication

Disowning one's seen real body during an out-of-body illusion

Arvid Guterstam *, H. Henrik Ehrsson

Brain, Body & Self Laboratory, Department of Neuroscience, Karolinska Institutet, Retzius väg 8, 171 77 Stockholm, Sweden

ARTICLE INFO

Article history:
Received 26 September 2011
Available online 28 February 2012

Keywords:
Body perception
Out-of-body illusion
Multisensory integration
Body ownership
Self

ABSTRACT

Under normal circumstances, we experience that our center of awareness is located behind our eyes and inside our own body. To learn more about the perceptual processes that underlie this tight coupling between the spatial dimensions of our consciously perceived self and our physical body, we conducted a series of experiments using an 'out-of-body illusion'. In this illusion, the conscious sense of self is displaced in the testing room by experimental manipulation of the congruency of visual and tactile information and a change in the visual perspective. We demonstrate that when healthy individuals experience that they are located in a different place from their real body, they disown this body and no longer perceive it as part of themselves. Our findings are important because they reveal a relationship between the representation of self-location in the local environment and the multisensory representation of one's own body.

1. Introduction

Why do we experience that our 'self' is located inside our physical body; and what is the exact relationship between the body and the center of conscious awareness? Studies on neurological patients suggest that the normal alignment of the consciously experienced self and the physical body can be disrupted by brain pathology, such as during autoscopic phenomena and out-of-body experiences (Blanke, Landis, Spinelli, & Seeck, 2004; Brugger, 2002). Recently, it has been made possible to elicit similar experiences in healthy participants in laboratory experiments involving multisensory stimulation and perceptual illusions (Ehrsson, 2007; Lenggenhager, Tadi, Metzinger, & Blanke, 2007). These studies suggest that multisensory integration in egocentric coordinate systems and the first-person visual perspective are fundamental factors for the creation of a unified experience of oneself in space. An important unresolved question, however, relates to how the real body is represented in the brain during an out-of-body experience. While this question remains extremely difficult to tackle in neurological patients, it can be examined in healthy participants during multisensory 'full-body illusions' which engage the perceptual processes likely to be involved in out-of-body experiences in patients (Blanke & Metzinger, 2009; Ehrsson, 2007; Lenggenhager et al., 2007).

In this study, we investigate how the sense of being located at single place in the environment (self-location) and the perception of owning a body, relate to the representation of one's seen real body when healthy subjects experience the 'out-of-body illusion' (Ehrsson, 2007). This experimental setup uses virtual reality technology and a real-time video feed to change the participant's visual perspective to that of a pair of cameras placed 2 m behind their physical body. The experimenter then repetitively touches the participant's chest using a small rod out of view from the cameras (and thus, the subject), while the participant observes an identical rod approaching and disappearing just below the field of view of the cameras. Because the seen movement of the rod and felt touches on the chest are synchronous and spatially congruent from the first-person point of view, this setup creates a vivid illusory experience that one's own body is located in the position of the

* Corresponding author.
E-mail addresses: arvid.guterstam@ki.se (A. Guterstam), henrik.ehrsson@ki.se (H.H. Ehrsson).

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doi:10.1016/j.concog.2012.01.018

cameras, 2 m behind the real body, and that the rod approaching the cameras is directly causing the felt touch (Ehrsson, 2007). Thus, two basic experiences are involved in this illusion: the feeling of having an unseen body being touched below the cameras (which we refer to as 'illusory body') and the experience of being located in this position in the room ('illusory self-location').

It is worth emphasizing the principal differences between the 'out-of-body illusion' (Ehrsson, 2007) and other published full-body illusions; namely the 'body-swap illusion' (Petkova & Ehrsson, 2008) and the full-body illusion described by Lenggenhager et al. (2007). In the latter experiment, participants receive tactile stimulation on their back simultaneously as they view the back of their own body being touched by an object, filmed from a distance of 2 m (Lenggenhager et al., 2007). Thus, in contrast to the 'out-of-body illusion' (Ehrsson, 2007), the touches delivered to the real body are directly visible to the participants, and there is no visual stimulation directed towards the cameras. In fact, this setup results in self-identification with the own body presented in visual extra-personal space (Lenggenhager et al., 2007), rather than the feeling of having an 'illusory body' at the location of the cameras (Ehrsson, 2007). In the 'body-swap illusion' (Petkova & Ehrsson, 2008), participants experience a *mannequin's* body as their own. In this illusion, the subjects look down and directly observe a mannequin's body being touched through the head-mounted displays (HMDs), in synchrony with tactile stimulation applied to the real body (Petkova & Ehrsson, 2008). Moreover, the participant's physical body is not within the field of view, and neither is the spatial context in which the artificial body is placed. These two factors distinguish the 'body-swap illusion' from the 'out-of-body illusion,' in which the 'illusory body' is not directly visible but felt in the location just below the field of view of the cameras.

In the study presented here, we use the 'out-of-body illusion' (Ehrsson, 2007) to test the hypothesis that when people perceive that they are located in a different place from their real body, the seen physical body is disowned and no longer represented as one's own (as if the conscious self had 'left the body'). The importance of the findings are twofold. First, they reveal a relationship between the representation of self-location in the local environment and the multisensory representation of one's own body. Second, to our knowledge they constitute the first evidence of full-body disownership in healthy individuals, which has important implications for theories of body ownership (de Vignemont, 2011; Makin, Holmes, & Ehrsson, 2008; Tsakiris, 2010).

2. Methods and results

We used a modified version of the experimental setup described in Ehrsson (2007), which is illustrated in Fig. 1 (left panel; see Supplementary material for full description of the experimental procedures). The participants sat on a chair, wearing a set of HMDs, in which they saw a real-time video feed from a pair of cameras located 2 m behind them. The left eye displayed the video image from the left camera, and the right eye displayed the video image from the right camera. Thus, the participants observed their own back with stereoscopic vision from the perspective of a person sitting 2 m behind them. The experimenter was located just behind the participant's right shoulder, and for 1 min simultaneously touched the participant's chest, which was out of view, and the space below the cameras (i.e., the chest of the 'illusory body') with two small plastic rods. The touching of the participant's real chest and the 'illusory chest' was either synchronous, a condition that induces the out-of-body illusion, or asynchronous, a mode of stimulation which significantly reduces the illusion and allows for the comparison of otherwise equivalent conditions.

2.1. Experiment 1 and 2: evidence for changed self-location

In Experiment 1 (16 naïve healthy participants; 10 females, 27 ± 7 years), following 1 min of visuo-tactile stimulation to elicit the illusion as described above, the participants were given a map of the experimental room and were asked to indicate

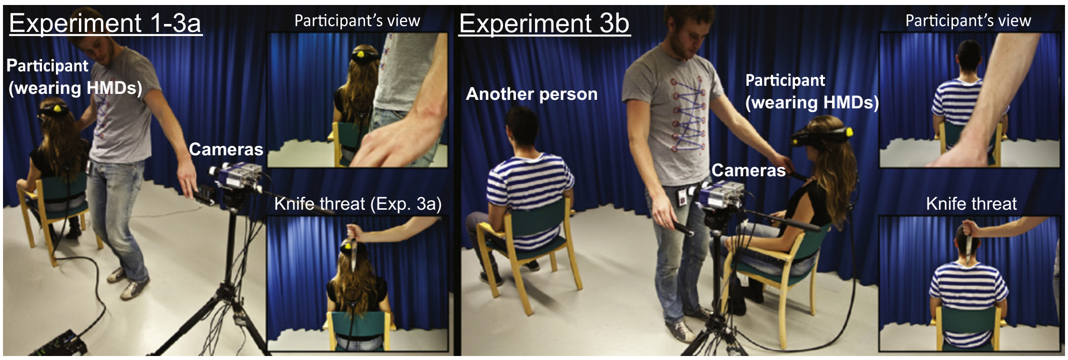

Fig. 1. Experimental setup. In Experiment 1–3a, the subject sat in front of the cameras and observed her own back through a pair of head-mounted displays (HMDs). After 1 min of synchronous or asynchronous touching of the subject's chest and the chest of the 'illusory body' below the cameras, the participant indicated her perceived self-location on a map (Experiment 1), filled out a questionnaire about her experiences (Experiment 2), or as an objective measure of body ownership, observed her own back being threatened by a knife while the evoked skin conductance response (SCR) was recorded (Experiment 3a). In Experiment 3b (which serves as a control to Experiment 3a) the participant was placed out of view of the cameras and observed another person's back being threatened while all the other conditions used in Experiment 3a were kept constant.