



Sense of body ownership in patients affected by functional motor symptoms (conversion disorder)



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ABSTRACT

Background and aim: Patients with functional neurological symptoms are commonly seen in neurological practice. Nevertheless their aetiopathology remains unclear. We have recently shown that patients affected by functional motor symptoms (FMS) present lower interoceptive awareness and higher alexithymia levels than healthy controls. Nevertheless sense of body ownership has never been studied in FMS patients.

The aim of the present study was to systematically investigate the sense of body ownership, with the rubber hand illusion (RHI) paradigm, in patients with FMS and healthy controls.

Materials and methods: We included in the study 16 patients with FMS and 18 healthy controls (HC). Patients and HC were asked to complete the Toronto Alexithymia Scale (TAS-20) and the self-consciousness scale (self-objectification questionnaire). All participants underwent the RHI paradigm: illusionary experience was measured by self-report and by proprioceptive alteration.

Results: A Mann–Whitney *U* test performed revealed that FMS (median = 2.11) participants embodied the rubber hand to the same extent than HC participants (median = 2.0, $Z = -0.86$, $p > 0.05$, $r = -0.15$). The same test revealed no significant difference in the Proprioceptive Drift experience between FMS (median = 0.0) and HC participants (median = -0.5 , $Z = -0.96$, $p > 0.05$, $r = -0.16$).

Conclusions: Our study revealed that sense of body ownership is not impaired in patients affected by FMS. This, together with the results from our previous experiment (studying the interoceptive awareness), supports the hypothesis that interoceptive awareness and sense of body ownership may be dissociated in patients with FMS.

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1. Introduction

Self-awareness is defined as the capacity for introspection and the ability to recognize oneself as an individual separate from the environment and other individuals. Basic facets of our bodily, self-awareness includes the senses of body ownership

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and agency. Body ownership refers to the perceptual status of one's own body, which makes bodily sensations seem unique to oneself (Tsakiris, Hesse, Boy, Haggard, & Fink, 2007), and it contributes to a sense of self and a developmental basis for a psychological identity (Gallagher, 2000). There has been an increased scientific interest in body ownership since Botvinick and Cohen's (1998) first reported the rubber hand illusion (RHI), during which participants experience a lifelike rubber hand as part of their body, when their own unseen hand is synchronously stroked. This is now considered one of the most reliable experimental paradigms to investigate body ownership (Tsakiris, 2010). A great scientific challenge has been to clarify the neurocognitive constituents of body ownership during the RHI, and it has been suggested that both low-level multisensory integration and high-level body representations contribute to our sense of body ownership (Makin, Holmes, & Ehrsson, 2008; Tsakiris, 2010; Tsakiris & Haggard, 2005). In order to assess different aspects of body representation, several questionnaires have also been developed. Fredrickson and colleagues developed the Self-Objectification Questionnaire (Fredrickson, Roberts, Noll, Quinn, & Twenge, 1998) and operationalized the state of self-objectification (the tendency to experience one's body principally as an object, evaluating it for its appearance rather than for its effectiveness).

The sense of body ownership has been recently investigated by means of the RHI experiment in different psychiatric conditions, including eating disorders (Eshkevari, Rieger, Longo, Haggard, & Treasure, 2012) and schizophrenia (Thakkar, Nichols, McIntosh, & Park, 2011). Both clinical populations experienced the RHI significantly more strongly than healthy controls, suggesting that these patients might have a weaker or more changeable body representation. Recently the sense of body ownership has been assessed in patients affected by medically unexplained symptoms (MUS) using the RHI protocol (Miles, Poliakoff, & Brown, 2011), and it has been shown that the tendency to report MUS is associated with decreased experience of this bodily illusion.

Recent studies have shown that interoceptive awareness as a measure of sensory perception of the body from within (i.e. heartbeat perception) is negatively correlated to the sensory perception of the body from outside (i.e. self-objectification, rubber hand illusion), namely those individuals with low interoceptive awareness experience a stronger rubber hand illusion (Tsakiris, Tajadura-Jiménez, & Costantini, 2011).

Functional motor symptoms (FMS) are part of the wide spectrum of functional neurological symptoms and they include abnormal movements and weakness (Stone et al., 2010).

We have previously demonstrated (Ricciardi et al., *in press*) that patients with FMS have poorer interoceptive awareness (sensitivity to internal bodily signals) than healthy subjects and they commonly have alexithymia (failure to identify and describe emotions in oneself and a difficulty in distinguishing and appreciating the emotions of others) when compared to patients with organic movement disorders and healthy controls (Demartini et al., 2014). Moreover we showed that in FMS patients lower interoceptive awareness was a significant predictor of self-objectification.

To date no studies have explored sense of body ownership in patients affected by FMS. The aim of the present study was to systematically investigate the sense of body ownership, with the RHI paradigm, in patients with FMS and healthy control subjects. We hypothesized that patients with FMS would experience a stronger illusion than healthy controls and such stronger illusion would be correlated with higher alexithymia and self-objectification levels. Overall, we envisioned that such investigations could provide some insight into potential emotional abnormalities in patients with FMS at a more mechanistic level than studies concentrating on traumatic life events and related risk factors.

2. Materials and methods

2.1. Participants

Patients affected by FMS, as diagnosed using the Fahn & Williams criteria for movement disorders and the DSM V Conversion Disorder criteria for functional weakness (American Psychiatric Association, 2013), were recruited from neuropsychiatry and neurology outpatient clinics at the National Hospital for Neurology and Neurosurgery (NHNN), London, UK. Sixteen patients affected by FMS assessed at NHNN between January and July 2013 were included in the study, and they were compared to 18 age- and sex-matched healthy controls (HC). Patients and healthy controls gave written, informed consent. Institutional ethics approval was obtained and the experiment was conducted in accordance with the Declaration of Helsinki.

2.2. Design and statistical analysis

The experiment used a 2 (Group: FMS vs. HC) \times 2 (Stroking Mode: synchronous vs. asynchronous) mixed factorial design, with repeated measures on the latter factor. The order of conditions was randomized across participants. For the first, between-subjects manipulation, 16 FMS participants and 18 HC participants watched a rubber hand being stroked during the relevant four conditions.

Dependent variables comprised: (1) an embodiment questionnaire (Longo, Schüür, Kammers, Tsakiris, & Haggard, 2008) was used to capture the subjective experience of the illusion (13 statements rated on a 7-point Likert-type scale; -3 = strongly disagree, $+3$ = strongly agree). In each condition, the questionnaire was administered pre- (i.e. embodiment due to the visual capture effect) and post-stroking and we calculated their difference to obtain a measure of subjective embodiment due to visuo-tactile integration. This questionnaire consisted of four sub-components: felt ownership, that is related to the feeling that the rubber hand was part of one's body; felt location of own hand, that related to the feeling that

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