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Brief article

'Am I moving?' An illusion of agency and ownership in mirror-touch synaesthesia

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ABSTRACT

Mirror-touch synaesthesia (MTS) is a condition that leads people to experience tactile sensations on their own body when watching at someone else being touched. Recent accounts postulate that MTS is linked with atypical self-other representations. It has been suggested that this may be associated with disturbances in two main components of self-awareness: sense of agency and sense of ownership. This study investigates changes in sense of agency and sense of ownership in MTS. Using a paradigm that deliberately blurs the boundaries between the self and the other, we not only found that MTS affects sense of agency and sense of ownership, but that these aspects of self-awareness are affected differently. We suggest that alterations in sense of agency can be linked to more profound disturbances in sense of ownership in MTS, and that MTS may be characterised by underlying difficulties in self-other processing.

1. Introduction

Recent findings have shown a near universal tendency for us to vicariously represent the actions and sensations of others. For example, similar neural networks are recruited when we experience touch directly on ourselves or when we observe another person being touched (e.g. see Keysers, Kaas, & Gazzola, 2010 for a review). This vicarious activation is normally implicit, in that it does not lead to an explicit sensation of the observed event on the body of the observer, however, in mirror-touch synaesthesia (MTS) the vicarious experience of touch is overt (Banissy, 2013; Ward & Banissy, 2015). In MTS individuals feel a tactile sensation on their own body simply by observing touch being applied to someone else (Blakemore, Bristow, Bird, Frith, & Ward, 2005). This experience is thought to occur in approximately 1.6% of individuals (Banissy, Kadosh, Maus, Walsh, & Ward, 2009) and there is growing interest in using MTS as a vehicle to provide insights on mechanisms of social perception and cognition. For example, prior has examined facial affect processing in MTS in order to examine theoretical accounts on the role of simulation processes in affect recognition (Banissy, Kusnir, Duchaine, Walsh, & Ward, 2011).

Prior neuroimaging studies suggest that MTS is linked to over-activity within neural regions supporting normal mirroring of touch. In people with MTS, observation of touch recruits a similar network of areas to those activated in non synaesthetes, but compared to them, they show a hyper-activation (Blakemore et al., 2005; Holle, Banissy, & Ward, 2013). Recently, it has been suggested that a breakdown in self-other processing may contribute to this over-active tactile mirroring in MTS. More specifically, mechanisms responsible for controlling self-other representations may be impaired in MTS, and this would lead to a difficulty in inhibiting the experiences of others (Banissy & Ward, 2013; Ward & Banissy, 2015).

In line with this, prior behavioural work has shown that bodily self-awareness is altered in MTS (Aimola Davies & White, 2013; Maister, Banissy, & Tsakiris, 2013). Here, we sought to build on these findings by investigating the effects of MTS on the two main aspects of self-awareness: the sense of ownership (SO) and the sense of agency (SA). SO refers to the feeling that one's body is one's own, whereas SA refers to the feeling that one's actions are one's own. As noted above, prior work from Aimola Davies et al. and Master et al. have suggested that SO is atypical in MTS, but nothing is known about changes in SA in MTS. There are good reasons to predict SA changes in MTS (see Cioffi, Moore, & Banissy, 2014, for a review). First, theoretical accounts of agency processing argue that the positive experience of agency is predicated on feeling that the body part that is moving is one's own (Gallagher, 2000). Second, two brain regions associated with SA, namely the temporo-parietal junction (TPJ) and the anterior insula (Decety & Lamm, 2007; Farrer & Frith, 2002), have also been implicated in MTS (Blakemore et al., 2005; Holle et al., 2013). By extending the investigation of self-awareness to include SA, our aim was to

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improve our understanding of the extent of self-awareness changes in MTS, and to shed light on how these two features of self-awareness interact more generally.

To do so, a group of participants with MTS and non-synaesthete controls were tested on a vicarious agency paradigm that deliberately blurs the boundaries between the self and the other: we used a modified version of a paradigm created by Wegner, Sparrow, and Winerman (2004) to induce an illusion of agency and ownership. We predicted that people with MTS will be more vulnerable to the illusion, indicating greater sense of ownership and a more malleable experience of agency.

2. Method

2.1. Participants

A group of eight adult mirror-touch synaesthetes (age range = 19–60, average age = 36.3, SD = 16.8, one male) and a group of eight non-synaesthetes controls (age range = 19–38, average age = 26.5, SD = 8.33, four males) were recruited. All participants were right-handed. All mirror-touch synaesthetes were confirmed as individuals with MTS using the Visuo-Tactile Stroop task, designed to detect the authenticity of the condition (Banissy & Ward, 2007; Banissy et al., 2009). All MTS participants significantly differed on a single subject basis (using Crawford's modified *t*-test; Crawford & Howell, 1998) to previous published control data on this task (Banissy & Ward, 2007; Banissy et al., 2009). All controls were interviewed with a synaesthesia questionnaire (including a question on MTS; adapted from Banissy et al., 2009) and did not report any synaesthetic experiences. Three of the mirror-touch synaesthetes self-reported other types of synaesthesia. All participants gave consent to participate in the study and were paid £10/h to take part in the experiment. The study was approved by the local ethical committee.

2.2. Procedure

The procedure is a modified version of the paradigm developed by Wegner et al. (2004). Participants sat on a chair facing a full-length mirror. Participants wore over-ear headphones on which were played action previews. A blue sheet covered the participants' body from the shoulders downwards. A curtain with two holes was placed behind the participant in order to block their view of the experimenter.

Participants' arms were placed out of view under the sheet. The experimenter wore another set of headphones to hear the instructions, a blouse that was the same colour as the sheet covering the participant, and a pair of white gloves that were sewn on to the blouse. The experimenter sat behind the curtain in a comfortable position and inserted his arms through the holes in the curtain. The experimenter placed his arm (either left or right) forward so that it appeared where the participant's own arm would have been (Fig. 1). Participants were asked to look at the mirror in front of them while the experimenter performed the gestures with either the left or the right hand. They were also asked to remain still during the experiment.

A tape with a list of 16 unimanual action instructions was played (e.g., "make a waving gesture," "snap the fingers twice", "point to the mirror"). The experimenter performed each action just after the end of each instruction. Each trial, consisting of one instruction and one action, lasted between eight and ten seconds, with a three second break between trials. The list of 16 instruction-action trials was repeated three times from the beginning to the end without interruption for each condition (see below) and each hand, so as to augment the effects of this manipulation.

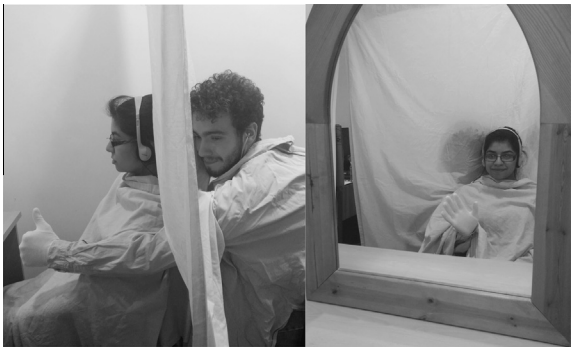

Fig. 1. Experimental set-up. Pictured side view (left) and participant view (right). The experimenter sits behind the curtain hidden from the participant's view. Here, the experimenter places his arm forward, where the participant's arm would normally appear. The participant sits in front of the mirror where she can see the arm as her own. The participant hears instructions through the headphones and observes the action being performed by the arm. In the match condition instructions and actions are congruent, while they are incongruent in the mismatch condition.

There were two within-subject conditions. In the *match condition* the action corresponded to the instruction; whereas in the *mismatch condition* each instruction was randomly matched with a different action (for example, after the instruction "make a waving gesture" the examiner snapped their fingers). In this mismatch condition, the gesture was different for every repetition of the same instruction (e.g., on the second repetition, after the instruction "make a waving gesture" the examiner pointed to the mirror). The actions performed during the mismatch conditions were previously established and the presentation order was differently randomised for each of the three repetitions. The conditions were completed for both the left and right hand. The order of match–mismatch conditions and the order in which each hand was tested were counterbalanced across participants.

After the third repetition of the instruction-action list for each condition, the participants were asked to report their experiences by answering three questions on a 7 point scale with 1 being "not at all" and 7 being "very much" (this was done for each hand). In total, each participant was given 12 trials and provided four ratings for each of the questions reported below.

The questions were adapted from Wegner et al.'s (2004) study. We asked:

(1) Anticipation: "*To what degree did you feel you could anticipate the movements of the arm?*"

This control question assesses the success of the manipulation and whether the primes were attended to. This was included because a failure to attend to the primes may explain any putative performance differences in the two groups.

(2) Agency: "*How much control did you feel you had over the arm's movements?*"
(3) Ownership: "*To what degree did the arm feel like it belonged to you?*"

A practice session consisting of 3 match and 3 mismatch trials was performed at the beginning of the experiment.

3. Results

A preliminary analysis on left and right hands were carried out for each condition using a paired sample test to see if their results could be distinguished. As no significant differences emerged, the mean judgements for left and right hands were collapsed into a