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Medically unexplained symptom reports are associated with a decreased response to the rubber hand illusion

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ABSTRACT

Objective: Medically unexplained symptoms (MUS) have been hypothesized to result from a distortion in perception, whereby top-down factors influence the process of body representation. Perceptual illusions provide a novel method of investigating this hypothesis. This study aimed to investigate whether self-reported unexplained symptoms are associated with altered experience of the rubber hand illusion (RHI).
Methods: A non-clinical MUS group with high scores on the Somatoform Dissociation Questionnaire (SDQ), and a control group with low scores on this scale, were exposed to the RHI. Illusion experience was measured by self-reports and by proprioceptive alteration.
Results: After controlling for somatosensory amplification and trait anxiety, the low-SDQ group responded significantly more strongly to the RHI on both questionnaire and proprioceptive measures of the illusion. In contrast, the high-SDQ group scored significantly higher on the Perceptual Aberrations Scale, a measure of bodily distortions in daily life.
Conclusion: These findings support the proposed link between MUS and disturbances in body representation, and suggest that a decreased reliance on current sensory inputs may contribute to symptom experience in susceptible individuals.

Introduction

Medically unexplained symptoms (MUS) are potentially disabling physical symptoms that arise in the absence of medical pathology. They have been estimated to account for at least a third of the symptoms seen in primary care [1]. In general, explanations of MUS have focused on the interaction between cognitive, behavioural and physiological factors, which are hypothesized to form a self-perpetuating vicious circle of symptom experience [2]. Most models assume that MUS arise when relatively benign physical events in the body are misinterpreted as evidence of serious illness [3–5]. Although such models can account for many MUS, they are less able to explain symptoms such as unexplained blindness and paralysis, where more profound perceptual distortions seem to be in evidence. One model that does address these symptoms explicitly is that of Brown [6], which identifies them as distortions in somatic awareness arising from overactive symptom representations in memory. In this view, MUS reflect the fact that bodily experience is an interpretation rather than a direct representation of sensory input, subject to 'top-down' as well as 'bottom-up' factors. In this paper, we aim to experimentally test this hypothesis through the use of a perceptual illusion.

There are many perceptual illusions that illustrate how bodily experience can be distorted by relatively simple manipulations. Vibration of the biceps tendon, for example, can give rise to a perceived extension of the elbow joint and even illusory elongation of the nose if it is held during the procedure (the so-called 'Pinocchio' illusion) [7]. In the rubber hand illusion (RHI), stroking a rubber hand in synchrony with the participant's hidden hand can induce the sensation that the fake hand has become part of their body [8]. The illusion does not occur when stimulation is asynchronous, demonstrating a necessary bottom-up condition for this effect; neither does it occur when the rubber hand is in an implausible position or when an object other than a hand is used [9], demonstrating the influence of top-down factors. There are often large individual differences in the experience of such illusions [10,11], and evidence suggests that some of this variation might reflect a trait-like dimension associated with body experience more generally. For example, one study [10] found a correlation between the strength of illusory arm extension (as in the 'Pinocchio' illusion) and scores on the Perceptual Aberration Scale (PAS) [12], which asks about other experiences of body distortion in everyday life.

If responsiveness to bodily illusions is a reflection of individual differences in everyday bodily experience, these illusions may provide a method by which body distortion in clinical populations can be assessed, with the advantage of being more objective than retrospective self-reports. Indeed, experience of the RHI has been found to correlate positively with self-reported bulimic symptoms in

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university students [13], while patients with anorexia nervosa appear less susceptible to the illusion than controls [14]. This experimental evidence both implicates perceptual processes in these disorders, and suggests that these body distortions may be specific to different conditions. In order to study the role of such processes in unexplained symptom reporting, we compared susceptibility to the RHI in a group with high scores on a measure of self-reported MUS (Somatoform Dissociation Questionnaire; SDQ-20) [15] and a control group with low scores on the measure, using both self-report and proprioceptive measures of the illusion. If, as suggested by Brown [6], the tendency to experience MUS is related to a disproportionate reliance on top-down factors during the process of body representation, high MUS reporters may be less susceptible to the illusion, which ultimately relies on 'tricking' this process with discrepant sensory input. If MUS experience represents a more general tendency to experience perceptual distortion, however, high MUS reporters may be more prone to experience the RHI than controls. In this case, they might also experience distortion during the control condition (where the illusion does not typically arise), or report experiencing sensations unrelated to the illusion.

Table 1
Demographic information and dependent measures for the two SDQ groups. All numbers represent means and standard deviations unless otherwise specified

	Low SDQ group ($n=20$)	High SDQ group ($n=20$)
Age	19.8 (1.6)	19.6 (1.5)
Percent female (n)	70.0 (14)	85.0 (17)
Clinical questionnaires		
Somatoform Dissociation Questionnaire	20.3 (0.5)	36.0 (9.2)
State-Trait Anxiety Scale (state subscale)	32.3 (8.0)	40.5 (9.4)
State-Trait Anxiety Scale (trait subscale)	33.8 (10.8)	43.9 (10.4)
Somatosensory Amplification Scale	25.8 (7.8)	31.5 (5.4)
Perceptual Aberration Scale	3.3 (2.9)	10.8 (4.4)
Perceptual drift towards the rubber hand (mm)		
Experimental condition	40.0 (31.6)	22.6 (28.6)
Control condition	−9.6 (28.0)	5.8 (29.4)
Reported experience of sensations relevant to illusion		
Experimental condition	1.5 (1.4)	0.9 (1.7)
Control condition	−0.5 (1.4)	−1.0 (1.6)
Reported experience of sensations not relevant to illusion		
Experimental condition	−0.8 (1.2)	−0.3 (1.1)
Control condition	−1.1 (1.3)	−0.7 (1.3)

Method

Participants

Undergraduate students at the University of Manchester were grouped according to self-reported MUS experience on the SDQ-20 [15]. The SDQ-20 asks participants to rate their experience of 20 physical symptoms (e.g., "My body, or a part of it, feels numb"; 'I have an attack that resembles an epileptic seizure') during the past year, on a scale from 1 (this applies to me not at all) to 5 (this applies to me extremely), and to state whether the symptom has been given an explanation by a physician. In order to compute a score representing only unexplained symptom experience, we rescored symptoms with an identified cause to 1 before adding up the total score. Using this method, the range of potential scores (20 to 100) remained the same, with the minimum score of 20 representing a participant who reported zero unexplained symptoms, and with symptoms only contributing towards an increased score if they were undiagnosed. For the MUS group, we selected twenty participants with relatively high scores compared to population norms ($\geq$28) [16] and comparable to those reported in somatoform disorder patients [17]. For the control group, we selected twenty individuals with low scores on the scale (20 or 21; see Table 1 for demographics). Sixteen participants with scores between 22 and 27 also took part, but were excluded.

Measures

Clinical questionnaires

State-Trait Anxiety Inventory. As negative affectivity is known to co-vary with MUS experience [18,19], the trait subscale of the State-Trait Anxiety Inventory (STAI-T) [20] was used to assess and control for between-group differences. The STAI-T asks participants to rate 20 statements (e.g., 'I feel nervous'; 'I am worried') according to how they generally feel, on a scale of 1 (not at all) to 4 (very much so), giving a total score of between 20 and 80. The STAI-T has good reliability and validity [20].

Somatosensory Amplification Scale. The Somatosensory Amplification Scale (SSAS) [21] asks participants to rate 10 statements (e.g., 'I hate to be too hot or cold'; 'Sudden loud noises really bother me') on a scale of 1 (not at all true) to 5 (extremely true), giving a total score of between 10 and 50. This measure is thought to assess the tendency to find sensations unpleasant and disturbing [3], and has been shown to relate to symptom experience [22–24]. Given that the rubber hand illusion has an affective component, whereby ratings of pleasantness of touch and enjoyment are related to illusion experience [25], this measure was included as a covariate in order to ensure that differences between groups were not attributable to differences in affective response to the tactile sensations. The SSAS has good psychometric properties [21].

Perceptual Aberration Scale. Following previous research [10], we gave participants the Perceptual Aberration Scale (PAS), [12] which measures the frequency of other bodily alterations in everyday life, to enable us to relate symptom experience to individual differences in self-reported bodily experience more generally. This scale asks participants to rate 35 statements (e.g., 'I have had the momentary feeling that my body has become misshapen'; 'I have sometimes felt that some part of my body no longer belongs to me') as either true or false, giving a total score of between 0 and 35. The PAS has been shown to demonstrate good internal consistency and moderate stability [26,27].

Rubber hand illusion

The experiment was set up and conducted in a similar manner to other RHI studies (Fig. 1). Participants wore an orange rubber glove on their left hand throughout the experiment, and rested this hand on a table beneath a black box. Their right hand was placed underneath the table. A black cape extending from their neck to the box obscured their view of their arms throughout the experiment. During the illusion, a stuffed left-handed rubber glove was placed on the box, with its index finger 20 cm to the right of the participant's index finger, approximately 7 cm above their real hand. Two paintbrushes were used to stroke the participant's and rubber hand's index fingers during the illusion. Stimulation was given between the first and second knuckles of the left hand, in an irregular pattern consisting of long and short strokes. In the experimental condition the paintbrush strokes on the two hands were given at the same time (synchronous), and in the control condition the rhythm of the strokes was varied in an irregular fashion between the two hands (asynchronous). In the experimental condition, the paintbrushes were attached with a hinge to ensure that stimulation on the real hand and rubber hand was synchronised. A black screen blocked the participant's view of the paintbrush touching their hand.

The first dependent measure of the illusion was perceptual drift towards the hand, that is, the degree to which the participant's perceived