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The Empathy Quotient (EQ) predicts perceived strength of bodily illusions and illusion-related sensations of pain

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ABSTRACT

In this study we test the possible implications of high empathising skills on bodily self–other distinction by measuring the strength of a body ownership illusion and a related experience of illusory pain. One-hundred adult participants completed the Empathy Quotient (EQ) questionnaire. Twenty participants from the top quintile and 20 participants from the bottom quintile of the EQ distribution took part in a laboratory experiment. In the experiment, a classical Rubber Hand Illusion (RHI) was induced followed by the presentation of a series of painful stimuli to the rubber hand. Participants were asked to self-rate the strength of their subjective experience of the RHI and of the illusory pain. A proprioceptive location judgment on the position of the hidden hand was also required before and after RHI induction, to record drifts towards the rubber hand. We found a significant difference between high- and low-empathy participants in RHI and pain score. The EQ was not related with the proprioceptive location judgement drift. It thus appears to be a better predictor of subjective ownership feelings and phenomenological self–other merging than of the behavioural components of bodily illusions.

1. Introduction

1.1. The empathising–systemizing theory

The empathising–systemizing theory suggests that the female brain is mostly hardwired for empathy and the male brain for understanding and building systems (Baron-Cohen, 2002). Systemizing is defined as a drive to analyse or construct systems, and empathising is defined as a drive to identify a person's thoughts and feelings, predict behaviour and respond to these with an appropriate emotion (Baron-Cohen, 2002). It was noted that individuals who score extremely high at systemizing and extremely low at empathising usually have an autistic spectrum disorder. A large number of autistic traits including deficits and delays in cognitive empathy are more likely to be found in men; therefore, extreme systemizing has been linked to the *Extreme Male Brain* theory of autism (Baron-Cohen, Knickmeyer, & Belmonte, 2005). Also an *Extreme Female Brain* theory was formulated however, according to Baron-Cohen (2005), individuals with this type of brain would not experience any difficulties in our contemporary society. Even though the potential issues related with being an extreme empathizer are still unclear, it has been related to eating disorders (Bremser & Gallup, 2012) and psychosis (Brosnan, Ashwin, Walker, & Donaghue, 2010). Here we explore the possibility that high empathising may hinder a basic form of self–other distinction.

1.2. Empathy and the Rubber Hand Illusion (RHI)

Botvinick and Cohen (1998) introduced a protocol to measure the tactile sensations experienced after observing a rubber hand being touched. They used a fake but realistic hand, made of rubber, and placed it directly in front of the subject while the real hand was hidden from view. They asked participants to focus on the rubber hand while the experimenter was synchronously stroking both the visible rubber hand and the participant's hidden hand using two paintbrushes. Before and after the stroking, a proprioceptive location judgment was introduced where participants were asked to indicate on a ruler – with their eyes closed – the location where they felt that their hidden hand's index finger was located. This enabled checking if the reported location had drifted towards the rubber hand after the stroking session. Finally, participants were asked to complete a questionnaire which included 9 statements describing the experienced sensations (e.g., "It seemed as if I were

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feeling the touch of the paintbrush in the location where I saw the rubber hand touched"). Most of the participants reported saying that it felt as if the rubber hand were their own hand. The finding was later named as the RHI and prompts the question whether/why some people are more susceptible to this illusion than others.

Asai, Mao, Sugimori, and Tanno (2011) have recently investigated the relation between RHI and empathic personality traits as measured with the Interpersonal Reactivity Index and reported that high empathic people were more susceptible to the illusion than those who had low empathising skills. According to them, high empathic people can be so absorbed by the rubber hand being touched that they can be easily triggered into believing that it is their own hand and forgetting that the real hand is hidden from them.

1.3. Mirror-touch synaesthesia and self–other merging

It has been argued that, in order to understand others, empathic people must understand themselves as well thus skills involved in understanding the self (self-awareness) and others (theory of mind) are interrelated (Galinsky, Ku, & Wang, 2005). In extremely empathic individuals, this would imply large overlaps between their representations of self and others, possibly leading to self–other confusion (Decety & Sommerville, 2003). Jackson, Brunet, Meltzoff, and Decety (2006) conducted a perspective taking study where pictures of painful situations were displayed within familiar everyday events. Participants were asked to rate the level of pain they believe another person, and the participants themselves, would perceive. Pain ratings presented by participants with higher than average empathy were shown to maintain only a small distinctiveness between the self and other (Jackson et al., 2006).

Self–other merging may also occur in individuals with mirror-touch synaesthesia (MTS), a condition which makes them feel a tactile sensation on their own body by watching another person being touched (Maister, Banissy, & Tsakiris, 2013). Studies suggest that individuals with MTS have increased activity in the tactile mirror system, and in some cases they are able to literally feel pain when they observe others experiencing pain (Blakemore, Bristow, Bird, Frith, & Ward, 2005). For this reason, individuals with such a condition have also been thought to have very high levels of empathy (Banissy & Ward, 2007). No appropriate and objective measure for mirror-touch or mirror-pain synaesthesia has yet been developed however research suggests that about 30% of the population may experience sensations, similar to those evoked by mirror-pain synaesthesia (Osborn & Derbyshire, 2010).

The flexibility of self–other boundaries was probed in a self-facial recognition task where MTS and non-MTS participants observed an unfamiliar person being touched, without being touched themselves (Maister et al., 2013). A self-facial recognition task was presented before and after seeing the other face, with participants having to evaluate whether the target face looked more like the self or the other. After viewing the touch on another's face, MTS individuals judged the images which were at first judged as containing equal self and other features as more likely to reflect the self than the other. This suggests that self–other similarity was increased when MTS participants' mental representations of their facial look have changed in order to include the features of the other's face. Similarly, during RHI, non-MTS individuals reported feeling as if the rubber hand began to resemble their own hand in terms of shape, skin tone and freckles (Botvinick & Cohen, 1998). This suggests that self–other merging can occur for both MTS and non-MTS individuals, with non-MTS individuals having to possess high levels of empathy in order to experience such sensations (Asai et al., 2011). Indeed, high levels of empathy have been also linked to the condition of MTS (Banissy & Ward, 2007).

1.4. RHI and painful stimuli

Ehrsson, Wiech, Weiskopf, Dolan, and Passingham (2007) used an RHI induction method combined with a threatening pain stimulus. The aim was to examine whether threatening a rubber hand and participant's real hand can induce a similar level of activity in the brain regions associated with anxiety. After RHI induction, the experimenter would begin to make threatening movements with a sharp needle next to the rubber hand without actually touching it. In order to compare participants' reactions, the threat was also presented to their real hand. Brain-imaging data showed that threat to the rubber hand and threat to a real hand can induce similar levels of activity in the insula and anterior cingulate cortex. The authors concluded that those participants who were able to demonstrate stronger ownership feelings over the rubber hand also had stronger neuronal responses in the brain areas responsible for anxiety when the threat was presented (Ehrsson et al., 2007).

The ability to share pain can depend on an individual's past experiences and pain memories. Derbyshire, Osborn, and Brown (2013) showed that only individuals with high and moderate tooth sensitivity were able to report pain after viewing images of someone eating an ice-popsicle. However, others argue that individual predispositions may play a role in shared pain experiences too. Fitzgibbon, Giummarra, Georgiou-Karistianis, Enticott, and Bradshaw (2010) argued that empathy for pain requires an individual to take the perspective of another person without confusing it with one's own, in order to maintain crucial boundaries between self and other. Synaesthesia for pain does not show any self–other distinctions when the observer experiences the pain of the other, which may suggest that synaesthesia for pain is an abnormal form of empathy for pain (Fitzgibbon et al., 2010).

1.5. Our study

In this study we examine whether high-empathy individuals are more susceptible to bodily illusions and more prone to perceive painful sensations without having any contact with painful stimuli. Individuals with very high empathising skills might be able to experience shared pain sensations similar to individuals with MTS. It may also be that high – but not extreme – empathisers might only show self–other overlap as measured by the RHI. The purpose of the study is to collect evidence that may help clarify whether being a high empathiser is associated to difficulties or risks, for example a predisposition to more abnormal forms like MTS. We hypothesise the presence of a significant association between empathy and self-rated RHI score, empathy and the proprioceptive location judgement drift and empathy and self-reported intensity of pain sensations under RHI.

2. Method

2.1. Participants

One-hundred volunteers (66 females) ranging in age from 18 to 43 years old (mean age = 24, SE = 1) initially completed the EQ questionnaire. They were recruited using a convenience sampling method from the Abertay University student pool. Following the initial screening procedure, 20 participants (EQ range: 56–77; 15 females; age: $M = 24$, SE = 1) whose scores were in the upper quintile and 20 participants (EQ range: 14–34; 8 females; age: $M = 24$, SE = 1) whose scores were in the lower quintile of the overall distribution of EQ scores took part in a laboratory experiment. The study was approved by the Ethics committee of the School of Social and Health Sciences of Abertay University.