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Decreased interoceptive accuracy following social exclusion

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ABSTRACT

The need for social affiliation is one of the most important and fundamental human needs. Unsurprisingly, humans display strong negative reactions to social exclusion. In the present study, we investigated the effect of social exclusion on interoceptive accuracy – accuracy in detecting signals arising inside the body – measured with a heartbeat perception task. We manipulated exclusion using Cyberball, a widely used paradigm of a virtual ball-tossing game, with half of the participants being included during the game and the other half of participants being ostracized during the game. Our results indicated that heartbeat perception accuracy decreased in the excluded, but not in the included, participants. We discuss these results in the context of social and physical pain overlap, as well as in relation to internally versus externally oriented attention.

1. Introduction

The need for social affiliation is one of the most important and fundamental human needs. From an evolutionary perspective, belonging to social groups carries several advantages in terms of survival, and reproductive opportunities and success (Brewer, 2004). Consequently, it is not surprising that humans display strong negative reactions to social exclusion and rejection. Long-term social isolation and loneliness have been associated with depression and other negative health outcomes such as increased mortality (e.g., Steptoe et al., 2013) and enhanced risk of immune dysregulation (e.g., Jaremka et al., 2013). Even small-scale social rejection in a computerized ball-tossing game, Cyberball (Williams et al., 2000; Williams and Jarvis, 2006) – a paradigm developed to study social ostracism in an experimental setting – can impact individual's psychological and physiological state. A few minutes of being Cyber-ostracized can significantly increase negative affect and lower one's sense of belonging, control, meaningful existence and self-esteem (see Williams, 2009 for a review) – independently of factors such as monetary gains and costs associated with ball possession (van Beest and Williams, 2006), or the desirability of the ostracisers (Gonsalkorale and Williams, 2007). Social exclusion has also been found to bring about a significant drop in skin temperature (Ijzerman et al., 2012), while both, heart rate deceleration (Gunther Moor et al., 2010) and acceleration (Iffland et al., 2014) have been observed in response to exclusion.

As Cyberball-excluded individuals show increased activation in the dorsal anterior cingulate cortex and the anterior insula (see Eisenberger, 2012a,b) – brain regions associated with the affectively distressing component of physical pain (Rainville, 2002) – it has been suggested that social exclusion constitutes a form of social pain. A close connection exists between the experience of social and physical pain—both in terms of neural correlates (see Eisenberger, 2012a,b for a review) as well as psychological consequences (Riva et al., 2011, 2014). However, recent research suggests that there is a limit to the social and physical pain overlap. More specifically, Riva et al. (2014) have observed that fear of physical pain and fear of social pain selectively affect the experience of physical and social pain, respectively, failing to find an effect of fear of physical pain on the experience social pain and vice versa. Additionally, a recent meta-analysis by Cacioppo et al. (2013) did not indicate a full overlap in the neural networks activated by social rejection and by physical pain, suggesting that the connection between social and physical pain systems might be more complex than previously thought. Consequently, Cacioppo and colleagues suggest that the neural network activated by social exclusion – reliably involving the anterior insula and the anterior cingulate – might be more reflective of "social uncertainty, rumination, distress, and craving rather than social pain per se" (p. 2).

Interoception – the perception of afferent visceral signals – is a key process linking physiological states and emotional experience, and the insula – the central brain region associated with interoception – has been proposed to integrate sensory inputs from the body to bring about feeling states (Craig, 2009). The fact that the insula has been consistently found to be activated by social exclusion (Cacioppo et al., 2013; Eisenberger, 2012a,b) suggests that interoceptive accuracy – the

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accuracy with which an individual perceives own internal signals (directly associated with insula activity (e.g., Critchley et al., 2004)) – might be affected by this socially distressing experience. Interoceptive accuracy, assessed via heartbeat perception accuracy, has been proposed to be a mediating factor in the subjective experience of emotion (e.g., Pollatos et al., 2005). Accumulating evidence indicates that individuals with better heartbeat perception accuracy experience emotions more intensely, as indicated by subjective ratings of arousal (e.g., Pollatos et al., 2007) and patterns of electroencephalographic activity during exposure to emotion-eliciting stimuli (Herbert et al., 2007). Although, in the past, interoceptive accuracy has been characterized mainly as a stable individual difference variable (e.g., Schandry, 1981), recent research suggests that interoceptive accuracy is also subject to state changes, with heartbeat perception accuracy increasing in conditions characterized by heightened self-focus (Ainley et al., 2012, 2013) and anxiety (Durlik, Brown, and Tsakiris, 2014).

The present study investigated the stability of interoceptive accuracy, measured via heartbeat perception accuracy, in response to Cyberball social exclusion. As social exclusion has been found to bring about increased activity in the anterior insula (Cacioppo et al., 2013; Eisenberger, 2012a,b), which, in turn, has been associated with enhanced interoceptive accuracy (e.g., Critchley et al., 2004), we hypothesized that social exclusion during the Cyberball game would bring about increased interoceptive accuracy—as reflected by an increase in heartbeat perception accuracy from pre- to post-Cyberball in excluded, but not included, individuals. As previous research has found heartbeat perception accuracy to be directly associated with the intensity of emotional experience (e.g., Pollatos et al., 2007), we hypothesized that the increase in heartbeat perception accuracy from pre- to post-Cyberball in the excluded individuals will be positively correlated with self-reported distress following the exclusion. Lastly, potential moderating effects of baseline heartbeat perception accuracy and sex were examined in the present study. Previous research has found that individuals with lower baseline heartbeat perception accuracy, categorized with median splits, experienced greater subjective reactions to social exclusion (Werner et al., 2013) and greater enhancement in accuracy due to self-focus (Ainley et al., 2012). Additionally, some studies have found sex differences in interoceptive accuracy, with males being more accurate than females (Cameron, 2001). Consequently, we included baseline heartbeat perception accuracy and sex as between-subjects factors in our analyses.

2. Material and methods

2.1. Participants

64 (43 females; Mean age = 21.31; *SD* = 2.86) students at Royal Holloway, University of London took part in the experiment in compensation for £5. The sample size was based on previous research investigating state changes in heartbeat perception accuracy (e.g., Durlik, Brown, & Tsakiris, 2014). Participants were randomly assigned to one of two conditions so that half of the participants were in the experimental condition ($N = 32$), where they were excluded while playing Cyberball and the other half of the participants were in the control condition ($N = 32$), where they were included while playing Cyberball. All participants were non-psychology students who were naïve to the Cyberball paradigm.

2.2. Cyberball

The computerized ball tossing game (Williams et al., 2000) consisted of 30 ball tosses in total, between the participant and 2 computerized players. Participants were asked to pose for a photograph to be taken. They were told that the photograph would be displayed in a box beside their avatar, while they played the game, for the other participants to see. Photographs of the computerized players: Player 1 and Player 3 were taken from The Center for Vital Longevity Face Database (Minear and Park, 2004; obtained from: http://agingmind.utdallas.edu/stimuli/facedb/). Player 2 was the participant. The photograph of the participant was not visible on the screen during the game in order not to increase self-focus, which has been found to enhance heartbeat perception accuracy (Ainley et al., 2012, 2013). In the included condition, the tosses were distributed equally among the three players, with the participant receiving the ball on one third of the tosses (10 tosses in total). In the excluded condition, the participant received the ball 2 times, at the very beginning of the game (once from Player 1 and once from Player 3), after which the participant was excluded from the game while the ball was passed only between Player 1 and Player 3 for the remainder of tosses (28 tosses). Cyberball 4.0 (Williams et al., 2012) was administered through the online survey software Qualtrics (www.qualtrics.com), using the script obtained on www.cyberball.wikispaces.com.

2.3. Post-Cyberball questionnaire

The post-Cyberball questionnaire was based on previous studies utilizing the Cyberball paradigm (e.g., Williams et al., 2002; Zadro et al., 2006) and assessed four fundamental needs (with five items per need): Belonging, Control, Meaningful existence and Self-esteem. Eight items retrospectively assessed positive and negative affect during the game. Additionally, participants reported how “ignored” and “excluded” they felt during the game and estimated the percentage of total throws they think they received during the game. All items, except for the percentage estimate, were rated on a continuous 5-point scale ranging from ‘not at all’ to ‘extremely’.

2.4. Heartbeat perception accuracy task

Interoceptive accuracy was assessed via heartbeat perception, using the Mental Tracking Method (Schandry, 1981). Participants were instructed to lightly place the heels of their hands on the heart rate sensor that was attached to the desk in front of them. Participants were asked to mentally count their heartbeats from the moment they received an audio cue signaling the start of the trial, until they received an otherwise identical cue signaling the end of the trial, and then to verbally report to the experimenter the number of heartbeats they have counted. Every participant was first presented with a 10-second training trial (during the first assessment only), and then with a pseudo-randomized block of 35-second, 25-second, and 45-second trials, with 20-second pauses in between the trials. Note that in small samples, where randomization often does not result in comparable distributions of conditions across groups, a pseudo-random order can increase procedural comparability between groups (Wölk et al., 2014). During the whole duration of the task, participants' true heart rate was monitored using the POLAR RS800CX heart rate monitor (Polar Electro Oy, Kempele, Finland sampling rate of 1000 Hz). Signals were analyzed by the Polar ProTrainer 5 software (version 5.40.172), which relies on the HRV analysis software of the University of Kuopio, Finland (Niskanen et al., 2004). The software's filtering process corrects for missed beats and false positives using median and moving average based filtering methods (polar.com/en/support/Polar_ProTrainer_5). POLAR products have excellent construct validity and instrument reliability, measuring heart rate and R-R interval data on par with electrocardiogram recorded data (e.g., Kingsley et al., 2005; Nunan et al., 2008; Quintana et al., 2012; Weippert et al., 2010). Throughout the task, participants were not permitted to take their pulse, or to use any other strategy such as holding their breath. No information regarding the length of the individual trials or feedback regarding participants' performance was given. All participants performed the heartbeat accuracy task twice: at baseline and after the Cyberball game.