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Secure attachment partners attenuate neural responses to social exclusion: An fMRI investigation

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ABSTRACT

Research has shown that social exclusion has devastating psychological, physiological, and behavioral consequences. However, little is known about possible ways to shield individuals from the detrimental effects of social exclusion. The present study, in which participants were excluded during a ball-tossing game, examined whether (reminders of) secure attachment relationships could attenuate neurophysiological pain- and stress-related responses to social exclusion. Social exclusion was associated with activation in brain areas implicated in the regulation and experience of social distress, including areas in the lateral and medial prefrontal cortex, ventral anterior cingulate cortex, and hypothalamus. However, less activation in these areas was found to the extent that participants felt more securely attached to their attachment figure. Moreover, the psychological presence (i.e., salience) of an attachment figure attenuated hypothalamus activation during episodes of social exclusion, thereby providing insight into the neural mechanisms by which attachment relationships may help in coping with social stress.

1. Introduction

Social rejection can have devastating consequences, including depression and social anxiety (Williams, 2001). Indeed, social rejection hurts. Although often regarded as a metaphor, recent evidence suggests that the “pain” experienced upon social rejection or exclusion may actually be associated with the same neural mechanisms underlying physical pain experience (Eisenberger et al., 2003; MacDonald and Leary, 2005) Such findings are in line with the idea that because both physical pain and social pain are cues that signal situations that may threaten survival, physical pain and social pain rely on a shared system that helps detecting and preventing such situations.

If social exclusion and rejection have such profound effects, and lead to the actual experience of pain, a theoretically interesting – and societally important – question is whether the opposite might also be true (Panksepp, 2003). That is, can supportive and loving relationships reduce the literal sting of pain by rejection? Can supportive relationship partners help in coping with the social pain and stress experienced upon social exclusion? Based on principles of attachment theory, the central goal of the present study was to examine whether reminders of secure attachment relationships can diminish the activation of brain areas related to pain and stress during exclusion.

In his early accounts of attachment theory, Bowlby (1982) sought to understand, from an evolutionary perspective, how and why infants become emotionally attached to their primary caregivers. When infants experience distress (from hunger, noise, pain, illness, or other causes) the attachment system is activated, causing them to seek protection and comfort from the primary caregiver, which increases survival chances. The distress-reducing or “safe have” function of attachment has been widely established in infant and child research (Ainsworth et al., 1978). It is supposed that also adults rely on attachment figures – often a romantic partner, close friend, or family member – when coping with distressing or threatening situations (Hazan and Shaver, 1987). Indeed, various lines of research have demonstrated that in anxiety-provoking situations, adults seek support from an attachment figure (Collins and Feeney, 2004; Simpson et al., 1992). Furthermore, the psychological or actual presence of an attachment figure has been shown to diminish the harmful consequences of stressful situations, as indicated both by self-reports and physiological responses (Feeney and Kirkpatrick, 1996).

Can secure attachment bonds also serve as a buffer against the distress caused by social exclusion? There is some suggestive evidence relevant to this proposition. For example, a recent fMRI study by Eisenberger and colleagues revealed that individual differences in perceived social support – a central function of attachment bonds – were negatively correlated with stress-related brain activity (e.g., dorsal anterior cingulate and hypothalamus) during a social exclusion episode (Eisenberger et al., 2007). However, because this study was correlational, it was not possible to determine the direction of

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causality (for example, it is plausible that people that have weaker neural responses to social exclusion also perceive more social support in their daily lives). Other evidence relevant to our hypothesis comes from a recent experimental fMRI study, in which women were subjected to the threat of receiving an electric shock, while their hand was held either by their spouse (i.e., an attachment figure) or by a stranger (Coan et al., 2006). In the spouse hand-holding condition, participants displayed diminished activation in threat-related brain areas such as anterior insula, superior frontal gyrus, and hypothalamus.

Although the latter finding suggests that attachment bonds can alleviate the distress experienced upon (anticipated) physical pain, it is not yet clear whether attachment bonds can diminish neural activity related to *social* distress resulting from social exclusion. Such findings would provide further support for the idea that shared neural substrates are involved in both physical and social pain, and would provide insight into the neural mechanisms by which attachment may buffer stress-responses. To address these issues, we conducted a study that used a procedure similar to Eisenberger and colleagues (Eisenberger et al., 2003; Eisenberger et al., 2007). In these studies, participants played a ball tossing game with two alleged participants on a computer, ostensibly via an internet connection. At some point, participants did not receive the ball anymore and were thus excluded from the game. While being excluded, participants typically exhibit blood-flow changes in brain areas related to the experience and regulation of pain and distress. Although initial social exclusion research mainly focused on the dorsal anterior cingulated cortex (dACC), insula, and right ventral lateral prefrontal cortex (RVLPFC; Eisenberger et al., 2003), more recent studies found that other stress-related regions such as the hypothalamus and regions in the lateral and medial prefrontal cortex (in particular, BA8) were involved in responses to social exclusion as well (Eisenberger et al., 2007). In addition, other studies – using the same ball-tossing exclusion paradigm – have found activity in the ventral part of the anterior cingulate cortex (vACC; Burklund, Eisenberger, & Lieberman, 2007; Masten et al, 2009). This latter finding is consistent with results from other studies indicating that the ventral areas of the anterior cingulate cortex are associated with affective responses to social rejection (Bush et al., 2000; Sommerville et al., 2006).

The major purpose of the present research was to experimentally examine whether attachment bonds can attenuate neural activity related to pain and distress upon social exclusion. We examined whether this proposed attenuation effect could be obtained by the mere psychological (rather than physical) presence of the attachment figure, as previous research has suggested that the mere exposure of an attachment figure's name is sufficient to activate the attachment system (Mikulincer and Shaver, 2001). Therefore, while being socially excluded during the cyberball game, participants were either exposed to the name of their most important attachment figure, or to the name of a non-attachment control figure. By doing so, we examined whether regions activated upon social exclusion are attenuated by the mere psychological presence of an attachment figure (i.e., the *attachment buffer hypothesis*).

2. Method

2.1. Participants

Fifteen (10 females, 5 males) participants mean 22 years, range 19–33 years) were paid 15 Euros for participation.

2.2. Stimuli and task

Participants were invited to the lab to participate in a neuro-imaging study on 'visual imagination.' They were told they were going to play a virtual ball-tossing game ('Cyberball') with two other people while their brain activation would be scanned. Before the game, participants were asked to provide the name of two persons — an attachment figure and a non-attachment control figure. The *attachment figure* was defined as "the person that first comes to mind that you would go to when you need help, for instance in times when things are not going very well, when you are experiencing any kind of problem, or when you simply do not feel very well." The *non-attachment figure* was defined as "a person that you would not go to when you need help in such situations — however, it is not that you dislike this person, in fact you think of this person as a nice person, but you simply would not seek out help from him or her." This operationalization aimed to distinguish between feelings of mere liking versus feelings of attachment, including the providing of a "safe haven" to rely on when in need for support or help (Bowlby, 1982; Collins and Feeney, 2004). Next, participants played Cyberball while in the scanner. Cyberball is ostensibly played via a network, with three players – two preprogrammed stooges and the participant — throwing a ball at each other on the computer screen. The participant can throw the ball at one of the two players by pressing one of two keys on a button box.

Participants played six rounds of Cyberball, three rounds in which the attachment figure's name was made salient, and three rounds in which the non-attachment figure's name was made salient. Each round consisted of 60 throws. To make it realistic, the "other" players waited for 0.5–1.5 seconds before making a throw. In the first round, the *control condition*, instructions stated that "on the screen, you will see the two other players throw a ball at each other. However, you are not connected, and will thus not play along in this round. In the lower right corner of the screen, the name [name of the attachment figure as provided by the participant, e.g., Barbara] will appear. Please imagine that Barbara stands a little behind you, while you are watching the two other players throwing the ball at each other." In the second round, the *inclusion condition*, participants were told they were now connected and would play the game with the two other players. Again, in the bottom right corner the name of the attachment figure appeared, and the participant was instructed to imagine that this person was standing a little behind him or her during the game. In the third round, the *exclusion condition*, participants were given the same instructions as in the second round. However, after about 12 throws, the participant did not get the ball anymore from the two other players, and was thus excluded from the game.

The three (control, inclusion, exclusion) conditions were repeated, except that now the non-attachment figure's name appeared on the screen, and participants were instructed to imagine that this person was standing a little behind them while playing. Which name appeared in the first three rounds was counterbalanced between participants.

After participants left the fMRI scanner, they completed a questionnaire assessing feelings of attachment to the two persons named (3 items for both the attachment and non-attachment figure, e.g. "This person can comfort me when I feel tensed", $\alpha = .72$ for the attachment figure; $\alpha = .66$ for the non-attachment figure). Participants also indicated on three items how much distress they experienced when they did not receive the ball anymore. They completed this measure twice, both regarding when the attachment person was "present," and when the non-attachment person was "present" (e.g., "When Barbara was "present" at the game, it felt unpleasant when I did not receive the ball anymore," "When Barbara was "present" at the game, I felt invisible," and "When Barbara was "present" at the game, I felt distressed"; $\alpha = .77$ for the attachment condition; $\alpha = .93$ for the non-attachment condition). We averaged the three items as an indicator of experienced distress, separately for the attachment and the non-attachment condition. It is important to note that, as we did not want to raise suspicion about the goals of our study by giving the distress measure while in the scanner and during the game, completing the measurement of distress after the experiment has other limitations,