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The impact of social exclusion on anticipatory attentional processing

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ABSTRACT

The importance of understanding how we anticipate and prepare for social rejection is underscored by the mental and physical toll of continual social vigilance. In this study, we investigate the impact of social rejection on anticipatory attentional processes using the well-known Cyberball task, a paradigm in which participants engage in a game of catch with virtual avatars who after an initial period of fair-play (inclusion condition) then exclude the participant from the game (exclusion condition). The degree of anticipatory attention allocated by subjects towards the avatars was assessed by measuring P3b responses towards the avatars' preparatory actions (i.e. the phase preceding their exclusionary actions) using high density EEG. The results of the study show that relative to the inclusion, participants exhibit elevated levels of anticipatory attentional allocation towards the avatars during the exclusion block. This shift was however significantly moderated by participants' self-reported cognitive regulation tendencies. Participants with higher levels of self-reported cognitive reappraisal tendencies showed larger anticipatory P3b increases from the inclusion to exclusion block relative to participants with reduced levels of reappraisal tendencies. These results highlight the impact of social exclusion on anticipatory neural processing and the moderating role of cognitive reappraisal on these effects.

1. Introduction

Social exclusion threatens a wide range of basic human needs (Buss, 1990; Williams, 2009b). Consequently, the experience of social rejection often sparks a cascade of psychological and physiological responses linked to numerous adverse mental and physical health outcomes. Social exclusion has been associated with a wide range of negative psychological outcomes including anxiety (Baumeister and Tice, 1990; Leary, 1990), depression (Marcus and Askari, 1999; Williams and Zadro, 2001) and cognitive impairment (Baumeister et al., 2002; Buelow et al., 2015). Social rejection and isolation have also been linked with the development of adverse health issues such as impaired immune system functioning (Kiecolt-Glaser et al., 1984), poor blood pressure regulation (Hawkley et al., 2003), reduced sleep efficiency levels (Cacioppo et al., 2002; Pereira et al., 2013), and even higher morbidity and mortality rates (Holt-Lunstad et al., 2015; House et al., 1988).

The adverse impact of social exclusion incentivizes high sensitivity in detecting potential social rejection. Many social processing frameworks such as the Need Threat Model of Ostracism (Williams, 1997) and Social Monitoring System Model (Pickett and Gardner, 2005) emphasize the role of anticipatory processes in responding to social exclusion. One key hypothesis from the Social Monitoring System model in particular is that social exclusion heightens sensitivity towards signals of potential exclusion in future interactions (Gardner et al., 2000; Pickett and Gardner, 2005; Pickett et al., 2004b). This prediction receives empirical support from a large body of research showing how exclusion-related experiences elevates future levels of rejection sensitivity (Böckler et al., 2014; Cacioppo et al., 2009; Garner et al., 2006; Kiat et al., 2017; Masten et al., 2012; see Romero-Canyas et al., 2010 for a review; Sleegers et al., 2017).

The importance of anticipatory activity in social processing is also highlighted in numerous neuroimaging studies. Research in this area has shown anticipatory neural activity towards social feedback and social stimuli to be linked with social anxiety disorders (Guyer et al., 2008; Heitmann et al., 2014; Mueller et al., 2008), social rejection sensitivity (Buckner et al., 2010; Powers et al., 2013; Rossignol et al., 2013; Van Der Molen et al., 2014) and chronic social isolation (Cacioppo et al., 2016; Qualter et al., 2013).

Anticipatory hypervigilance is linked with elevated levels of attention-related processing (Bogels and Mansell, 2004; Layden et al., 2017) and increased allocation of neural resources towards cognitive regulation (see Hofmann et al., 2012 for a review). Drawing on this body of work and research linking attentional biases towards negative social

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stimuli with cognitive reappraisal (Adam et al., 2014; Arndt and Fujiwara, 2012), it is likely that a significant portion of anticipatory activity towards potential exclusion is linked with reappraisal-related processes. Cognitive reappraisal, defined as the tendency to respond to (usually negative) emotion-eliciting situations by cognitively reconstruing them, is an antecedent-focused regulation strategy that occurs before the emotional response is generated (Gross and John, 2003; Paul et al., 2013). This antecedent-focused strategy stands in contrast to the response-focused strategy of emotional suppression in which affective reactions are actively inhibited. The anticipatory nature of cognitive reappraisal situates it well with regard to playing a key role in moderating anticipatory responses towards social exclusion.

In summary, a significant body of research supports the importance of assessing anticipatory processes that precede direct responses to social exclusion. While a single experience of social exclusion may lead to negative real-world consequences in and of itself, the anxiety and rumination associated with social hypervigilance may well have the greater weight in the long run. Research has shown links between social hypervigilance and negative health outcomes including poor sleep quality (Hicken et al., 2013), decreased arterial elasticity (Clark et al., 2006) and hypertension (Hicken et al., 2014). These far-reaching consequences underscore the importance of understanding the neural processes that underlie not only how we respond to, but also how we anticipate negative social outcomes.

1.1. The Cyberball task

The well-known “game of catch” Cyberball task (Williams et al., 2000), commonly used to assess direct social exclusion reactivity, has significant potential as a measure of anticipatory responses. In the Cyberball task, participants engage in a simulated ball tossing game, making and receiving ball passes from two or more on-screen virtual players. The Cyberball game typically consists of two separate trial blocks, an “inclusion” block and an “exclusion” one. During the inclusion block condition, the other avatars include the participant in the game for a set number of exchanges. In the exclusion block condition, after a brief inclusion period, the avatars start to substantially reduce the number of passes made to the player, often to the point of completely excluding the player from the game.

The Cyberball task has been behaviorally validated in a wide range of populations and contexts (Beekman et al., 2016; Boyes and French, 2009; Eisenberger et al., 2006; Gerber et al., 2017; Seidel et al., 2013; Wesselmann et al., 2012; Zadro et al., 2006). Research has shown that participants prefer to take a monetary loss than be excluded in the task (van Beest and Williams, 2006) and that even being explicitly told that the avatars are computer controlled fails to mitigate the task's psychological impact (Zadro et al., 2004).

The Cyberball task has proven to be a valuable tool in investigating the neural mechanisms underlying how the brain processes and responds to direct social exclusion (see Wang et al., 2017 for a review). A large number of functional magnetic resonance imaging (fMRI) investigations, beginning with pioneering work by Eisenberger et al. (2003), have shown Cyberball exclusion to be associated with activation in the dorsal ACC (Eisenberger et al., 2003; Gonzalez et al., 2015; Kross et al., 2007; Slavich et al., 2010), subgenual/ventral ACC (Bolling et al., 2012; Karremans et al., 2011; Masten et al., 2009; Onoda et al., 2009; Sebastian et al., 2011; Somerville et al., 2006), posterior cingulate (Kross et al., 2007; Masten et al., 2009), insula (Eisenberger et al., 2003; Kross et al., 2007; Masten et al., 2009; Slavich et al., 2010) and various prefrontal regions (Kross et al., 2007; Masten et al., 2009; Sebastian et al., 2011).

Identifying the specific psychological processes reflected by these neural activations has however proven to be a challenge. Some researchers have proposed a social/physical pain overlap model in which exclusion-related Cyberball responses are seen associated with social pain processing, analogous to physical pain (Eisenberger, 2012; Eisenberger et al., 2006; Sleegers et al., 2017). Others however argue that these activations more likely represent a “saliency network” or the processing of expectation violations (Iannetti et al., 2013; Somerville et al., 2006). To shed additional light on these questions, researchers have focused on disentangling the time course of neural activity associated with processing outcomes on the Cyberball task. As a high degree of temporal resolution is required to disentangle this neural cascade, one of the most popular methods of choice in this line of research is the use of event-related brain potentials (ERPs) focused electroencephalography (EEG).

One of the most consistently implicated components of interest in these studies is the P300, a well-studied neural measure associated with attentional processing (Donchin, 1981). Most commonly, these studies focus on the P3b subcomponent of the P300 complex (Gutz et al., 2011; Kawamoto et al., 2010; Themanson et al., 2013; Themanson et al., 2015; Weschke and Niedeggen, 2013, 2015, 2016). The P3b is a parietally distributed positive ERP deflection typically peaking approximately 250–500 ms post-stimulus presentation (Duncan et al., 2009; Johnson and Donchin, 1980), with the specific time-window often varying as a function of the task (see Polich, 2007 for a review). The component is linked to processes associated with attentional allocation, discrepancy detection, expectancy violation and stimulus representation updating (Kiat and Cheadle, 2017; Linden, 2005; Nieuwenhuis et al., 2005; Nieuwenhuis et al., 2004; Sato et al., 2005; Yeung and Sanfey, 2004).

Of particular interest to the current study, the amplitude of the P3b response has repeatedly been shown to be positively related to the motivational significance of a stimulus (Nieuwenhuis et al., 2005; Polich, 2007; van der Veen et al., 2014). Studies have shown affectively arousing (e.g. Conroy and Polich, 2007; Cuthbert et al., 2000; see Hajcak et al., 2010 for a review) and self-relevant outcomes (Gray et al., 2004; Ninomiya et al., 1998; Turk et al., 2011; Zhou et al., 2010) to be consistently associated with elevated P3b responses.

In the context of Cyberball, researchers have focused on the P3b response towards (1) the player receiving the ball and (2) the player observing passes between the other avatars as a function of whether those events occur in the inclusion versus exclusion stage. P3b response to passes received by the player has been repeatedly shown to be more positive when they occur in the exclusion stage (Gutz et al., 2015; Weschke and Niedeggen, 2013, 2016). However, findings involving P3b differences between passes that do not include the player in the inclusion (i.e. “not-my-turn” passes) relative to exclusion condition have been less consistent. While some researchers have found evidence for elevated P3b responses towards exclusion-related passes relative to “not-my-turn” passes (Crowley et al., 2010; Themanson et al., 2013), others have found the reverse to be true (Gutz et al., 2011; Kawamoto et al., 2010; Weschke and Niedeggen, 2015).

One possible explanation for this apparent discrepancy is that multiple factors are likely to influence the P3b response. The first of these is the strength or saliency of the exclusion experience. For instance, Crowley et al. (2010) and Themanson et al. (2013) both employed Cyberball designs with a higher proportion of exclusion versus inclusion events during the exclusion stage (96% in Crowley et al., 2010, 100% in Themanson et al., 2013) relative to Gutz et al. (2011) and Weschke and Niedeggen (2015) (84% and 66% respectively). Thus in Crowley et al. (2010) and Themanson et al. (2013), the heightened motivational salience of total exclusion induced by the near absolute lack of inclusion events in the exclusion stage may have elevated attentional responses towards exclusionary outcomes.

Another possibility, given the influence of subjective probability on the P3b response (Johnson and Donchin, 1980), is that the abrupt transition from inclusion to exclusion in Crowley et al. (2010) and Themanson et al. (2013), relative to the partial exclusion manipulation in Gutz et al. (2011) and Weschke and Niedeggen (2015), led to an increase in the P3b response to exclusion outcomes driven by the strong violation of subjective expectancy. This interpretation, initially