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Social exclusion impairs distractor suppression but not target enhancement in selective attention

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ABSTRACT

Social exclusion has been thought to weaken one's ability to exert inhibitory control. Existing studies have primarily focused on the relationship between exclusion and behavioral inhibition, and have reported that exclusion impairs behavioral inhibition. However, whether exclusion also affects selective attention, another important aspect of inhibitory control, remains unknown. Therefore, the current study aimed to explore whether social exclusion impairs selective attention, and to specifically examine its effect on two hypothesized mechanisms of selective attention: target enhancement and distractor suppression. The Cyberball game was used to manipulate social exclusion. Participants then performed a visual search task while event-related potentials were recorded. In the visual search task, target and salient distractor were either both presented laterally or one was presented on the vertical midline and the other laterally. Results showed that social exclusion differentially affected target and distractor processing. While exclusion impaired distractor suppression, reflected as smaller distractor-positivity (Pd) amplitudes for the exclusion group compared to the inclusion group, it did not affect target enhancement, reflected as similar target-negativity (Nt) amplitudes for both the exclusion and inclusion groups. Together, these results extend our understanding of the relationship between exclusion and inhibitory control, and suggest that social exclusion affects selective attention in a more complex manner than previously thought.

1. Introduction

Inhibitory control is the ability that allows people to control themselves in accordance with social norms, and is thus essential for daily life activities, and even survival. Indeed, deficits in inhibitory control have severe consequences: failing to brake to a halt when traffic lights turn red, for example, can lead to life-threatening traffic accidents. Given the importance of inhibitory control in social life, it is of great importance to understand how social interactions may affect this ability. Among numerous social interaction conditions, social exclusion, in which we are rejected or unaccepted by others, is one of the most common cases (Williams, 2007). Therefore the examination about how social exclusion influences inhibitory control is required.

Challenging the fundamental human need for strong and stable social bonds, social exclusion has been suggested to impair inhibitory control, with ample evidences demonstrated that excluded participants show more impulsive behaviors and aggression (Baumeister et al., 2005; Leary et al., 2006; Lurquin et al., 2014). One hypothesis for this effect is that the self-regulation of exclusion-related negative feelings depletes limited attentional resources, leaving insufficient resources for effective inhibitory control (Chester and DeWall, 2014; Lurquin et al., 2014). However, existing evidence has primarily focused on behavioral inhibition (i.e., self-control), and few studies have explored whether social exclusion exerts similar impacts on selective attention (i.e., interference control), another important aspect of inhibitory control (Diamond, 2013; Friedman and Miyake, 2004). This gap in the literature is surprising considering the specificity and importance of selective attention, and the possible influence it may have on behavioral inhibition. Specifically, although selective attention is found to closely related with behavioral inhibition (Friedman and Miyake, 2004), they are still different in many aspects (Adams and Jarrold, 2012). While behavioral inhibition involves suppressing impulsive or prepotent

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behaviors, which denotes relatively late-stage cognitive processes; selective attention enables us to selectively attend, to focus on what we choose, and to suppress attention to other stimuli, which represents relatively early-stage cognitive processes (DeWall et al., 2009; Diamond, 2013; Verbruggen et al., 2014a). Indeed, some researchers have demonstrated the differences between selective attention and behavioral inhibition (Adams and Jarrold, 2012). For instance, Adams and Jarrold (2012) asked autism children to complete a selective attention task (flanker task) and a behavioral inhibition task (stop-signal task), and found that children with autism had difficulty in inhibiting irrelevant distractors but not prepotent responses. Moreover, Verbruggen et al., (2014a) put forward an action control framework, proposing that later action control might depend on early selective attention. According to this framework, early-stage selective attention would exert quite a significant influence on late-stage behavioral inhibition (Friedman and Miyake, 2004; Verbruggen et al., 2014b). This idea has also been demonstrated recently: using a modified stop-signal task (i.e., stop signal was surrounded by salient distractors), Verbruggen et al., (2014b) reported that worse performance on selective attention (failing to efficiently suppress distractors and detect stop signal) was followed by weaker behavioral inhibition. Therefore, in the present study, we sought to extend these findings and simultaneously help fill the gap in the literature by examining how exclusion influences selective attention.

Surrounded by vast streams of information, selective attention is vital, as it allows us to filter relevant from irrelevant information (Feldmann-Wustefeld and Schubo, 2013; Wang et al., 2013). Two mechanisms of selective attention have been proposed: target enhancement and distractor suppression (Adam and Vogel, 2016; Hickey et al., 2009). To explain these terms, imagine that you take a call on your phone while the television plays loudly in the background. To make it easier to hear the caller, you can either turn up the volume on your phone (target enhancement) or turn down the volume on the television (distractor suppression). Both mechanisms presumably lead to the same behavioral outcome: you hear the caller more clearly. To explore the mechanisms underlying selective attention (enhancement and suppression), Hickey et al. (2009) adopted the additional singleton paradigm in which participants searched for a target while ignoring another more salient distractor. In this paradigm, the relative position of the stimuli is crucial for examining selective attention; target and distractor stimuli are either both presented laterally, or one is presented laterally and the other on the vertical midline (i.e., unlateralized). Since unlateralized stimuli cannot typically elicit a lateralized event-related potential (ERP) component, target- and distractor-evoked potentials could be analyzed independently. Consequently, the authors found three lateralized components considered to be markers of selective attention: the N2pc, a negative deflection of the ERP contralateral to the attended items (goal relevant target or physically salient distractor) when target and distractors were both lateral, reflecting attentional selection; the Pd (distractor-positivity), a positive deflection contralateral to the distractor when only the distractor was presented laterally, reflecting distractor inhibition; and the Nt (target-negativity), a negative deflection contralateral to the target when only the target was presented laterally, reflecting target enhancement. Moreover, the Pd and Nt were hypothesized to be subcomponents of the N2pc (Hickey et al., 2009), and this assumption has recently been verified (Gaspar and McDonald, 2014).

Currently, the influence of social exclusion on selective attention (target enhancement and distractor suppression) remains unexplored. However, some indirect evidence should be noted (Baumeister et al., 2005; DeWall et al., 2008; Weimer, 2016). Using a dichotic listening task, Baumeister et al. (2005) presented information simultaneously to both ears, and asked participants to ignore the material spoken in one ear so as to be able to screen the list of words presented to the other ear. They found that excluded participants displayed worse performance than included participants did, which indicates that excluded participants experienced a greater distractor interference effect. Similarly, Weimer (2016) asked participants to perform a Flanker task, and found that excluded participants showed a trend of worse performance (i.e., longer response time and higher error rate) relative to included participants, suggesting that rejected participants are more susceptible to the interference of distractor stimuli. Based on these studies, it seems plausible to conclude that exclusion impairs distractor suppression. However, the Flanker task and dichotic listening task might be completely different tasks, tapping into very different attentional/executive function mechanisms. More importantly, because the target and distractor processing were mixed and could not be separately examined in these studies, it is thus difficult to know to what extent these results were related to target enhancement or distractor suppression. The question therefore remains as to whether and/or how exclusion influences selective attention.

In summary, although existing studies have investigated how social exclusion may influence behavioral inhibition, few studies have extended this research to selective attention. Furthermore, studies that *have* attempted to examine this failed to distinguish target processing from distractor processing (DeWall et al., 2008; Lurquin et al., 2014). Consequently, the present study aimed to explore how social exclusion affects selective attention, and to disentangle the processing of the target, as reflected by the Nt component, and inhibition of a distractor, as reflected by the Pd component. To manipulate social exclusion, we implemented a Cyberball game, and to measure selective attention, participants performed a unidimensional variant of the additional singleton search task (Gaspar and McDonald, 2014). Similar to Hickey et al. (2009), target and salient distractor stimuli were either both presented laterally or one was presented on the vertical midline and the other laterally.

We hypothesized that social exclusion would affect selective attention, which would manifest as less efficient target processing at the behavioral level as well as smaller N2pc amplitude at the neural level. In order to overcome the fact that these measures were the combined outcomes of both distractor and target processing (Gaspar and McDonald, 2014), we also investigated how exclusion would affect the attention-related N2pc subcomponents, Pd and Nt, and more importantly, whether they would be similarly affected. More precisely, we hypothesized that exclusion would affect distractor and target processing differently. For distractor processing, we hypothesized that exclusion would impair distractor suppression, which would manifest as a smaller Pd amplitude for excluded participants than for included participants (DeWall et al., 2008; Lurquin et al., 2014). This hypothesis was made based on the close relationship between distractor inhibition and response inhibition (Friedman and Miyake, 2004): as many previous studies have demonstrated the impairment effect of exclusion on response inhibition, this hypothesis might be reasonable. Moreover, because some studies have shown that exclusion does not influence basic attention performance (Baumeister et al., 2005; Buelow et al., 2015), we hypothesized that, for target processing, exclusion would not impair target enhancement, and that this would manifest as a similar Nt amplitude for excluded and included participants.

2. Methods

2.1. Participants

Thirty-six female volunteers (18–22 years; $M = 20.95$, $SD = 1.18$) took part in this experiment and were randomly assigned to either the inclusion or exclusion group. Three participants were excluded, one from exclusion group and two from inclusion group, as they doubted the credibility of the Cyberball procedure. This resulted in a total of 17 and 16 participants in exclusion and inclusion group, respectively. We included only female participants because previous research has shown that female subjects are more likely to suffer from social exclusion (Benenson et al., 2013). The research protocol was approved by the