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Attentional avoidance of threats in obsessive compulsive disorder: An event related potential study

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ABSTRACT

The neural mechanism underlying attentional bias in OCD (Obsessive-Compulsive Disorder) remains unclear. The goal of this study was to examine and compare the time course and the event related potential (ERP) components in OCD patients and healthy controls (HC) to reveal the complex brain activation pattern associated with attentional bias in OCD. The behavioural and electroencephalogram (EEG) data were recorded while the participants performed an emotional Stroop task. Compared to HC, the individuals with OCD exhibited slower response time, prolonged *N1* latency and larger *N1* and *P2* amplitudes across different emotional words. In addition, we discovered that the OCD group showed an enlarged *N1* component to OCD-related threat words compared to neutral words. Moreover, the OCD group had decreased *P3* and later positive potential (*LPP*) amplitudes towards all types of words compared to the HC group. More importantly, the OCD group manifested smaller *LPP* amplitude to threat words compared to the HC group. Our findings suggest that OCD individuals may excessively direct their attention away from the threat at the late processing stage, probably due to the intensive processing or overestimation of the stimuli in the early automatic processing stage.

1. Introduction

Obsessive-Compulsive Disorder (OCD) is a highly recurrent and intractable mental disorder that is associated with a high lifetime prevalence of 2–3% (Ruscio, Stein, Chiu, & Kessler, 2010). OCD is characterized by persistent and unwanted obsessions mostly accompanied by ritualistic compulsions (American Psychiatric Association, 2013). Accruing evidence indicates that compared to other mental disorders, OCD patients are more vulnerable to social dysfunction (Jacoby, Leonard, Riemann, & Abramowitz, 2014). Consequently, it is essential to understand the mechanisms underlying OCD for guiding clinical practice for maintenance treatment and alleviating the impact of this debilitating psychiatric disorder on public health.

Interestingly, recent scientific findings based on cognitive theories suggest that the attentional bias to relevant threats probably contributes to the cause and maintenance of OCD (Cisler & Olatunji, 2010; Fan et al., 2014; Foa, Ilai, McCarthy, Shoyer, & Murdock, 1993; Kyrios & Iob, 1998; Lavy, Van Oppen, & Van Den Hout, 1994; Tata, Leibowitz, Prunty, Cameron, & Pickering, 1996; Thomas, Gonsalvez, & Johnstone, 2013; Unoki, Kasuga, Matsushima, & Ohta, 1999). Attentional bias is the process by which a person may allocate imbalanced attentional resources towards potential threats (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzendoorn, 2007; MacLeod, Mathews, & Tata, 1986; Mogg & Bradley, 1998), and it comprises three core components including facilitated attention, difficulty in disengagement and attentional avoidance (Cisler & Koster, 2010). Several behavioural studies have explored attentional bias in OCD, but the conclusions have been inconsistent. On the one hand, several studies have shown that OCD individuals allocated more attentional resources to OCD-related stimuli (Foa et al., 1993; Kyrios & Iob, 1998; Lavy et al., 1994; Tata et al., 1996; Unoki et al., 1999). On the other hand, other

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behavioural studies failed to discover this phenomenon in OCD patients (Harkness, Harris, Jones, & Vaccaro, 2009; Moritz et al., 2008; Moritz & von Mühlenen, 2008).

All of behavioural studies mentioned above, however, did not investigate the elaborate cognitive processing that was involved in attentional bias. In contrast, ERP is an ideal tool for the investigation of neural activity that can provide ideal temporal resolution and sensitivity to emotional processing (Fan et al., 2016, 2014; Luck, 2014; Thomas, Johnstone, & Gonsalvez, 2007). In particular, ERPs have been successfully applied to explore an individual's response to events in the external and internal environment (Key, Dove, & Maguire, 2005). Specifically, a great variety of ERP components have been identified that are associated with the general and specific aspects of cognitive tasks. It has been noted that visual cognitive processing has two stages: the early automatic and the late strategic stage, which represent the exogenous and endogenous aspects of stimuli, respectively (Luck, 2014). In the early processing stage, *P1*/*N1*/*P2* are presented, which basically reflect an individual's automatic cognitive processing. In contrast, *N2*/*P3*/*LPP* (late positive potentials) are the late cognitive processing components, representing more elaborate, elegant and conscious processing.

The emotional Stroop task is one popular paradigm to detect an individual's attentional bias (Williams, Mathews, & MacLeod, 1996) that was also employed in our study. A number of ERP studies have been executed to explore the emotional Stroop phenomena among nonclinical populations (González-Villar, Triñanes, Zurrón, & Carrillo-de-la-Peña, 2014; Gootjes, Coppens, Zwaan, Franken, & Van Strien, 2011; Li, Zinbarg, & Paller, 2007; Pérez-Edgar & Fox, 2003; Thomas et al., 2007; Sass et al., 2010; Van Hooff, Dietz, Sharma, & Bowman, 2008). However, the ERP results are controversial. For example, one study suggested that the *N1* amplitude was decreased for emotional stimuli (Pérez-Edgar & Fox, 2003), whereas other studies showed that there was no such *N1* effect (González-Villar et al., 2014; Thomas et al., 2007). An enlarged *P*1 amplitude to emotional stimuli, however, has been consistently detected by several studies (Li et al., 2007; Sass et al., 2010; Van Hooff et al., 2008). Generally, *P1* and *N1,* whose peaks appear around 100 ms, are sensitive to attention allocation (Luck, Woodman, & Vogel, 2000) and probably represent facilitated attention to emotional stimuli (Carretié et al., 2009; Li et al., 2007; Thomas et al., 2013; Van Hooff et al., 2008), which could be modulated by the amygdala (Cisler & Koster, 2010; Citron, 2012). An enhanced *P2* amplitude has been induced by emotional stimuli (González-Villar et al., 2014), and the voltage in the right hemisphere was larger than that in the left (Thomas et al., 2007). As suggested, *P2*, whose peak appears around 200 ms, indicates the attentional modulation of non-target stimuli or the classification of different stimuli (Crowley & Colrain, 2004; for a review, see Key et al., 2005). It is widely recognized that *N2* is associated with attentional control and inhibition (Folstein & Van Petten, 2008). Researchers have suggested that difficulty in disengagement occurs in the early automatic and late strategic processing stages (Cisler & Koster, 2010). This process of disengaging attention from a threat stimulus appears to be modulated by attentional control and inhibition (Cisler & Koster, 2010). Therefore, *P2* and *N2* could be neural markers of difficulty with disengagement.

At the late strategic processing stage, a pronounced *P3* amplitude (Li et al., 2007; Sass et al., 2010; Thomas et al., 2007), a delayed *P3* latency and a larger *LPP* (Pérez-Edgar & Fox, 2003) to emotional stimuli have been discovered. Moreover, decreased and increased slow negative potentials were both discovered (Sass et al., 2010; Van Hooff et al., 2008). The *P3* is sensitive to the amount of attentional resources engaged during dual-task performance (Polich, 2007) and appears to reflect the capturing and allocation of capacity-limited attentional resources to a motivationally salient environment (Hajcak, MacNamara, & Olvet, 2010). The *LPP* is able to reflect increased salience of stimuli or sustained attention to emotional stimuli (Foti, Hajcak, & Dien, 2009; Gootjes, Coppens, Zwaan, Franken, & Strien, 2011; Hajcak & Olvet, 2008; for a review, see Hajcak et al., 2010), which is related to the intensity of the stimuli (Hajcak et al., 2010). Attentional avoidance, one component of attentional bias, occurs at the late strategic processing stage and may be modulated by emotion regulation (Cisler & Koster, 2010). Collectively, the results indicate that the *P3* and *LPP* are probably the neural indexes of attentional avoidance. The larger *P3* or *LPP* could denote enhanced sustained attentional processing (Hajcak et al., 2010), whereas smaller ones could represent attentional avoidance processing.

In contrast with the studies of emotional Stroop in healthy groups, however, to the best of our knowledge, very few studies have been conducted to explore the time course of attentional bias towards emotional stimuli in OCD. Even in those limited studies, the findings are still controversial. In one study, the researchers explored attentional bias in OCD and panic disorders (PD) by manipulating threat words (OCD-related and PD-related) and neutral words (Thomas et al., 2013). The results showed that in the OCD group, the participants manifested larger *P1* amplitude and longer *N1* latency to the threat stimuli. However, in other studies (Fan et al., 2014, 2016) that also utilized an emotional Stroop task, the researchers failed to discover augmented *P1* or *N1* amplitude. Nevertheless, they found that the OCD participants showed enhanced *P2* and *P3* amplitudes to all kinds of words, including positive, negative and neutral characters (Fan et al., 2014, 2016). The analysis of latencies among ERPs, however, was absent in their study. From the aforementioned behavioural and ERP studies, we can see that both the behavioural and neural processes associated with attentional bias in OCD are still controversial and unclear. Therefore, more efforts are needed to understand this topic. More importantly, none of the previous studies showed the component of attentional bias in OCD clearly, which is vital to guiding treatment. For example, if OCD patients showed excessive attentional avoidance to threats, exposure and response prevention (EX/RP) seems to be appropriate. Setting aside the inconsistent results, we could infer that ERPs are sensitive to the cognitive processing of the emotional Stroop task (Thomas et al., 2007, 2013). Therefore, this pilot study explored the neural mechanism of attentional bias in OCD using ERPs.

As such, we conducted this study aiming to consolidate and expand upon previous results and explore the components of attentional bias in OCD with the help of ERP and the emotional Stroop task. According to the previous studies, we hypothesized that (1) if the component of attentional bias in OCD facilitates attention, the OCD group will have shorter latency and larger peak *N1* or *P1* compared to the healthy controls (HC) group; (2) if the component is difficulty in disengagement, then enlarged *P2* and *N2* will be detected and pronounced *P3* will be seen as well in the OCD group; and (3) if OCD individuals process threat words intensively in the early stage but direct attentional avoidance strategically away from the threat in the late stage, then early components (*P1* or *N1*, *P2*) should show larger amplitudes for threat words coupled with smaller late components (*P3* and *LPP*) reflecting a lack of continued engagement (Sass et al., 2010). To test those hypotheses, we examined the response times and ERP components to different emotional words between the OCD and HC groups. It was anticipated that the investigation into differences in ERP components between the OCD and HC groups during the completion of a Stroop task will help us improve the understanding of the neural mechanisms of OCD.