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Enhanced action tendencies in obsessive-compulsive disorder: An ERP study

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ABSTRACT

Obsessive-compulsive disorder (OCD) is characterized by repeated thoughts and behaviors. This study explored the stages of motor response preparation that precede action performance or inhibition: We investigated whether OCD is related to enhanced action tendencies in response to external stimuli. Response preparation processes were assessed using the event-related potential (ERP) component of the readiness potential (RP). ERPs were recorded while 15 participants with OCD and 16 healthy controls performed a variation of the go/no-go task and the stop-signal task using schematic faces (angry and neutral). The OCD group presented with a greater RP slope gradient and amplitude over bilateral frontoparietal areas corresponding to the motor cortex. The amplitude effect was further enhanced under negative valence, compared to the neutral condition. Results support the hypothesis that stronger readiness for action might characterize OCD, especially in the presence of threatening stimuli. These findings – specifically correlated with OCD and not with anxiety and depression symptoms – may underlie habitual behavior and embodiment tendencies in OCD. This study suggests that early stages of motor preparation might be important to the etiology and maintenance of OCD.

1. Introduction

Obsessive-compulsive disorder (OCD) is characterized by persistent, intrusive, and distressing obsessions and/or compulsions and is associated with marked impairments in quality of life (American Psychiatric Association, 2013; Eisen et al., 2006). Vast neuropsychological research of OCD patients indicates that they show deficits in executive functions, specifically response inhibition (Bannon, Gonsalvez, Croft, & Boyce, 2002; Chamberlain, Fineberg, Blackwell, Robbins, & Sahakian, 2006; Penades et al., 2007). Response inhibition is one of the most widely investigated functions suspected to be impaired in OCD. It refers to the ability to voluntarily select a task-appropriate and task-relevant, goal-directed response while suppressing a more compelling – but task-inappropriate – response (e.g., Luna, Padmanabhan, & O'Hearn, 2010; Verbruggen & Logan, 2008).

Results for response inhibition research in OCD are inconsistent. On the one hand, some studies show evidence of inhibitory deficits in OCD patients as well as their first degree relatives in measures such as stop-response latencies in the stop-signal task and stronger interference in the Stroop task (Bannon et al., 2002; Chamberlain et al., 2006; Menzies et al., 2007; Penades et al., 2007). On the other hand, some studies have found no response inhibition deficits in OCD patients (Krishna et al., 2011; Roth et al., 2007). Abramovitch and Abramowitz (2014), for example, assert that it is improbable that response inhibition is significant in OCD and provide several alternatives to this claim. Nevertheless, both lines of research refer to the inhibitory stage, or rather, to the lack of sufficient inhibition for an executed response.

A more intense and early initiation of a response to a stimulus may contribute to or account for impaired inhibitory processes. Such processes, unlike later stages of response inhibition, have been much less studied in OCD (Gilbert et al., 2004; Greenberg et al., 2000; Hajcak & Simons, 2002; Okasha et al., 2000). However, preliminary evidence in the electrophysiological and functional imaging literature suggests that a more intense connectivity between stimulus perception and motor response initiation might be an additional characteristic of OCD symptomology (e.g., Greenberg et al., 2000; Hajcak & Simons, 2002; Okasha et al., 2000; Yucel et al., 2007). For instance, a study using functional magnetic resonance imaging found greater relative activation of the supplementary motor area in OCD patients when compared to control participants

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(Yucel et al., 2007). Another study conducted transcranial magnetic stimulation (TMS) and demonstrated that subjects with OCD have increased intracortical disinhibition and a lower threshold for motor-evoked potential, relative to healthy controls (Greenberg et al., 2000). It has further been shown in event-related potential (ERP) studies that subjects with OCD have higher amplitudes in various components, indicating stronger stimulus processing reactivity (Hajcak & Simons, 2002; Okasha et al., 2000). These studies, therefore, further support the possibility for stronger motor response initiation as a characteristic of OCD.

Current research also implicates impaired sensorimotor gating, as manifested in significantly less prepulse inhibition in both a medicated and unmedicated OCD population (Ahmari, Risbrough, Geyer, & Simpson, 2012; Hoenig, Hochrein, Quednow, Maier, & Wagner, 2005). Sensorimotor gating refers to the neural process through which we screen external and internal sensory, cognitive, and motor information to allow uninterrupted processing of the most salient and relevant environmental stimuli (Butler et al., 1990). This process might have significant psychophysiological implications for motor compulsions in OCD (Rossi et al., 2005). Thus, impaired sensorimotor gating in OCD may be maintained via enhanced action tendencies in OCD, which may manifest as a deficiency in controlling compulsive urges.

It is highly likely that enhanced action tendencies in response to an external stimulus would produce stronger processes of motor preparation. A suitable electrophysiological indicator of such perceptual and motor preparatory processes is the ERP component known as the readiness potential (RP). This component is considered the most suitable correlate of motor response preparation for an external stimulus (for a comprehensive review, see Colebatch, 2007). Indeed, previous research conducted in our lab has shown this component to be enhanced in college undergraduates with high OC symptoms versus low OC symptoms (Dayan, Berger, & Anholt, 2014). Further, results showed that these group differences were enhanced in response to negatively valenced stimuli and were not explained by levels of anxiety or depression. However, no study to date has investigated RP in a clinical OCD sample.

Our study tested the action tendency hypothesis in a clinical sample to establish its relevance to OCD patients. In addition, because OCD is highly comorbid (Simon et al., 2004), psychopathology was assessed to ensure that results were not explained by symptoms other than OCD. This study investigated whether OCD is related to enhanced RP. We expected participants with OCD to exhibit faster reaction times (RT) and greater RP than healthy controls. We used a go/no-go task combined with a stop-signal task; both tasks are specifically involved in the inhibition of action tendencies and are often used in OCD research. As OC symptoms often co-occur with anxiety disorders (Hofmeijer-Sevink et al., 2013; Nestadt et al., 2001), we also set out to show that our results were specific to OC symptoms relative to trait anxiety symptoms. We relied on research indicating that higher self-sensitivity and increased vigilance to affective stimuli – specifically danger cues – is more prevalent in OCD (e.g., Doron & Kyrios, 2005); thus, we also expected our behavioral and ERP effects to be exacerbated in a negative emotional context.

2. Method

2.1. Participants

This study involved 31 undergraduate students who received course credit or a small monetary compensation for participation (mean age = 24.03 years; *SD* = 1.83; 17 females and 14 males). An advertisement was sent via e-mail to 490 undergraduate students asking them to complete an online questionnaire that assesses OCD symptoms (Obsessive-Compulsive Inventory-Revised [OCI-R]; Foa et al., 2002). The ad stated that participants might then be invited to the lab to participate in further research on OCD for either course credit or a small monetary compensation. Participants with a high OCI-R score suggestive of a likely diagnosis of OCD and participants with an OCI-R below this cut-off were invited for a clinical interview. Exclusion criteria included self-reported history of neurological disorders, current use of medication, learning disabilities, head injury, and left-hand dominance. The study was approved by the Helsinki Ethics Board of Soroka University Medical Center and the Ethics Committee of the Ben-Gurion University of the Negev Psychology Department. All participants willingly signed informed consent forms and were debriefed at the end of the experiment.

2.2. Questionnaires

In this study, 490 participants were prescreened for OCD symptoms using the Obsessive-Compulsive Inventory-Revised (OCI-R; Foa et al., 2002). Fifty participants with high OCD symptoms suggestive of a likely OCD diagnosis, and 20 participants below this cut-off were then invited for a clinical interview by a clinical psychology graduate students under the supervision of an OCD expert (GEA), who used the Mini International Neuropsychiatric Interview (M.I.N.I.), a clinical diagnostic interview based on DSM-IV (Sheehan et al., 1998). A score of 21 on the OCI-R was set as the cut-off score for inviting subjects with suspected OCD for clinical interviews as this is the recommended cut-off score, with scores at or above this level indicating the likely presence of OCD (Foa et al., 2002). Participants whose scores were greater than 21 were invited for a clinical interview and were admitted to the OCD group if they were diagnosed with OCD and no other psychopathology. Participants with scores lower than 21were admitted to the control group after screening for OCD or any other psychopathology. OCD symptoms were evaluated using the Yale-Brown Obsessive Compulsive Scale (Y-BOCS; Goodman et al., 1989). Participants were diagnosed as having OCD if they met the OCD criteria on the M.I.N.I. and had a Y-BOCS score greater than 16 as this is the recommended cut-off score, with scores at or above this level indicating moderate, severe, or extreme OCD (Goodman et al., 1989). Participants with no psychopathological comorbidity were allocated to the OCD group (8 male and 7 female participants, mean OCI-R score = 36.13, *SD* = 5.91, mean Y-BOCS score = 20.20, *SD* = 2.04). Participants with low OC symptoms (OCI-R < 21) and who were assessed as not having OCD or any other psychopathology (evaluated using the M.I.N.I.) were allocated to the control group (6 male and 10 female participants, mean OCI-R score = 13.06, *SD* = 5.04). The groups differed significantly in OCI-R score $t(29) = 11.716$, $p = 0.000$, one-tailed. The groups did not differ in gender or in age (see Table 1). Participants were also evaluated using the State Trait Anxiety Inventory (STAI; Spielberger, 1983) and the Beck Depression Inventory (BDI; Beck, Ward, & Mendelson, 1961). Although anxiety and depression comorbidities were excluded from the sample, the OCD group maintained increased levels of anxiety and depression relative to the control group (see Table 1).

2.3. Experimental tasks and procedure

Participants performed a variation of the go/no-go task with stop-signals used by van den Wildenberg, van der Molen, and Logan (2002). The go/no-go task is one in which stimuli are presented in a continuous stream, and participants make a binary decision for each stimulus. One of the outcomes requires a motor response from participants (go), and the other outcome requires participants to refrain from making a motor response (no-go).