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Explicit instructions facilitate performance of OCD participants but impair performance of non-OCD participants on a serial reaction time task

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ABSTRACT

Previous studies have shown that individuals diagnosed with OCD tend to rely on explicit processing while performing implicit learning tasks. We sought to investigate whether individuals with OCD are capable of implicit learning, but would demonstrate improved performance when explicit processing strategies are enhanced. Twenty-four participants with OCD and 24 non-psychiatric control (NPC) participants performed an implicit learning task in which they responded to a single target stimulus that successively appears at one of four locations according to an underlying sequence. We manipulated the learning strategy by informing half of the participants that the target stimulus location was determined by an underlying sequence, which they should identify (intentional learning). The other half of the participants was not informed of the existence of the underlying sequence, and was expected to learn the sequence implicitly (standard learning). We predicted that OCD participants will exhibit inferior performance compared to NPC participants in the standard learning condition, and that intentional learning instructions would impair the performance of NPC participants, but enhance the performance of OCD participants. The results supported these predictions and suggest that individuals with OCD prefer controlled to automatic processing. We discuss the implications of this conclusion to our understanding of OCD.

1. Introduction

Obsessive-compulsive disorder (OCD) is characterized by prominent cognitive symptoms, including obsessions, doubt, distrust of memory and perception, mental checking and reconstruction, and difficulty in decision making (Nestadt et al., 2016; Radomsky & Alcolado, 2010; Samuels et al., 2017; van den Hout & Kindt, 2003). Ample research and subsequent theoretical models have focused on understanding obsessive-compulsive (OC) phenomena in terms of information processing impairment (Muller & Roberts, 2005; Purcell, Maruff, Kyrios, & Pantelis, 1998; Radomsky & Alcolado, 2011). This research includes a growing body of evidence suggesting that understanding the interplay between explicit and implicit learning in OCD may be of particular relevance.

Implicit learning is characterized by non-intentional acquisition of knowledge (Frensch, 1998), and is typically employed when acquiring complex or non-salient regularities such as language (Berry & Broadbent, 1987, 1988; Reber, 1976; Reber, Kassin, Lewis, & Cantor, 1980). Knowledge resulting from implicit learning is difficult to express verbally (Dienes & Berry, 1997; Reber & Lewis, 1977), and instead manifests itself as a feeling-of-knowing (Reber, 1997; Spehn & Reder, 2000) or intuition (Lieberman, 2000; McCrea, 2010; Reber, 1989). For example, participants in a standard implicit learning task have an evocative feeling of what is the right action or solution (Dulany, 1991, 1996), but nevertheless often fail to verbalize or recognize the underlying regularity of the task in post experiment questioning (Frensch & Rünger, 2003).

In contrast to implicit learning, explicit learning is characterized by intentional acquisition of information (Frensch & Rünger, 2003; Dienes & Perner, 2002). It typically results in verbalizable, symbolic knowledge (Sun, Slusarz, & Terry, 2005; O'Brien-Malone & Maybery, 1998). This type of learning is considered most suitable for discovering simple and salient regularities (Berry & Broadbent, 1988). The dissociation between implicit and explicit learning is particularly evident when individuals who would naturally learn implicitly (such as in the artificial grammar learning task; see Reber, 1989) are instructed to search for the underlying rule structure and as a result employ explicit strategies. In such situations, if the underlying pattern is complex or non-salient, attempts at explicit learning often impede learning compared to a situation in which no explicit strategies are encouraged (Berry &

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Broadbent, 1987, 1988; Reber, 1976, 1989).

Several studies have shown that individuals with OCD perform poorly on tasks that require implicit learning (Deckersbach et al., 2002; Marker, Calamari, Woodard, & Riemann, 2006) or entirely fail to learn such tasks (Joel et al., 2005). Early brain imaging studies substantiated these findings by examining the brain activation patters in individuals with OCD when performing a Serial Reaction Time (SRT) task (Nissen & Bullemer, 1987). Performance in this task is typically correlated with activation in striatal brain regions that are associated with implicit learning (Rauch et al., 1997). However, OCD participants showed increased activity in orbitofrontal and hippocampal brain areas that are typically involved in explicit learning. These findings led Rauch et al. (1997) to conclude that the striatal system, which normally subserves implicit learning, is dysfunctional in OCD, and that recruitment of the orbitofrontal and hippocampal systems may compensate for this dysfunction in implicit processing.

Deficient performance in implicit learning is consistent with the clinical features of OCD. The phenomenology of OCD suggests that these individuals operate in a highly focused, intentional and tense mode. They tend to continuously monitor their own actions and thoughts (Purdon & Clark, 2002; Ursu, Stenger, Shear, Jones, & Carter, 2003) and their behavior is marked by deliberateness and conscious efforts (Liberman & Dar, 2009; Wahl, Salkovskis, & Cotter, 2008). This mode of operation is accompanied by a prominent impoverishment in the feeling of knowing, which is reflected in questioning and doubting perceptions, thoughts and motives (Dar, Rish, Hermesh, Taub, & Fux, 2000; O'Connor, Aardema, & Pélissier, 2005; Rapoport, 1989; Reed, 1985; van den Hout et al., 2009). Deficiency in implicit learning may therefore represent a specific aspect of a more general mode of operating and information processing in OCD.

But what is the nature of the deficiency in implicit learning in OCD? In a study that replicated and extended the earlier study by Rauch et al. (1997) mentioned above, Rauch et al. (2007) obtained fMRI scans of participants with OCD and matched controls while performing the SRT task. Consistent with their previous findings, Rauch and colleagues found comparable learning between groups but greater recruitment of brain areas associated with explicit learning in OCD compared to a non-psychiatric control sample. However, in contrast to the previous study (Rauch et al., 1997), OCD participants showed intact activation of the striatal brain areas associated with implicit learning. Rauch et al. (2007) argued that the normal striatal activation in the OCD group challenges the notion of striatal dysfunction in OCD, and instead points to the primary role that aberrant hippocampal activity plays in OCD. Moreover, although across different studies participants with OCD performed the SRT task more poorly than non- psychiatric controls (Goldman et al., 2008; Kathmann, Rupertseder, Hauke, & Zaudig, 2005; Marker et al., 2006), they nevertheless performed the task reasonably well, at levels that were was much above chance. Furthermore, in another implicit task, the Pursuit Rotor, participants with OCD demonstrated better implicit learning during the early (but not later) trial blocks of the task, as compared to non-clinical controls (Roth, Baribeau, Milovan, O'Connor, & Todorov, 2004).

Interpreting the results of previous SRT studies is complicated, however, due to a particular methodological weakness. In the SRT task, participants are required to press as rapidly and accurately as possible keys that spatially correspond to the location of a single target stimulus that successively appears at one of four locations. Unknown to participants, the stimulus location is altered according to an underlying fixed sequence. Learning the underlying sequence is evidenced by the gradual decrease in reaction times (RTs) throughout training, and more critically, by the significant increase in RTs once the sequence is altered (Schwarb & Schumacher, 2012; for a more detailed description of the task see the Methods section). The SRT task is considered to be a measure of implicit learning because participants acquire the underlying sequence even though they are not instructed to identify it. However, not instructing participants to search for the underlying sequence does not prevent them from adopting an explicit strategy if they decide to do so. Hence, performance on this task confounds intentional and non-intentional processes.[1] Specifically, in the studies described above, participants with OCD may have explicitly searched for an underlying rule more than did participants in the control condition. If this was the case, it is possible that those participants performed the task well, whereas among participants that relied primarily on implicit strategies, OCD was associated with poorer performance.

In order to reduce the probability that participants would intentionally search for regularities, Destrebecqz and Cleeremans (2001) introduced a modified version of the SRT task in which the target stimulus is removed as soon as a key is pressed and the next stimulus appears immediately (i.e., no-Response-Stimuli-Interval; no-RSI). The no-RSI version of the SRT is believed to minimize opportunity for conscious monitoring and control, so that the knowledge acquired while performing the task remains predominantly implicit (Destrebecqz & Cleeremans, 2001, 2003; Destrebecqz et al., 2005). These authors rationalized that under the no-RSI, participants do not have sufficient time to consciously anticipate the next target location, whereas longer RSI's enable the development of such conscious anticipation and control over the expression of the acquired sequence knowledge. In the same vein, Cleeremans and Jiménez (2002) argued that no-RSI may reduce representation quality of acquired implicit knowledge, and therefore make it harder to become available to consciousness and control. For the present study we used this modified version of the SRT task, and in order to facilitate interpretation of task performance we introduced a direct manipulation of participants' strategy.

Specifically, this study tested the hypothesis that individuals with OCD would be capable of implicit learning, but would perform better in explicit rather than implicit mode. Participants with OCD and matched non-psychiatric control participants performed the no-response stimuli interval version of the SRT task. Half of the participants in each group received explicit instructions to search for the rule, whereas the other half performed the task with standard instructions. We hypothesized an interaction between group and instructions, so that in the standard instructions condition OCD participants will show inferior performance compared to the control group of participants. Since people with OCD were found in previous research to rely less than controls on implicit learning and more on explicit learning in the SRT task, we hypothesized that intentional learning instructions will impair the performance of control participants, but will enhance the performance of OCD participants.

2. Material and method

2.1. Participants

Participants were 24 individuals with a DSM-IV diagnosis of OCD and 24 non-psychiatric control (NPC) participants who were matched for age, gender, and education to the OCD sample. Participants in the OCD group responded to advertisements in a large online OCD forum, which included a brief description of the study. Participants' ages ranged from 19 to 44 years, and no age difference was found between the OCD ($M = 29.3$, $SD = 6.9$) and NPC ($M = 27.6$, $SD = 5.3$) groups [$t(46) = 0.96$, $p = 0.34$]. Both samples included similar proportions of women (54.1%), so that no difference was found between samples on

[1] A similar problem in distinguishing between intentional and non-intentional processing has been raised with respect to the Weather Prediction Task (WPT; Knowlton, Squire, & Gluck, 1994), a task evaluating implicit learning in OCD (i.e., Exner, Zetsche, Lincoln, & Rief, 2014; Kelmendi et al., 2016; Zetsche, Rief, Westermann, & Exner, 2015). In some studies using the WPT, poorer acquisition of the task by individuals with OCD was reported (e.g., Kelmendi et al., 2016). However, the use of the WPT as a valid measure of implicit learning has been criticized (see Newell, Lagnado, & Shanks, 2007; Poldrack & Foerde, 2008), and in fact is currently associated with intentional-explicit strategies (Ashby and Maddox, 2005; Price, 2009).