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The nature of prospective memory deficit in patients with obsessive–compulsive disorder

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ABSTRACT

We comprehensively examined prospective memory (PM) performance in patients with obsessive–compulsive disorder (OCD), and explored the cognitive and psychopathological correlates of PM in this clinical population. Fifty-eight OCD patients and 58 healthy controls were assessed with computer-based PM tasks and related neurocognitive functions, and the participants also reported frequency of PM failures and compulsive behaviours in daily life. OCD patients had intact activity-based PM performance but had lower accuracy in time-based PM and longer reaction time to event-based PM cues compared to healthy controls. Among the neurocognitive functions, both the WCST (perseverative error) and the letter number span correlated with time-based PM. OCD patients reported similar number of PM failures in daily life as controls, which correlated with their intact event-based PM performance, suggesting a generally good insight into their PM functions. Neither clinician-assessed nor self-reported OCD symptoms correlated with PM performance. This study indicates that PM impairment tends to vary with the PM cue types in OCD patients. In addition, certain executive functions (i.e., mental shifting and updating) may contribute to time-based PM impairment in patients with OCD.

1. Introduction

Remembering to carry out intentions in the future requires a unique cognitive function called prospective memory (PM). PM tasks are common in daily life, such as remembering to bring an important document to the office, passing a message to a colleague at work, and picking up children from school at a certain time. PM failures may lead to serious consequences in everyday life.

In clinical populations, failing to remember to take medications can aggravate illness. In fact, PM deficits have been reported in various neuropsychiatric disorders, including Alzheimer's disease, Parkinson's disease, schizophrenia, attention deficit hyperactivity disorder and autism (Kliegel et al., 2008). However, relatively few studies have examined PM performance in patients with obsessive–compulsive disorder (OCD). It is possible that, because of their heightened vigilance and frequent checking behaviours, OCD patients are not expected to have PM problems. However, neurocognitive functions known to be associated with PM such as retrospective memory and executive functions have been found to be impaired in OCD patients (Abramovitch et al., 2013), suggesting the likelihood of PM deficit in these patients. To date, only four studies have examined PM in OCD patients (Jelinek et al., 2006; Moritz et al., 2006; Harris et al., 2010; Racsmany et al., 2011). The diverse methods and inconsistent results of these studies, however, prevent a clear conclusion about the nature and extent of PM deficits in OCD patients.

A typical PM task paradigm involves reacting to embedded PM cues in an ongoing task (Einstein and McDaniel, 1990). Based on the associated cues, PM can be divided into time-based (e.g., attending a meeting at a specific time), event-based (e.g., buying bread when passing a bakery), or activity-based (e.g., switching off the gas after cooking). Among these, activity-based PM task is relatively easy because it often occurs at the end of an activity and is cued by the conclusion of one's own action. Because it does not involve interruption of the ongoing task, activity-based PM task often leaves more cognitive resources for retrieving PM intentions (Kvavilashvili and Ellis, 1996). In contrast, both event and time-

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based PM tasks require voluntary or self-initiated interruption of the ongoing task. Event-based PM cues are often conspicuous and help remind the retrieval of associated PM intentions. Time-based PM cues are more obscure temporal cues that call for additional self-initiated monitoring (Craik, 1986; Einstein et al., 1995). Regardless, little is known about the performance of OCD patients in these three PM subtypes.

Early investigation of PM focused on people with subclinical OCD. Cuttler and Graf conducted a series of studies on subclinical compulsive checkers (2007, 2008, 2009). The checkers were impaired in event- and time-based PM tasks, mainly reflected in the frequency rather than the punctuality of executing PM intentions. Consistent with their checking frequency, high checkers also reported more frequent PM failures than low checkers in daily life, suggesting their intact insights into PM failures. The authors explained these results using a compensation theory, arguing that PM deficit contributes to the development and maintenance of checking compulsions. Marsh et al. (2009) investigated whether PM deficit would vary with the emotional disturbance of the task in a group of subclinical obsessive washers. For the event-based PM tasks, the cues were either neutral words like 'desk' or 'goat' or disturbing words (e.g., blood and mucus) selected based on individual ratings beforehand. PM impairment was only found when PM cues were neutral but not when they were disturbing. It has been suggested that the obsessive washers' attentional bias towards threat-related information might have helped them to overcome PM deficits. However, in another study that examined PM in subclinical checkers, PM deficit was found even when PM cues were threatening (Harris and Cranney, 2012). The authors speculated that the discrepancy in finding might be due to the use of the same threatening cues for all checkers. As a result, the cues lacked personal relevance and thus might not be emotionally relevant to the participants.

In OCD patients, the results were mixed. Using a battery of tests capturing various types of memory, Jelinek et al. (2006) found no PM deficit in a clinical OCD sample. In a group of pure compulsive checkers, Harris et al. (2010) found PM deficits in activity-based but not time-based PM. However, the two PM tasks differed in personal relevance and so whether OCD patients have cue-specific PM deficits remains unclear. Moreover, the PM tasks in both studies were single-trial tasks, which may not have sufficient power in detecting minor PM deficits. To overcome this, Racsmany et al. (2011) used a computerized event-based PM task containing multiple PM trials. OCD patients had similar PM accuracy as controls but longer reaction times in PM and ongoing tasks, suggesting extra monitoring cost for maintaining the same level of PM accuracy. Nevertheless, the low cognitive demand of the ongoing task and the unusually high frequency of PM trials made the PM task relatively easy, which might have masked subtle PM deficits in OCD patients.

Regarding the subjective report of PM in everyday life, OCD patients did not make more complaints in PM failures compared to healthy controls (Moritz et al., 2006; Harris et al., 2010). This is in contrast to the elevated PM complaints in subclinical populations (Cuttler and Graf, 2007, 2008, 2009). Harris et al. (2010) suggested that PM failures may arouse concerns in individuals with subclinical OCD, who may gradually develop checking behaviours to cope. When these checking behaviours become habitual and the individual develops clinical OCD, the increased confidence in compensating for PM deficits may paradoxically result in fewer PM complaints in OCD patients. However, this speculation clearly needs more direct evidence based on comparison of subclinical and clinical populations in the same study.

PM is a complex cognitive function in terms of its processing mechanisms and its reliance on other cognitive functions. According to the multi-process model of PM, retrieval of PM intention can rely on either automatic or controlled processes, which varies with a number of factors, such as the characteristics of the PM, association between PM cue and response, and the demand of the ongoing task (McDaniel and Einstein, 2000). Importantly, temporal cues are usually less conspicuous than external event-based cues and therefore time-based PM tasks often rely more on controlled processes than event-based PM tasks. In PM, controlled processing involves strategic resource-demand monitoring, which requires executive functions (Kliegel et al., 2002; Martin et al., 2003; Salthouse et al., 2004; West et al., 2006; Zeintl et al., 2007). According to the widely accepted conceptual framework of executive functions (Miyake et al., 2000), executive functions are not unitary construct but can be separated into three components (i.e., inhibition, updating and set shifting). While both event- and time-based PM are associated with inhibition (Gonneaud et al., 2011), evidence is stronger for the involvement of set-shifting in time-based PM (Kliegel et al., 2003) than in event-based PM (Kliegel et al., 2003; Gonneaud et al., 2011; Schnitzspahn et al., 2013). In terms of updating, there is no evidence for its involvement in event-based PM (Gonneaud et al., 2011; Schnitzspahn et al., 2013), whereas the relationship between updating and time-based PM is complex (Mäntylä et al., 2007; Gonneaud et al., 2011). Apart from executive functions, retrospective memory also plays an important role in retaining the details of a PM task (Brandimonte and Passolunghi, 1994; Zeintl et al., 2007).

Among these cognitive functions, OCD patients were found to be particularly impaired in inhibition and set-shifting (Abramovitch et al., 2013, meta-analysis), but less impaired in updating. In particular, impaired set-shifting and inhibition are considered the core deficits of OCD, which may be related to dysfunction of the lateral orbitofrontal lobe (Chamberlain et al., 2005). Interestingly, the lateral orbitofrontal cortex in this loop includes Brodmann area 10 (Kringelbach, 2005), the brain area activated when retrieving PM intentions (Burgess et al., 2011). In view of these findings, PM performance may also be impaired in OCD patients and impairment in other cognitive functions may contribute to PM deficit. Therefore, one of the goals of this study was to investigate the association between cognitive functions and PM and how they contribute to PM deficits in OCD patients.

The severity of clinical symptoms in OCD patients may also influence their PM performance. OCD is characterized by obsessions of intrusive and disturbing thoughts or compulsions of repetitive and unwanted behaviours. However, it remains unclear how these symptoms affect PM. Among the four studies examining PM in OCD patients, only one examined the correlation between PM and clinical symptoms, which failed to find any correlation (Moritz et al., 2006). In a series of studies investigating subclinical compulsive checkers (Cuttler and Graf, 2007, 2008, 2009), higher self-reported frequency of checking behaviour was associated with increased subjective PM complaints (even after depression, anxiety and distractibility were controlled for), and a higher rate of checking was also associated with better PM performance. As mentioned, the increased checking behaviour may be a compensatory strategy for frequent PM failures used by subclinical checkers in daily life. However, in another study examining PM in subclinical obsessive washers, a higher frequency of washing and distress was associated with poorer PM performance (Marsh et al., 2009). This discrepancy may be due to the different types of subclinical OCDs; that is, checking behaviour might have facilitated monitoring of PM cues and helped subclinical checkers, whereas in subclinical obsessive washers, consuming thoughts of washing competed with cognitive resource for monitoring PM cues and impeded PM retrieval.

Taken together, the investigation of PM in OCD patients is relatively limited. The extent, and more importantly, the nature of the PM deficit remain unclear. Therefore, in this study, we aimed