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Threat-related processing supports prospective memory retrieval for people with obsessive tendencies

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Abstract

Obsessive-compulsive disorder can result in a variety of deficits to cognitive performance, including negative consequences for attention and memory performance. The question addressed in the current study concerned whether this disorder influenced performance in an event-based prospective memory task. The results from a subclinical population indicated that, relative to non-anxious controls and mildly depressed controls, people with obsessive-compulsive tendencies (washing compulsions) incur decrements in remembering to respond to cues related to a neutral intention (respond to animals). This deficit was ameliorated by giving the subclinical group an intention about a threat-related category (respond tobodily fluids) and cueing them with concepts that they had previously rated as particularly disturbing to them. Thus, their normal attentional bias for extended processing of threat-related information overcame their natural deficit in event-based prospective memory.

People encode an intention to perform some activity at a later time when the current environmental conditions may not be conducive to fulfilling the task immediately. This sort of memory, called prospective memory, supports planning and successful goal-directed behaviour that is needed on a daily basis for normal human functioning. In event-based prospective tasks, like the one being studied here, people off-load the intention onto the environment and they wait for an environmental cue to serve as a reminder of the intention. For example, if one needs to replenish postage stamps, one might wait for the sight of a post office or a sticker in the grocery store to serve as a reminder that the intention can now be

fulfilled. Under certain environmental constraints, attentional resources can be devoted to detecting cues relevant to previously established intentions (Einstein et al., 2005; Marsh & Hicks, 1998; Smith, 2008). In the present study we investigated event-based cue detection in an obsessive-compulsive population known for attentional dysregulation (i.e., participants with subclinical washing obsessions).

Event-based prospective memory is studied in the laboratory using a rich variety of paradigms, many of which have the following basic characteristics. To simulate the demands of everyday life, participants are busily engaged in some ongoing activity such as making pleasantness ratings, identifying famous faces, counting the number of syllables in words, making lexical decisions, etc. (e.g., Einstein, Holland, McDaniel, & Guynn, 1992; Ellis & Milne, 1996; Maylor, 1996, 1998). Prior to participants engaging in this task, they are asked to respond to prospective memory cues with an extra key press (or with a different key press) than they would have used normally for responding to the ongoing activity. The proportion of cues they detect is a common measure of the efficiency of prospective memory processes. Ongoing tasks can draw attentional focus either towards or away from event-based cues (Einstein & McDaniel, 2005). Detection of focal event-based prospective memory cues benefits from ongoing task processing which focuses attention towards relevant features of the cue, engendering spontaneous retrieval processes in the absence of cue-focused processing (e.g., specific cues can be detected without monitoring processes). In cases where attention is not focused on relevant features of the event-based cues, participants may rely on more conscious monitoring strategies to detect these nonfocal cues (e.g., participants may set a different attentional allocation policy to aid detection of categorical cues; Einstein et al., 2005; Ellis & Milne, 1996; Marsh, Hicks, Cook, Hansen, & Pallos, 2003; McDaniel & Einstein, 1993). For example, participants who are engaged in a lexical decision task will either be given the intention to respond to a specific animal (e.g., deer) or to respond to any member from the category animals which may occur in the context of the lexical decision task.

In cases where ongoing task processing draws attention away from features of the cues, event-based prospective memory performance may be dependent on some optimum level of central executive functioning (Marsh & Hicks, 1998), and consequently is better for people with more available working memory resources (Cherry & LeCompte, 1999; Smith & Bayen, 2005). Thus, placing people under divided attention conditions or testing individuals with lower working memory capacity can elicit worse event-based prospective memory. For these reasons, event-based prospective memory is often compromised in normal ageing (e.g., Einstein, McDaniel, Marsh, & West, 2008; McDaniel, Einstein, Stout, & Morgan, 2003; West, Herndon, & Covell, 2003). The purpose of the present study was to ascertain how a group of people with subclinical symptoms of obsessive-compulsive disorder (OCD) perform on an event-based prospective memory task.[1]

There are a number of reasons to believe that those with untreated OCD will behave much like older adults in so far as their detection of event-based cues may suffer due to

[1]We use the acronym OCD to refer to the disorder. However, we do acknowledge that our student population has not actually received such a diagnosis but rather is based on self-report questionnaire data.

misallocation of valuable central executive resources (cf. Cuttler & Graf, 2008; Harris & Menzies, 1999). Some investigators have argued that information-processing deficits or biases in attention underlie the repetitive thoughts and behaviours that characterise this disorder (e.g., Tallis, 1997). Eysenck (1992) suggested more generally that increased levels of anxiety can be associated with working memory resources being consumed by task-irrelevant thoughts (see also Gotlib, Roberts, & Gilboa, 1996). Recent research has shown that individuals with generalised anxiety disorder have reduced working memory resources and threat-related attentional biases (Hayes & Hirsch, 2007). Consistent with this proposition, Sher, Frost, Kushner, Crews, and Alexander (1989) compared individuals with checking obsessions to a control group equated for general intellectual ability and found that individuals with checking obsessions had significantly lower working memory capacity scores. In addition to these findings, people with subclinical checking compulsions have weaker correlations with prospective memory performance and working memory capacity (Cuttler & Graf, 2008; see also Cuttler & Graf, 2007). In these studies, subclinical checking compulsions were also related to self-reported everyday prospective memory failures. Thus, based on this general line of reasoning, we predicted that a group of individuals with subclinical obsessive-compulsive symptoms given a neutral categorical intention (e.g., respond to words denoting animals or pieces of furniture) would detect these cues less often than a non-anxious control (NAC) group. Beyond testing that basic prediction, we also wanted to test whether the same group of individuals with subclinical obsessive-compulsive symptoms would detect event-based cues better if those cues were threat-related to their specific obsessions. One well-supported proposition is that individuals plagued with obsessive-compulsive disorder have biased attentional allocation towards emotionally threatening material (for a review see Williams, Matthews, & MacLeod, 1996). For example, they are disproportionately slowed in Stroop colour naming for threatening words, presumably because they cannot avoid the semantically threatening content. More specifically, OCD patients will not show this slowing on panic-related words or general threat words, suggesting that the attentional bias is more specifically related to their own idiosyncratic cognitions (e.g., McNally et al., 1994). Another means of showing this sticky attentional allocation to threat-related material comes from studies using the dot-probe paradigm (e.g., Amir, Najmi, & Morrison, 2008; MacLeod, Matthews, & Tata, 1986). In that approach, pairs of words are presented (one on top of the other) followed unpredictably by a dot to which the participant is to make a speeded response (top or bottom). When the dot appears in the location of the screen where a threatening word had just been presented, individuals with OCD are faster to respond than control participants, which suggests that they had already been allocating attention to that screen location (see also Tata, Leibowitz, Prunty, Cameron, & Pickering, 1996). Combined with a possible inability to selectively ignore threat-related material (e.g., Clayton, Richards, & Edwards, 1999), we predicted that individuals with subclinical obsessive-compulsive symptoms would detect personally relevant and emotionally negative words as cues more often than control words about which they had the identical intention. To test these ideas, we administered many screenings of our college-aged population (at the University of Georgia) to obtain our NAC and OCW (Obsessive-Compulsive symptoms as indexed by Washing obsessions) groups. The washing obsessions subscale was chosen because both neutral and threat-related event-based prospective memory cues could be derived for each participant in the OCW group which

were specific to their obsessions. Each participant was given both intentions at different points in the experiment in order to examine cue detection with a neutral intention versus with a threat-related intention (i.e., a repeated measures design was used). Because of the co-morbidity of OCD and depression, we also obtained a depressed group (DEP) and ensured that the OCW group was not depressed, as well as ensuring that the DEP group was free of the symptoms of OCD. We predicted that any deficit in event-based cue detection observed with the non-emotional intention would be ameliorated by the attentional bias that individuals with OCD often demonstrate towards threatening material. We had no a priori prediction whether the OCW group would outperform the NAC group with the emotional intention, only that cue detection would be better for the OCW group with the emotional intention.

METHOD

Participants

Through a series of large group screenings (test-ing over 600 people), we recruited 25 people in each of the OCW, NAC, and DEP groups. During the screenings we administered the Obsessive-Compulsive Inventory (OCI; Foa, Kozak, Salkovskis, Coles, & Amir, 1998), the 21-item Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996), the State-Trait Anxiety Inventory (Spielberger, 1983), and an emotionality rating of 90 words. From the OCI we used the frequency of washing subscale and the distress of washing subscale to identify the OCW participants. We created the OCW group based on distributions of OCI subscale scores from previously collected data at the University of Georgia. Based on these previously collected normative data for the OCI and other normative data for the BDI-II, a minimum item score of 1.5 (or greater) on both scales while also having a low BDI-II score was required for inclusion in the OCW group. To control for the comorbidity between obsessive tendencies and depression, we chose to place in the OCW group participants who reported very little depressive symptoms (BDI-II<7). For the DEP group, a minimum of 9 (or greater) on the BDI-II while simultaneously having low OCI sub-scale scores (OCI<1.5) was required for inclusion (i.e., subclinical population). The NAC group was identified as having neither OCD tendencies nor evidence of depression. The mean values of the frequency and distress from washing, as well as the BDI-II scores, are given in Table 1. A series of one-way analysis of variance (ANOVA) models confirmed that washing was highest in the OCW group, $F(2, 72)=57.10$, $p<.001$, $p_{rep}=.99$, $\eta_p^2=.66$, as well as the distress caused by washing, $F(2, 72)= 57.58$, $p<.001$, $p_{rep}=.99$, $\eta_p^2=.67$. Post-hoc t-tests indicated that all groups were significantly different from the OCW group who reported the highest values on both of the subscales: smallest $t(48)6.65$, $p<.001$. By contrast, the BDI-II scores placed the depressed group in the mild range of the scale as compared with the other two groups, $F(2, 72)=6.10$, $p<.01$, $p_{rep}=.98$, $\eta_p^2=.17$. Post-hoc t-tests showed that the DEP group ranked higher on the BDI-II than either the OCW or NAC groups, which were statistically equivalent to one another: smallest $t(48)=3.02$, $p<.001$. Thus we obtained three samples that met our criteria for inclusion. After identification, the participants were contacted from information collected on a demographic questionnaire and were invited to participate for additional credit towards a research appreciation requirement (beyond what they earned for performing the screening) or for a small cash payment ($10).

Materials and procedure

Prior to coming to the laboratory, a research coordinator inspected the emotionality ratings of the words for each participant in the OCW group. From a list of 10 critical items comprising the category of bodily fluids (mucus, urine, vomit, saliva, stool, pus, snot, blood, bile, and diarrhoea), the four most negatively rated items for each individual in the OCW group were identified. (Table 1)

Participants had rated these items on a 7-point scale from −3 to +3 denoting very disturbing at the low end to very pleasant at the high end. Four of the most neutral items (closest to 0) were also identified from either the five-member category of furniture (sofa, table, lamp, desk, or couch) or animals (pig, tortoise, goat, horse, or sheep). Once this constellation of four emotional and four neutral items was identified for a given OCW participant, these same eight items were yoked to another individual in each of the NAC and DEP groups. By yoking the cues from the OCW group to a participant in each of the NAC and DEP groups, the same items served as event-based prospective memory cues an equal number of times and in the same constellation. The experimenter was blind to the condition to which the participant belonged and was told only what code numbers to enter into the software controlling the experimental sequence. These code numbers specified the identification of the participant and the event-based prospective memory cues that participants would ultimately receive. To minimise any transient fluctuations that can be observed in the BDI-II, our pre-screenings were computer scored and participants were contacted within several days of the pre-screening to arrange testing.

Instructions for the ongoing task were read by the participant from a computer monitor and then verbally reiterated by the experimenter. The ongoing task asked participants to count the number of syllables that various words contained. There were two identical phases of the experiment. In one phase participants were asked to press the "/" key whenever they encountered a furniture (or animal) word prior to making their syllable rating. In the other phase they were asked to do the same thing, but whenever they encountered a bodily fluid. The instructions for completing the prospective memory task were delivered casually by the experimenter, explaining that we were also interested in people's ability to remember to do something in the future. After delivering these instructions, the experimenter cleared the computer monitor, and then gave the participant a multiplication distractor task to work on for 4 minutes. This multiplication task was administered after each of the two prospective intentions was delivered, thereby reducing the likelihood that the prospective memory task would become a vigilance task during the ongoing task. Following the distractor task, the participants worked through 104 syllable ratings without being reminded about the prospective memory task. The event-based cues were delivered on trials 25, 50, 75, and 100 in the 104-trial sequence in each phase. Whether participants received the emotional intention (bodily fluids) versus the non-emotional intention (animals or furniture) first was counterbalanced across successive participants in each of the three NAC, OCW, and DEP groups and there was no effect of counterbalancing F(2, 72)B2, ns. The software collected successful prospective responses and, as in all of our work (e.g., Marsh, Hicks, & Cook, 2005), counting the very few late responses as correct did not affect the pattern of

performance. Consequently, consistent with our past work, late responses were considered as non-responses.

RESULTS AND DISCUSSION

The average event-based cue detection is shown in Table 2. Because prospective memory performance is notoriously variable, and because some of the simple effects showed that Levine's test for the homogeneity of variance assumption was violated, we arcsin transformed the data before submitting them to the omnibus 3 (condition) × 2 (type of event-based cue: emotional vs nonemotional) ANOVA (see Winer, 1971, p. 403, regarding proportions). Critically, the interaction term was statistically significant, $F(2, 72)=4.38$, $p<.05$, $p_{rep}=.95$, $\eta_p^2=.11$, whereas neither main effect alone was statistically significant. In order to clarify the interaction term from the preceding analysis, we momentarily removed the DEP control group and reanalysed only the NAC and OCW conditions, which yielded the identical outcome with the interaction between condition and cue type being statistically significant, $F(1,48)=4.42$, $p=.05$, $p_{rep}=.93$, $\eta_p^2=.08$. As the reader can see in Table 2, event-based cue detection did not differ according to cue type in the NAC, $t(24)<1$, or the DEP groups, $t(24)<1$. However, the OCW group did respond differently depending on the cue type, $t(24)=2.17$, $p<.05$, $p_{rep}=.95$, $d=.32$. As predicted, their performance with neutral cues was impaired relative to the NAC, $t(48)=1.86$, $p=.07$, and to the DEP groups, $t(48)=1.97$, $p=.05$. Therefore, unless the cues are personally relevant and negatively emotionally valenced, the OCW group may perform as if they are under a cognitive load much like older adults who may also suffer a deficit in event-based cue detection (Table 2).

Although our study was not designed for correlational analyses (i.e., small sample sizes), we nevertheless correlated the washing frequency and washing distress scores with both cue detection for neutral and emotional cues without regard to condition. For neutral cues, both washing frequency and distress had negative relationships with cue detection, $r(75)=-.42$, $p<.001$ and $r(75)=.41$, $p<.001$ respectively. Thus, OCD washing symptoms were significantly negatively correlated with cue detection. However, none of the correlations was above chance levels for the emotional cues, which is consistent with the hypothesis that the OCW group has biased attention for them. In addition, the fact that the BDI-II scores did not significantly correlate with cue detection is at least suggestive that the severity of OCD symptoms predicts event-based prospective memory performance, not depression. Of course, with the sample sizes used here these correlational analyses should be further investigated (Cuttler & Graf, 2008).

CONCLUSION

This study had two primary aims. First, we wanted to ascertain whether individuals with OCD symptoms would display differences in event-based cue detection. Considering only the non-emotional intention to respond to words from the category of either furniture or animals, the answer to that question is affirmative. The OCW group displayed lower detection of the cues, presumably because they suffer from information-processing deficits or because their cognitive performance is disrupted by compromised working memory resources. This same deficit has been shown in individuals who had to concurrently engage

in a demanding task that tapped central executive resources while trying to remember to complete a neutral intention (Marsh & Hicks, 1998). The same is also true in normal ageing (e.g., Einstein, McDaniel, Smith, & Shaw, 1998). Thus, we would suspect that when individuals with obsessive-compulsive symptoms rely on the environment to cue them to perform some action in the future, then this strategy will fail them more often than it would for somebody of the same intellectual functioning without the OCD symptoms. These effects were obtained with a group of participants exhibiting OCD symptoms in the subclinical range. Based on these results, there seems to be an open line of inquiry regarding clinical populations with anxiety problems and their prospective memory abilities.

Second, we also wanted to ascertain whether any deficits in cue detection would be ameliorated by processing cues that were threatening, as personally rated by each individual in the OCW group. Cues that were emotionally disturbing to them caught their attention and elicited a prospective memory response more often than did the neutral cues. In fact, with emotional cues, all three groups performed equivalently. Because the emotional cues held no significant meaning on average for the NAC and DEP groups, their performance was equivalent to the non-emotional cues. These results are entirely consistent with biased attentional allocation to threat-related stimuli in OCD, at least with cues relevant to washing obsessions tested in this study. The fact that the DEP group did not show an impairment as in the OCW group may reflect the fact that their depression was mild, and cognitive impairment might only have been found with more severely depressed individuals (e.g., Austin, Mitchell, & Goodwin, 2001). In order to achieve equal sample sizes we used a criteria score to create the DEP group, which is somewhat low, and some of the participants in that group may have fallen into a subclinical range. Nevertheless, participants in the DEP did report more depressive symptoms, as measured by the BDI-II, than either the NAC or OCW groups. On the assumption that our samples were truly random, the comparison between the DEP and OCW groups suggests that individuals with obsessive-compulsive symptoms may be vulnerable to prospective memory deficits more than some other subclinical populations. Importantly, future research should investigate more severe clinical populations in order to assess how severely attention can be biased by threat-related information.

Very little work has examined the relationship between subclinical and clinical populations and event-based prospective memory. In their sample of 101 first-year college students, Harris and Menzies (1999) found that event-based prospective memory was negatively correlated with an individual's level of anxiety, although no reliable relationship was found with their level of depression. Thus, our results correspond well to their event-based prospective memory study. The primary difference between their study and the present one is that Harris and Menzies made no attempt to obtain samples approaching a clinical population, but rather merely correlated performance between the subscales of the Depression Anxiety Stress Scale (Lovibond & Lovibond, 1995) with event-based prospective memory. Therefore their population had anxiety and depression that were probably correlated, given the co-morbidity of the two disorders. By contrast, we specifically manipulated these in our three conditions. Nonetheless, the present results and theirs tell a consistent tale that anxiety, but not depression, affects the fulfilment of event-based intentions.

These results dovetail nicely with those found by Cuttler and Graf (2008). In their investigation of a subclinical sample of participants with compulsive checking behaviours, a similar relationship between checking behaviour and prospective memory performance was found (both in a laboratory paradigm and as assessed by self-report procedures). Anxiety, distractibility, and depression were found to be related to checking behaviours; however, these variables explained little variance in prospective memory performance. Similar to our study, which experimentally controlled for the effects of depression, the results from Cuttler and Graf demonstrated that intrusive thoughts associated with obsessive-compulsive disorder have negative influences on prospective memory processes. Our investigation has provided key evidence that attentional biases associated with OCD do influence prospective memory performance. Presumably, the increase or decrease in cue detection arises from cue-focused processes engaged when participants are given a non-focal cue, which may or may not be related to the participant's attentional bias. Thus, when attention allocation to threat arises naturally for the OCW group, they are better able to detect event-based cues. These findings correspond to Einstein and McDaniel's (2008) notion that many factors may influence the strategies that people bring to bear on a prospective memory task (see also Roediger, 2008). Given the current debate about whether people with OCD have retrospective memory difficulties and what sort of difficulties these are (for a recent review see Muller & Roberts, 2005), the results from this study suggest that prospective memory should be added to the list of potential sequelae emanating from having OCD. We have demonstrated that one way to increase accuracy in event-based cue detection is to give individuals with obsessions about washing an intention to respond to items that are threatening to them. Of course, this intention is probably one that they already possess in order to keep their anxiety and fear at minimal levels. So, in some sense, when the intention is consistent with a persistent or routine activity, people with OCD tendencies can bring their performance up to normal levels. In this unique case, attentionally biased cue-focused processes may support successful detection of event-based cues related to OCD obsessions. More generally, the current findings are in line with Hayes and Hirsch (2007) who argued that people with generalised anxiety disorder have severe attentional biases. One strategy that has been helpful in both younger and older adults without OCD is to form an implementation intention (e.g., Chasteen, Park, & Schwarz, 2001; Liu & Park, 2004; Meeks & Marsh, in press). To do so, the individuals with OCD will have to imagine themselves actually performing the intended activity during intention formation. This extra effort during encoding is costly, but enhances older adults' performance to the level of their younger counterparts on event-based tasks. To the extent that we have noted that participants with sub-clinical obsessive-compulsive symptoms are similar to older adults, in terms of prospective memory anyway, this suggestion about forming implementation intentions as a means of ameliorating prospective memory deficits in OCD awaits further scrutiny.

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TABLE 1

Mean frequency of washing and distress from the OCI and BDI-II scores

	OCI washing scores		
Condition	**Frequency**	**Distress**	**BDI-II scores**
NAC	0.85 (0.09)	1.07 (0.11)	6.00 (1.02)
OCW	2.07 (0.16)	2.42 (0.15)	6.47 (1.52)
DEP	0.30 (0.12)	0.58 (0.11)	11.68 (0.82)

NAC = Non-anxious control group, OCW = obsessive-compulsive washing group, DEP = depressed group. Standard errors are in parentheses.

TABLE 2

Average event-based prospective memory performance measured as the proportion of cues detected

Condition	Neutral cues	Emotional cues	Average
NAC	0.80 (0.05)	0.85 (0.05)	0.83 (0.05)
OCW	0.64 (0.08)	0.80 (0.04)	0.74 (0.04)
DEP	0.82 (0.05)	0.80 (0.06)	0.81 (0.05)

NAC Non-anxious control group, OCW = obsessive-compulsive washing group, DEP = depressed group. Standard errors are in parentheses.