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Memory and attention in Obsessive–Compulsive Disorder: a review

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Abstract

The present manuscript reviewed studies investigating biases and deficits in memory and attention related to Obsessive–Compulsive Disorder (OCD). Although the research has been mixed concerning memory for verbal information, there is more consistent evidence suggesting impairment for non-verbal information, particularly for complex visual stimuli and the individual's own actions. Further, a number of studies indicate that patients with OCD report less confidence in their judgments about recognition memory. Finally, OCD appears to be associated with an attentional bias favoring threatening information, as well as reduced levels of cognitive inhibition. The manuscript concludes with a number of recommendations for future research.

Keywords: OCD; Cognitive inhibition; Visual stimuli

As its name implies, Obsessive–Compulsive Disorder (OCD) is an anxiety disorder that involves two major components: obsessions and compulsions. Obsessions are defined as persistent thoughts, impulses or ideas that are experienced as inappropriate and that generate anxiety or distress. On the other hand, compulsions are defined as repetitive behaviors (e.g., hand washing) or mental acts (e.g., silently repeating numbers) that are typically performed in an attempt to relieve the distress brought on by the obsessions (American Psychiatric Association, 2000; Riggs & Foa, 1993). The two most common types of compulsions are

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checking compulsions, in which individuals repeatedly check to see if they have correctly completed an activity, and cleaning compulsions, in which individuals repeatedly wash themselves (Jenike, Baer, & Minichiello, 1990). Individuals with this disorder generally recognize that their symptoms are senseless or excessive, though there is a range of insight associated with OCD. Thus, individuals suffering from OCD feel compelled to think about something that they do not want to think about or to carry out some ritualistic (often pointless) action seemingly against their own will. Although these individuals realize that their behaviors are irrational, they do not feel that they can control these thoughts and actions.

Several cognitive accounts of OCD focus on these patients' dysfunctional beliefs and mental content (Rachman, 1998; Salkovskis, 1985). For example, Rachman (1998) posited that catastrophic misinterpretations of one's intrusive thoughts, images, and impulses are core contributors to the etiology of obsessions in OCD. In other words, patients with OCD attach undue significance to their intrusive thoughts. On the other hand, other investigators have proposed that the repetitive nature of the thoughts and behaviors that characterize this disorder are accounted for by certain information processing deficits and/or biases (e.g., Tallis, 1997). For example, patients with OCD often report they that are unsure whether or not they have performed an action or merely imagined having performed it. Such doubts may evolve into obsessions that lead to compulsive checking of doors, locks and so forth. What are the underlying causes of these doubts from an information processing perspective? Is it possible that obsessive–compulsive checkers have specific memory deficits that lead to these uncertainties? Or is it possible that their doubts and uncertainties reflect impairment in the way that they infer and attend to threatening information (attentional biases)?

In this manuscript, we review research investigating information processing biases and deficits in patients with OCD. Biases refer to enhanced processing of certain types of stimuli relative to other types of stimuli, whereas deficits refer to cognitive impairments that are more general in nature (i.e., impairments that cut across various types of content). The two general types of cognitive processes that will be examined are those related to memory and attention. Because OCD involves persistent doubts and uncertainties about whether or not certain actions have been taken, it is plausible that memory deficits or biases could play a key role in the etiology and maintenance of this disorder. Likewise, given their involvement across a range of other anxiety disorders (see Williams, Watts, Macleod, & Mathews, 1997 for a review), attentional biases favoring OCD-related stimuli, such as contamination, are potentially involved in this disorder as well.

As we discuss later, few of the studies reviewed included other-anxiety disorder control groups limiting our knowledge about whether various cognitive biases and deficits are specific to OCD versus common to anxiety disorders in general. Furthermore, although most of the studies reviewed treated OCD as a uniform and homogenous condition, it is becoming increasing clear that there are important subtypes within this category (e.g., Calamari, Wiegartz, & Janeck, 1999; Eichstedt

& Arnold, 2001; Leckman et al., 1997; Pigott, Myers, & Williams, 1996). These subtypes very well may vary in terms of information processing anomalies (Summerfeldt & Endler, 1998). We discuss the issue of heterogeneity in terms of future research directions.

1. Memory functioning

It is quite common for patients with OCD to report that they are uncertain whether they have carried out an action correctly as opposed to merely imagining that they have done so (Jenike et al., 1990). Apparently as a result of these uncertainties, patients with OCD frequently engage in repetitive rituals, such as compulsive checking of doors or locks. On the basis of these clinical observations, researchers have recently become interested in the memory functioning of patients with OCD. Specifically, studies have begun to examine possible memory deficits or biases in OCD patients, particularly those who are classified as ''checkers.''

It is important to note that memory is not a ''unitary'' phenomenon, but instead involves a number of somewhat independent processes and mechanisms. For example, research has shown that different brain regions may be specialized for different memory functions and that a single memory task may involve multiple processes or brain areas (e.g., Squire, 1992; Tulving & Schacter, 1990). In general, cognitive scientists have distinguished between three types of memories: episodic, semantic and procedural (Grusec, Lockhart, & Walters, 1990). Episodic memory refers to memory for personal events dated in one's past. This type of memory has been shown to be quite vulnerable to forgetting. In contrast, semantic memory refers to a person's general knowledge of the world. Semantic memory is memory for facts that have been divorced from their original learning context. For example, one may know that Albany is the capital of New York (semantic memory) but may not be able to recall when or where one had learned this fact (episodic memory). Procedural memory concerns memory for actions that are relatively automatic and not open to introspection. It is demonstrated by the learning and execution of perceptual-motor skills, such as riding a bicycle or tying one's shoe and cognitive skills such as reading and writing.

The distinction between different types of memory processes is important because it is possible that certain processes are more important than others in perpetuating and maintaining the repetitive behaviors that characterize OCD. Based on the above, episodic memory appears most relevant to OCD, and we therefore exclusively review studies investigating this form of memory. Nonetheless, there are many different types of episodic memory, including memory for verbal (e.g., words) and non-verbal (e.g., specific autobiographical events, visual information) forms of information. It is possible that the nature of the ''to-be-remembered'' information may play a crucial role in our understanding of the memory functioning of OCD patients. Further complicating matters, two types of

tasks are commonly used for measuring episodic memory: recall and recognition. In a recall task, participants are asked to produce an item from memory in the absence of any clues. In a recognition task, the participant is presented with a mixture of previously learned items with unlearned items (either in a general list or in a forced choice pair) and asked to identify the target items.

1.1. Memory for experimentally presented verbal and non-verbal stimuli

Do OCD checkers have a general episodic memory deficit that compels them to engage in repeated checking? As we shall see, the evidence is decidedly mixed and suggests that the nature of the stimuli to be recalled may be critical. We should also note that some of the inconsistency in findings is likely the result of differences in sample sizes and statistical power. We first review studies that examine memory for experimentally presented verbal stimuli.

In an early study, Sher, Mann, and Frost (1984) found that individuals with high levels of checking symptoms (e.g., the need to check appliances or to repeat actions many times) were relatively impaired in their memory for complex verbal information. Participants were 49 college students selected to represent an extensive range of compulsive checking behavior. Results indicated that checking was associated with overall scores on the Wechsler Memory Scale (WMS), particularly the Logical Memory subtest. This task requires that participants recall details from short passages that are read to them. This early research has been replicated by two recent neuropsychological studies (e.g., Deckersbach, Otto, Savage, Baer, & Jenike, 2000; Zitterl et al., 2001) that also suggest that OCD patients suffer from verbal memory impairments. For example, Deckersbach et al. (2000) used the California Verbal Learning Test (CLVT) to assess verbal memory among 17 OCD participants. A list of 16 shopping items was presented in five learning trials (memory was assessed after each trial) and participants were given both short- and long-delayed recall tests as well as a recognition test for the previously presented items. Results showed that OCD patients were impaired in both immediate and delayed free recall for the items relative to normative data, but had preserved verbal memory recognition. These results suggest that certain forms of verbal memory may be impaired in OCD patients and compulsive checkers, though these deficits do not appear to be pervasive and tend to be found on recall, but not recognition, tests.

On the other hand, there have been a number of studies that have failed to find evidence that OCD is associated with memory deficits for verbal information (e.g., Boone, Ananth, Philpott, Kaur, & Djenderjian, 1991; Christensen, Kim, Dyksen, & Hoover, 1992; Dirson, Bouvard, Cottraux, & Martin, 1995; Radomsky & Rachmen, 1999; Sher, Frost, Kushner, Crews, & Alexander, 1989; Zielinski, Taylor, & Juzwin, 1991). For example, MacDonald, Antony, MacLeod, and Richter (1997) investigated recall and recognition memory among OCD checkers ($n = 10$), OCD non-checkers ($n = 10$) and controls ($n = 10$). Participants were given tests of recall and recognition for words that

previously had been presented on a computer monitor. On both types of memory tests, none of the groups were statistically different. Thus, no memory deficits were found in OCD checkers and it was concluded that OCD checking is not related to these types of memory impairments. Furthermore, another study found that subclinical checkers ($n = 20$) actually exhibited *better* recognition memory for words than normal control participants ($n = 20$; Rubenstein, Peynircioglu, Chambless, & Pigott, 1993).

Despite the fact that the studies reviewed above failed to find consistent support for a general memory deficit for verbal information, it is quite possible OCD involves other types of memory impairment. Consistent with this possibility, several neuropsychological investigations have found that OCD patients show impairments in *non-verbal* episodic memory (Aronowitz et al., 1994; Boone et al., 1991; Christensen et al., 1992; Deckersbach et al., 2000; Dirson et al., 1995; Martinot et al., 1990; Purcell, Maruff, Kyrios, & Pantelis, 1998; Savage et al., 1996, 1999; Zielinski et al., 1991). For example, Sher et al. (1989) found that deficits on the overall WMS were associated with compulsive checking among psychiatric outpatients (with mixed diagnoses). Checkers ($n = 13$) achieved lower WMS scores compared to non-checkers ($n = 12$) despite the fact that they did not differ on general intellectual ability. In contrast to Sher et al. (1984), this study found that the Visual Memory subtest of the WMS most powerfully discriminated checkers from non-checkers.

Savage et al. (1999) observed that the non-verbal memory problems of OCD patients ($n = 20$) as measured by the Rey-Osterrieth Complex Figure Test (RCFT) were linked to impaired organizational strategies used during the initial copy of the RCFT figure. In particular, these patients tended to focus on irrelevant details of to-be-remembered items. Furthermore, a more recent study replicated these findings and further suggested that impaired organizational strategies mediate both non-verbal and verbal memory impairments in OCD patients ($n = 33$) compared to normal controls ($n = 30$; Savage et al., 2000). The relationship between organizational abilities and impaired memory could potentially reflect frontal-striatal system dysfunction in OCD patients (e.g., Savage, 1998). Another study by Tallis, Pratt, and Jamani (1999) also found that OCD patients with prominent checking symptoms ($n = 12$) were impaired in their recall and recognition of non-verbal information relative to normal controls ($n = 12$). However, checking symptoms did not significantly correlate with memory tasks, failing to support the hypothesis that checking is driven by a mnestic disturbance. It should be noted that a number of studies that have found evidence of non-verbal visual memory impairment in OCD have failed to find corresponding evidence of verbal memory impairment (e.g., Boone et al., 1991; Christensen et al., 1992; Dirson et al., 1995; Zielinski et al., 1991). This pattern further supports the notion of a rather specific deficit that is largely limited to visual memory.

In summary, the extant research has resulted in a mixed pattern of results concerning possible deficits in the recall or recognition of *verbal* information in OCD, whereas memory impairments for experimentally presented *non-verbal*

(particularly visual) stimuli have been more consistently demonstrated. A possible explanation for this pattern of results is that non-verbal memory is more susceptible than verbal memory to executive impairment (i.e., impaired encoding strategies) due to its more abstract nature and increased demands on organizational capacity (Savage et al., 1999; see Greisberg & Mckay, 2003 for a review). On the other hand, it is possible that it has been difficult to demonstrate deficits in verbal information as a result of limited statistical power. In this regard, published studies rarely include more than 20 OCD patients and consequently this literature is only able to detect large effect sizes. Small to moderate effect sizes would be left undetected.

1.2. Memory for personal experiences

Wilhem, McNally, Baer, and Florin (1997) found that patients with OCD tend to exhibit impairment in retrieving autobiographical memories. This study found that OCD patients ($n = 36$) showed difficulty retrieving specific autobiographical memories and had longer retrieval latencies compared to healthy controls ($n = 26$). Interestingly, further analyses suggested that these findings were due to comorbid major depression, which has been repeatedly associated with this form of memory impairment (Williams, 1992). Apparently OCD per se is not associated with difficulty retrieving specific autobiographical memories, and instead OCD patients show impairment because they also tend to suffer from depression. As we discuss below, because other studies included in this review generally did not assess for depression, it is possible that other apparent cognitive deficits and biases are the result of comorbid depression.

1.3. Memory for actions and imagined actions

It is also plausible that excessive checking, a common feature of OCD, is specifically related to deficits in memory for "actions." In other words, we might expect that OCD patients with prominent checking symptoms would be specifically impaired in their memory for their own actions, which in turn would compel them to engage in repeated checking. In this regard, a series of studies by Sher and his colleagues have demonstrated that checking is associated with impaired memory for actions in individuals with subclinical OCD (Sher, Frost, & Otto, 1983; Sher et al., 1984, 1989). Each of these three studies found that compulsive checking (n's = 13–49) was associated with relatively poor recall for the tasks engaged in over the course of the experiment. Interestingly, no differences were found for recognition memory of these tasks (Sher et al., 1989). Furthermore, one of these studies (Sher et al., 1989) found that checkers used less visual imagery when asked to recall certain biographical information (e.g., what they did on their last vacation) compared to controls.

Rubenstein et al. (1993) also found that subclinical OCD checkers ($n = 20$) exhibited deficits in recalling and recognizing previous actions. On the other

hand, checkers did not differ from controls in terms of the number of actions that they correctly recognized from a cartoon that they had been shown or in the percentage of words that they remembered from a list presented during the study. Likewise, Ecker and Engelkamp (1995) found that OCD patients who were checkers ($n = 24$) recalled fewer self-performed actions than low checking controls ($n = 24$). Thus, these results suggest that subclinical OCD checkers may be impaired in their recall of human actions, particularly their own actions, but not necessarily in more general information. These results are intriguing because a main feature of OCD is pathological doubt regarding whether an action has been completed correctly. If subclinical checkers suffer from action memory deficits, it could be that OCD checking results from memory impairments of this nature.

Another possibility is that OCD is associated with difficulties recalling whether a particular action was actually taken versus simply imagined, what Johnson and Raye (1981) coined as "reality monitoring" (the ability to distinguish between memories of doing from memories of imagined doing). For example, Rubenstein et al. (1993) investigated memory for personal actions among college students with subclinical checking symptoms ($n = 20$) and those with no OCD symptoms ($n = 20$). Participants read statements describing actions and were told either to perform, write or observe the actions. After this first stage of the experiment, participants were given a blank sheet of paper and told to write down all the actions they could remember and to indicate what the source of the actions was (i.e., to indicate if they had performed, written or observed each action). As discussed above, checkers recalled fewer actions overall, but furthermore they were more confused as to whether they had performed, written or observed the perceived action. This study suggests that individuals with OCD may have difficulty distinguishing between real and imagined actions. Likewise, Ecker and Engelkamp (1995) also found that OCD patients who were checkers experienced greater confusion between actual and imagined behaviors than low checking controls.

Although these results are theoretically appealing, a number of other studies have failed to replicate these findings. For example, McNally and Kohlbeck (1993) examined episodic memory and reality monitoring in OCD checkers ($n = 12$), OCD non-checkers ($n = 12$) and normal control participants ($n = 12$). Participants were required either to trace drawings or words, to imagine that they were tracing drawings or to simply observe drawings or words on cards. Following this first phase, participants performed a recognition memory test for the items that had been presented in the study phase and then were also asked to recall the activity that they had performed. Results of this study showed that participants with OCD did not exhibit reality-monitoring deficits. In other words, they were not impaired in distinguishing between real and imagined events.

Similarly, Merchelbach and Wessel (2000) failed to find evidence that OCD participants differ from normal control participants in terms of reality-monitoring skills. Their study was designed to test whether reality-monitoring deficits in

OCD patients result from high levels of dissociation (i.e., impaired integration of thoughts, feelings and experiences into consciousness and memory; see Hyman & Pentland, 1996). To test this notion, Merchelbach and Wessel (2000) presented OCD participants ($n = 19$) and controls ($n = 16$) with a reality-monitoring task that was immediately followed by a self-report measure of dissociation. After administration of this measure, participants received a recognition task for the items presented during the study phase and were told to indicate whether they had performed or only imagined each item. In addition, each of the participants was to indicate on a 3-point scale the level of confidence they had in their answers. Results showed that although OCD patients performed no worse than controls on the reality-monitoring task, they expressed less confidence in their reality-monitoring decisions (see Hermans, Martens, De Cort, Pieters, & Eelen, 2003 for similar findings using idiographically generated stimuli). At the same time, it was found that levels of dissociation were higher for the OCD patients and that these scores were significantly correlated with reduced confidence. In other words, the greater the level of dissociation, the less confidence participants had in their reality-monitoring decisions. Thus, Merchelbach and Wessel (2000) demonstrated that dissociation may play a role in OCD patients' unfavorable evaluation of their own reality monitoring decisions.

A number of additional studies have failed to find a reality monitoring deficit in OCD checkers (e.g., Brown, Koslyn, Breiter, Baer, & Jenike, 1994; Constans, Foa, Franklin, & Mathews, 1995; Sher et al., 1983), and a recent meta-analysis concluded that compulsive checkers are no more likely to have this problem than non-checkers (Woods, Vevea, Chambless, & Bayen, 2002). The Constans et al. (1995) study is particularly important, that it showed that OCD checkers ($n = 12$) could discriminate between memories for actions and memories for imagined actions even in anxiety-provoking contexts that were associated with personal responsibility. On the other hand, these patients reported that they desired higher levels of memory vividness in order to feel satisfied with their memories for both emotional and non-emotional events. Consequently, Constans et al. proposed that checking behavior may be motivated by a discrepancy between vividness of recall and one's desired level of vividness. In other words, OCD patients with checking compulsions may need higher levels of vividness of recall in order to feel confident that they actually performed an action. Relatedly, while Sher et al. (1983) failed to find an association between compulsive checking and reality-monitoring ability, checkers reported less confidence about their reality-monitoring performance.

Overall, the existing research suggests that OCD may be associated with impaired memory for personal actions, though it is unclear whether this form of memory impairment is specifically correlated with checking behaviors versus OCD in general. On the other hand, the research taken as a whole suggests that OCD patients do not tend to confuse memories of performed acts and memories of imagined acts. Instead, it may be that the compulsive checking behaviors are prompted by an overly critical attitude toward their own memory functioning.

1.4. Confidence in memory

Given that obsessional doubt has been seen as a key clinical feature of OCD, it is not surprising that investigators have been interested in the degree of confidence that individuals with OCD have in their memory. McNally and Kohlbeck's (1993) were the first to test the hypothesis that OCD is associated with decreased memory confidence. As noted previously, results indicated that OCD checkers' ($n = 12$) and OCD non-checkers' ($n = 12$) memory for actions and reality monitoring performance did not differ significantly from that of normal control participants ($n = 12$). However, OCD patients tended to express less confidence in their memories than did the control participants. Thus, it is possible that the obsessional doubts of OCD patients reflect deficits in memory confidence rather than deficits in the actual memory processes per se.

A number of studies have replicated McNally and Kohlbeck's (1993) initial finding that OCD patients lack confidence in their memories. For example, MacDonald et al. (1997) examined the episodic memories of OCD checkers ($n = 10$), OCD non-checkers ($n = 10$) and non-clinical control subjects ($n = 10$). Although the three groups did not differ on measures of recall and recognition, self-report confidence ratings for recognition judgments confirmed that when OCD checkers correctly identified previously seen words, they were less confident than OCD non-checkers and the control participants. As well, when OCD checkers correctly identified previously seen words, they were slower to respond than were the other groups. Thus, these results suggest that OCD checking is not related to the actual memory abilities of OCD checkers but instead to their confidence regarding their episodic memories. This conclusion was bolstered by a recent study by Tolin et al. (2001) that showed that patients with OCD ($n = 14$) did not differ from anxious controls ($n = 14$) and non-anxious controls ($n = 14$) in their recall of safe, unsafe or neutral objects. However, obsessive–compulsives showed less confidence in their memories for unsafe objects compared to the control groups and their confidence levels decreased over repeated trials. That is, when obsessive–compulsives were repeatedly exposed to the unsafe or threat-related objects (as in repeated checking), their level of confidence in remembering these objects progressively decreased. Likewise, Hermans et al. (2003) found that OCD patients ($n = 17$) reported lower confidence in their memories on a self-report measure compared to non-anxious controls ($n = 17$), though memory confidence was not associated with frequency of checking.

Foa, Amir, Gershuny, Molnar, and Kozak (1997) also found that although OCD patients ($n = 15$) did not demonstrate memory impairments relative to controls ($n = 15$), they did differ (marginally) in terms of memory confidence. Foa et al.'s experiment consisted of presenting participants with both contamination and non-contamination sentences and having participants repeat the sentences aloud. After a brief distraction period, participants heard about half of the old sentences and some new sentences in white noise. Participants were asked to repeat each sentence that they heard and to rate the level of the accompanying noise. This type

of test (presenting sentences in noise) is a type of implicit memory test. Implicit memory accounts for the phenomenon that a person's behavior is often influenced by a prior experience even though the person is not trying to consciously retrieve that experience (e.g., Graf & Schacter, 1985; Roediger, 1990). In the noise task used by Foa et al. (1997), implicit memory for a stimulus would be related to perceiving the noise as softer. Results of this study indicated that both OCD and control groups rated the noise accompanying old sentences as softer than that accompanying new sentences. This finding suggests that both groups formed implicit memories for the sentences. Results of an explicit recognition test that was also presented (participants had to discriminate between old and new sentences) showed that the recognition scores of OCD participants did not differ significantly from those of the controls regardless of sentence content. However, the groups marginally differed with regard to their confidence ratings for the recognition judgments; OCD participants tended to be less confident in the accuracy of their recognition for both types of sentences.

In summary, a number of studies have found that while OCD patients, both checkers and non-checkers, performed as well as control participants on measures of recall and recognition (explicit memory tasks), OCD checkers were less confident in their memory judgments. Importantly, this lack of confidence was evident from both self-report measures regarding confidence ratings and by the slower reaction times on the part of checkers (MacDonald et al., 1997). It is also important to note that it is possible that subclinical obsessive–compulsive individuals check in response to accurate appraisals of memory impairment, while OCD checkers check in response to doubts that are related to their OCD symptoms rather than to actual deficits in memory (see MacDonald et al., 1997).

1.5. Enhanced memory for threat-related stimuli?

Although OCD *checkers* may be impaired in their memory for various types of information, particularly visual stimuli and their own actions, it is plausible that OCD *washers* might demonstrate superior memory for stimuli involving threat of contamination. Clinically, we would expect that these individuals would be hypervigilant for signs of contamination. In line with this perspective, Radomsky and Rachmen (1999) recently reported that individuals with OCD with fears of contamination ($n = 10$) showed *better* memory for objects that were contaminated by the experimenter relative to anxious controls ($n = 10$) and healthy controls ($n = 20$). Groups did not differ in terms of general memory ability. A follow-up study by Radomsky, Rachman, and Hammond (2001) determined that a positive memory bias for threatening information in OCD checkers is contingent on the patient's perceived responsibility for the outcome of a particular check. Specifically, they found that as responsibility for the outcome of a check increased, the memory bias in favor of threat-relevant information was amplified. Another study by Constans et al. (1995) also found that OCD patients with prominent checking symptoms demonstrated superior memory for their actions

that elicited anxiety. On the other hand, Ceschi, der Linden, Dunker, Perroud, and Bredart (2003) failed to replicate Radomsky and Rachmen's (1999) findings of superior free-recall memory of contaminated stimuli. Instead, they found that OCD washers ($n = 16$) were more accurate in recalling whether or not contaminated objects had been touched by clean or dirty tissues, suggesting increased memory for the context surrounding threatening stimuli rather than those stimuli themselves. In contrast to the above studies, Foa et al. (1997) failed to find a memory bias among 15 OCD patients with contamination fears compared to 15 non-psychiatric controls despite the fact that the study employed both explicit and implicit measures of memory for neutral and contamination sentences.

It is also possible that OCD patients have difficulty in forgetting threatening information. To test this hypothesis, Wilhem, McNally, Baer, and Florin (1996) employed a directed forgetting procedure. In this task, participants were instructed to view a series of negative, positive, and neutral words, with instructions to either remember or forget each item. Results indicated that patients with OCD ($n = 36$) exhibited deficits in the ability to forget negative material, whereas healthy control participants ($n = 24$) did not show such deficits. Thus, this study may reflect the possibility that OCD patients have a selective information-processing bias, such that these individuals experience difficulty forgetting unwanted, negative information (see Tolin, Hamlin, & Foa, 2002, for similar findings). Interestingly, these findings appear to be specific to negative information; no group differences were found in a study comparing non-clinical checkers ($n = 23$) to non-checkers ($n = 35$) on directed forgetting of non-valenced words (Maki, O'Neill, & O'Neill, 1994).

In summary, the extant research has fairly uniformly demonstrated that OCD individuals exhibit a positive memory bias favoring threat-related stimuli. Although occurrence of this phenomenon was predicted in the case of OCD washers, it is somewhat surprising that similar biases were found with OCD checkers. In the latter group it appears that a memory bias for threatening information is dependent on the perceived responsibility of an outcome of a particular check.

2. Attentional biases and deficits

Eysenck (1992) suggests that increased levels of anxiety are associated with working memory being consumed in task irrelevant processing at the expense of task-relevant operations. According to this view, performance deficits associated with anxiety are caused by the cognitive interference of intrusive (task-irrelevant) information with the cognitive processing of task-relevant information (see also Gotlib, Roberts, & Gilboa, 1996). Anxious individuals may perform poorly on difficult experimental tasks because their cognitive systems preferentially process task-irrelevant information related to threat. In terms of clinically anxious patients, it has been found that such patients display an increased ability to

encode emotionally threatening information (e.g., Burgess et al., 1981). If OCD patients are similar to other types of anxiety disorder patients, one would expect a similar attentional bias for threatening information in OCD, though perhaps to stimuli that are personally threatening (e.g., contamination-related words). Do studies of OCD patients show that these individuals exhibit a cognitive bias in favor of the processing of threat-related information?

2.1. Studies testing attentional biases

To date, the limited empirical literature presents somewhat mixed evidence concerning attentional biases in OCD. In one of the first studies to address this issue, Foa and McNally (1986) used a dichotic listening task to test whether fear-relevant stimuli are perceived more readily than neutral stimuli. In a dichotic listening task, participants are presented with two prose passages, one to each ear and are requested to shadow (repeat aloud) the passage presented to the dominant ear. They are also asked to detect target words inserted in each passage. Participants usually detect targets presented in the attended passage but have a harder time recognizing targets in the unattended passage, unless the target words are unusually salient. In the Foa and McNally experiment, 11 participants with OCD completed dichotic listening tasks before and after treatment by exposure and response prevention. If fear-relevant words (e.g., urine, cancer, rabies, etc.) were more readily detected than neutral words because of their association with fear, then this difference should be reduced following exposure treatment. In contrast, if familiarity is the reason for the greater salience of these fear-words, then exposure treatment should enhance the difference in detectability between the fear-words and the neutral words. Results showed that fear-relevant words were detected more than neutral words before but not after the exposure treatment. This finding suggests that sensitivity to fear-relevant stimuli is due to fear and not familiarity and that elevated anxiety is associated with an enhanced capacity to encode threatening information.

Modified Stroop tasks have also been used to study attentional biases to threat-information in OCD. In a modified Stroop task, participants see emotionally laden words (e.g., toilet) presented in different colors and are instructed to name the color, while at the same time, attempting to ignore their semantic content. The logic of the task is that difficulty in avoiding the processing of particular types of word content that would result in taking a longer time to color-name the items. Numerous studies have shown that clinically anxious participants show a disproportionate amount of slowing to color naming emotionally threatening words compared to emotionally neutral words, which suggests that these participants found it difficult to avoid encoding the threatening word content (see Williams, Mathews, & MacLeod, 1996, for a review). However, relatively few studies have used the modified Stroop task with OCD samples.

Foa, Ilai, McCarthy, Shoyer, and Murdock (1993) administered a modified Stroop task to 23 OCD patients with washing rituals (washers), 10 OCD patients

without washing rituals (non-washers) and 14 normal participants. Each participant was required to color-name contamination words, general threat words, neutral words and nonwords. Interference scores were calculated by subtracting the latencies to respond to neutral words from latencies to contamination and general threat words. Results indicated that compared to non-washers and controls, washers evidenced longer latencies for color-naming contamination words (threat information specific to their tear). In contrast, OCD non-washers showed interference to general threat words relative to washers and controls. These differences between washers and non-washers arose despite the fact that the two groups were similar in overall OCD symptom severity and in measures of anxious and depressive symtomatology. Thus, these results demonstrate that selective processing of threat information in OCD might be highly specific to the patient's particular concerns. Likewise, Lavy, van Oppen, and van den Hout (1994) found specific attentional biases in OCD. Results indicated that the 33 patients with OCD selectively attended to threat words related to obsessions and compulsions relative to the 29 normal controls. Importantly, patients with OCD did not exhibit interference effects to positive words related to obsessions and compulsions or to negative threatening words in general. Interestingly, another study found that OCD patients did not show Stroop interference for panic-related or general threat words (McNally et al., 1994), suggesting that atttentional biases may be relatively specific to OCD-related content. Surprisingly, though one study found evidence of an attentional bias to words involving unpleasant bodily sensations (McNally, Riemann, Luro, Lukach, & Kim, 1992).

Utility of the modified Stroop task for measuring attentional bias in OCD patients was further demonstrated in a study by Direnfeld, Pato, and Roberts (2001). Direnfeld et al. assessed attentional bias in a heterogeneous sample of OCD patients ($n = 42$) over the course of a 12-week exposure and ritual prevention group treatment. At the beginning of each of the 12 sessions, OCD participants completed the Yale Brown Obsessive–Compulsive Scale (YBOCS) and were also administered a modified Stroop task. This study not only demonstrated that patients with OCD showed interference to threat-related stimuli relative to normal controls, but also that interference significantly correlated with the total number of obsessive and compulsive symptoms. Patients with more diverse symptomatology had the greatest attentional bias to threatening stimuli. Furthermore, attentional bias decreased significantly trom pre- to post-treatment (although the frequency of testing may have also led to practice effects) and participants who no longer experienced an attentional bias at treatment termination reported fewer total number of obsessive symptoms. These results are compelling because they indicate not only that OCD patients differ from normal control participants in Stroop interference, but that interference varies as a function of the number of symptoms within OCD patients and is reduced as these symptoms are ameliorated through treatment.

On the other hand, there have been two important failures to replicate these general findings (Kampman, Keijsers, Verbraak, Naring, & Hoogduin, 2002;

Kyrios & lob, 1998). Kampman et al. (2002) reported no differences between OCD patients ($n = 20$), Panic Disorder patients ($n = 20$) and normal controls ($n = 20$) on panic-related, OCD-related or general threat stimuli under either supraliminal or subliminal presentations. Likewise, Kyrios and lob (1998) found no difference between 15 patients with OCD and 15 normal controls on Stroop performance for OCD-related threat or general threat words presented either supraliminally or subliminally. Interestingly, comorbid depression was allowed in the Kyrios and lob study and, while Kampman et al. did not report whether not individuals with comorbid depression were excluded, their OCD group had elevated scores on the Beck Depression Inventory (mean = 15.7). As we discuss later, it is possible that comorbid symptoms of depression may attenuate attentional biases in anxiety disorders. In addition neither of these studies tested stimuli that were tailored to the particular concerns of their OCD patients.

It is important to point out that exaggerated interference effects in the presence of threatening distracters (as seen in the Stroop task) does not necessarily mean that these anxious individuals were selectively encoding the threatening distracter information (MacLeod, 1996). Indeed, a number of observations have challenged this interpretation of Stroop interference. For example, people who score high on questionnaire measures of ''repression,'' a personality trait that has been assumed to reflect the avoidance of processing of aversive information, also take a longer time to color name threat words relative to neutral-emotional words on the emotional Stroop task (Dawkins & Furnham, 1989). In addition, Lavy and van den Hout (1994) found that color naming latencies were increased when normal participants were asked to avoid reading certain types of semantic information. Such findings cast serious doubt on the idea that increased color naming interference among OCD patients necessarily reflects a greater tendency to selectively encode the threatening content of stimuli.

The visual dot-probe task (MacLeod, Mathews, & Tata, 1986) is another method for measuring selective attention that is less vulnerable to the interpretative concerns associated with the modified Stroop task. In this task, participants are exposed to word pairs on a computer screen and on some trials a dot (the probe) appears in the location of one of the words. Participants are instructed that their task is to press a button as fast as possible to indicate the detection of the probe. Selective attention can be determined because dot-probe detection will be more rapid if the participant was already attending to the location where the probe appears. In some of the trials, one word from each pair is a ''threat'' word and its location varies across trials in relation to the position of the subsequent probe. MacLeod et al. (1986) observed that anxious participants were fastest at responding to the probe when it was in the exact location of threat-related words. These investigators argued that this finding occurred because anxious participants were directing their attention disproportionately towards the threat location, i.e., anxious individuals demonstrated vigilance for threatening information. In contrast, normal participants tended to direct their attention away from the threat information suggesting that these individuals were avoiding threatening

information. Anxious individuals' increased speed for detecting probes appearing in the vicinity of threat stimuli has been replicated across a number of studies (e.g., MacLeod & Mathews, 1988; Mogg, Mathews, & Eysenck, 1992; Mogg, Millar, & Bradley, 2000).

Tata, Lebowitz, Prunty, Cameron, and Pickering (1996) attempted to demonstrate that patients with OCD are also characterized by a bias in selective attention for threat-related information using the dot-probe task. Tata et al. compared 13 OCD participants whose main concerns involved contamination with 18 participants with high trait anxiety. Using the dot-probe task, Tata et al. presented participants with both contamination and social anxiety words and studied the specific allocation of attention on the part of these two groups for the two types of stimuli. Results of this study revealed content specific vigilance: the OCD group was more vigilant for words that had contamination content, whereas the high trait anxiety controls showed greater vigilance for social anxiety words. Although this is a well-designed study with provocative findings, one must be cautious about generalizing these results to OCD patients who are not concerned with contamination. It may be that OCD washers and checkers have different cognitive biases (Summerfeldt & Endler, 1998).

In summary, the reported findings suggest that patients with OCD selectively attend to threatening information, particularly information related to their particular concerns. Similar attentional biases have been documented in a variety of anxiety disorders, including Post-Traumatic Stress Disorder (Buckley, Blanchard, & Neill, 2000; McNally, 1998a), Social Phobia (Heinrichs & Hofmann, 2001) and Generalized Anxiety Disorder (McNally, 1998b). Such biases in attention presumably would lead to the overrepresentation of threat cues within the information that anxious participants encode from their environment. It seems reasonable to postulate that such biases in selective attention could contribute to the development and maintenance of intrusive obsessive thoughts in OCD. It would be expected that such threatening information would be particularly hard for these individuals to ignore.

2.2. *Deficits in attentional inhibition*

Clinicians have long observed that individuals with OCD often have an exceedingly difficult time inhibiting various negative thoughts. From a cognitive science perspective, ''attentional inhibition'' refers to how an organism narrows down incoming information in order to selectively attend to the stimuli that are most relevant and minimize the processing of irrelevant information. The notion that inhibition plays a role in selective attention was advocated by Treisman and Geffen (1964) who argued that the selection of specific stimuli for analysis may involve the ignoring of others. It has been suggested that the process of cognitive inhibition occurs through a balance of the facilitory processing of task-relevant stimuli and the active inhibition or suppression of task-irrelevant stimuli (Tipper, 1985; Tipper & Cranston, 1985). Cognitive inhibition has been extensively

investigated through the negative priming paradigm (Tipper, 1985). Negative priming involves the re-presentation of a previously ignored distracter object as the target object or category to be named (i.e., the previous distracter item is now represented as the target item). In normal participants, the process of naming such items takes longer than if there had been no prior presentation of that item. Some theorists have argued that this effect is caused by a process of active inhibition of the distracter item causing the subsequent delay in responding (Tipper, 1985). Negative priming thus occurs as a consequence of the need to first overcome the inhibition before further processing of that item is possible.

The effect of cognitive inhibition can be shown using an adaptation of the Stroop color naming task. In the typical Stroop task, the participant has two interpretations of the stimulus which compete for control of behavior. For example, the word RED is written in green ink and the participant is asked to name the color the word is written in. In such a situation, the participant is able, of course, to make the correct response but there is a reaction time cost associated with it. If on a subsequent task, RED became the target response instead of the distracter, normal participants' responses are significantly slowed. Neill (1977) postulated that this effect occurs (increase in response latency) because the distracter word in the preceding trial had been actively inhibited and this inhibition produces a subsequent response cost in terms of increased reaction time (the need to undo the inhibition).

Given the difficulties OCD patients have in controlling unwanted intrusive thoughts, deficits in attentional inhibition may play an important role in this clinical condition. Enright and Beech (1990) compared an OCD group ($n = 16$) to a group composed of individuals with a variety of other anxiety disorders ($n = 15$) using a negative priming task. The target stimuli were the colors red, pink, green arid blue, whereas distractors were the color words 'RED,' 'PINK,' 'GREEN' and 'BLUE.' Participants were required to name the ink color as quickly as possible. The results of their study indicated that the OCD group showed less negative priming than the control group.

In a subsequent study, Enright and Beech (1993a) replicated these findings using both individual letters as well as color-words as stimuli. Similar to their first study, the OCD group ($n = 36$) displayed less negative priming than each of the other anxiety groups. Further, there were no differences between the other anxiety disorder groups. Similar findings were reported in another study (Enright & Beech, 1993b). More recently it was demonstrated that negative priming deficits in OCD (relative to other anxiety disorders) are strongest at relatively rapid presentation rates (100 ms), suggesting a possible preattentive deficit in cognitive inhibition (Enright, Beech, & Claridge, 1995). Interestingly, deficits in negative priming tended to be more apparent among OCD checkers as opposed to OCD non-checkers, suggesting that this particular cognitive deficit in OCD may vary across subtypes. In the only study we are aware of to examine negative priming with valenced stimuli, McNally, Wilhelm, Buhlmann, and Shin (2001) found marginal support for impaired negative priming in OCD patients when

stimuli were presented briefly (100 ms), though not at a longer presentation interval (500 ms). Surprisingly, effects did not vary between threatening and neutral stimuli.

Another study also demonstrated a deficit in attentional inhibition that appears to be specific to OCD relative to panic disorder (Clayton, Richards, & Edwards, 1999). Clayton et al. compared the performance of people with OCD ($n = 17$) with those with panic disorder ($n = 13$) and with control participants ($n = 14$) on series of psychometric attention tests known as the Test of Everyday Attention (TEA). They found that the OCD group performed less well than the panic and control groups on three of the four subtests of the TEA that are highly sensitive to selective attention. Clayton et al. interpreted these findings as suggesting that individuals with OCD have a reduced ability to selectively ignore competing external (sensory) and internal (cognitive) stimuli. On the other hand, Maki et al. (1994) reported that non-clinical checkers ($n = 23$) did not differ from non-checkers ($n = 35$) on a variety of measures of attentional control, including negative priming. These findings suggest the possibility that either elevated levels of non-clinical checking are qualitatively distinct from OCD or that difficulties in cognitive control are limited to subtypes of OCD other than checking.

The theoretical implications of these findings of a central deficit of inhibition in OCD may be crucial to our understanding of the disorder. Failure to inhibit undesirable and irrelevant stimuli pre-consciously may result in the person being bombded with recurrent unwanted and disturbing thoughts and images. In time, these difficult to control thoughts may produce and maintain severe anxiety, particularly when they arise in the context of meta-cognitions related to catastrophic misinterpretations of the significance of intrusive thoughts (see Rachman, 1997, 1998; Salkovskis, 1985, 1996). Unfortunately, there is reason to believe that conscious attempts by an OCD individual to suppress these unwanted thoughts probably produce the paradoxical effect of an increase in the frequency of the recurrent thoughts and images (Purdon, 1999; Wegner, Schneider, Carter, & White, 1987). Future studies are needed to replicate these preliminary findings, as well as to address additional issues, such as the degree to which inhibitory deficits vary across subtypes of OCD and the extent to which they may account for the attentional biases to threatening stimuli and memory disturbances documented earlier. It would be important to note that deficits in negative priming have also been documented in schizophrenia (Beech & Claridge, 1987; Beech, Powell, McWilliam, & Claridge, 1989), clinical depression (MacQueen, Tipper, & Levitt, 2000; see Shapiro & Roberts, 2004 for a review), and individuals with high levels of trait anxiety (Fox, 1994, Study 2). Together this work suggests that deficient attentional inhibition may cut across a number of diagnostic categories. It would be important for future work to determine whether there are certain facets of deficient inhibition that are specific to OCD. For example, are these biases specific to threat-related stimuli in OCD but more general in schizophrenia (cf. McNally et al., 2001)?

3. Conclusions and recommendations

Given the nature of symptomatology in OCD, it has been long thought that deficits and biases in memory and attention may be a key aspect of the psychopathology of this disorder. For example, it is easy to imagine that the checking rituals that many of these patients suffer from are sparked by memory impairment concerning the person's own actions. In other words, these individuals check because they simply do not recall having performed the action or because they are not sure if their memory is for an imagined as opposed to real action (see Tallis, 1997). Likewise, it is plausible that persistent intmsive thoughts only become a problem in OCD because the individual has difficulty suppressing or inhibiting these thoughts once they occur (see Purdon, 1999) and that vigilance to threatening stimuli in the environment sparks these cognitions. Although supporting some of these hypotheses, the present review also casts doubt on others.

Although the extant research has provided a rather mixed and inconclusive picture concerning the possibility of an overall memory deficit in OCD patients, there is relatively strong evidence that OCD is associated with low memory confidence, as well as memory biases towards threatening information. Further, recent neuropsychological studies suggest that individuals suffering from OCD exhibit deficits in non-verbal memory, particularly visual memory. They also appear to have memory problems concerning their own actions. However, memory deficits of this type do not appear to account for checking compulsions. For example, a study by Tallis et al. (1999) failed to find a significant relationship between performance on neuropsychological tests known to be sensitive to action memory functioning and severity of checking symptoms. Furthermore, the weight of evidence suggests that reality-monitoring deficits (i.e., an inability to distinguish memories for real versus imagined actions) fail to account for checking (Woods et al., 2002). Interestingly, recent research suggests that rather than repeated checking being the result of memory impairment, repeated checking can cause memory impairment by making recollection less vivid and detailed (van den Hout & Kindt, 2003). Taken together, the research discussed in this review suggests that repetitive checking behaviors are not the result of general or specific moments, but rather a lack of confidence in the patient's memory. It is possible that such lack of confidence on the part of OCD patients in their recognition memory plays an important role in the development and/or maintenance of this disorder.

Given the mixed pattern of results concerning verbal memory impairment, combined with limited statistical power, we must remain cautious about whether or not such impairment exists in OCD (cf. Woods et al., 2002). As we discuss below, low statistical power is a serious problem in this research that may account for null findings. Nevertheless, there is converging evidence that indicates that OCD patients exhibit specific deficits in executive and visual memory functioning (e.g., Purcell et al., 1998; Savage et al., 1999). Further, Purcell et al. (1998)

observed that OCD patients' ability to organize and execute a series of goal-directed behaviors was highly dependent on whether the executive planning task was one which provided external validation of ongoing performance. That is, on tests such as the ''Tower of London,'' OCD patients did not show impaired organizational strategies as they could externally monitor their performance (the goal arrangement remained on the screen throughout each trial). In contrast, when OCD patients were given a spatial working memory task for which they had to rely on internal representations to guide their selections, their performance suffered. Thus, Purcell et al. (1998) postulate that an inability to use internal representations to guide ongoing behaviors may be particularly relevant to OCD.

Although there is somewhat limited research, the available studies suggest that OCD is also associated with attentional biases to threatening information and reduced cognitive inhibition. Such attentional biases, coupled with memory biases for threatening information could fuel these patients' preoccupation with disturbing thoughts. These findings are potentially important for understanding the psychopathology of OCD because one of the cardinal symptoms is unwanted intrusive thoughts that become obsessive. It may be that a central deficit of inhibition in OCD sufferers contributes to the recurrent unwanted thought patterns symptomatic of this disorder, and future research needs to investigate the underlying processes that contribute to these difficulties in inhibition.

It is possible that OCD patients' difficulties in inhibiting the processing of irrelevant information are exacerbated when the information being processed has emotional significance (cf. McNally et al., 2001). Indeed, this notion is supported by some recent studies that have found that Obsessive–Compulsives (both checkers and cleaners) show a specific bias for remembering threat-related stimuli. As reported earlier, memory biases for threatening information among OCD checkers appears to be contingent on patients' perceived responsibility for the outcome of a particular check (Radomsky et al., 2001). As perceived responsibility for the outcome of a check increases, the memory bias in favor of threat-relevant information appears to be amplified. Radomsky et al.'s finding is consistent with cognitive accounts of OCD that hold that cognitive responses to intrusive thoughts are linked to beliefs concerning responsibility (Salkovskis, 1985, 1996). Indeed, situations that would normally elicit anxiety and subsequent checking behaviors do not elicit such effects when responsibility is shared (Roper & Rachman, 1976). Thus, an inflated sense of responsibility causes individuals with OCD to be on the ''lookout'' for threat-relevant stimuli (attentional biases). In turn, this increased vigilance may lead to enhanced memory (memory biases) for threat-relevant stimuli among these patients.

Although direct comparisons are largely absent, the pattern of anomalies in memory and attention demonstrated in OCD appear distinct from what has been seen in other anxiety disorders. Although Post-Traumatic Stress Disorder (PTSD) has been found to be associated with general memory impairment, perhaps resulting from stress-related hippocampal damage (Buckley et al., 2000),

OCD appears to be associated with specific impairments in memory related to behavioral actions and complex visual stimuli. Furthermore, although reviewers have argued that negative memory biases are generally not found in most anxiety disorders (Williams et al., 1997), with perhaps the exception of PTSD (Buckley et al., 2000; McNally, 1998a, 1998b), OCD patients appear to have enhanced memory for threat-related information. Future research should consistently include other anxiety disorder comparison groups in order to further clarify the cognitive processes that are unique to OCD versus those that are shared with other anxiety disorders. Until this research is completed, it is not possible to know whether any bias or deficit is specific to OCD or a characteristic of anxiety disorders in general.

In summary, cognitive biases/deficits in the domains of memory and attention appear to be associated with OCD and it is possible (though largely untested) that these cognitive anomalies are distinct from those seen in other anxiety disorders. However, given the criticism outlined above regarding statistical power and lack of other anxiety disorder comparison groups, we believe that there is much that remains unresolved within this realm. In light of this fact, we conclude the present review with several recommendations for future research that could help clarify the role of memory and attention in OCD.

3.1. Recommendation 1: other-anxiety disorder controls

As discussed above, only a few of the reviewed studies included other-anxiety disorder control groups. This is an important limitation as it precludes our ability to determine whether various cognitive biases and deficits are specific to OCD versus anxiety disorders in general. Relatedly, it is possible that apparent deficits and/or biases are the result of high trait anxiety irrespective of clinical disorder. Future studies should routinely include other-anxiety disorder control groups and measure and analyze the effects of trait anxiety on cognitive variables.

3.2. Recommendation 2: heterogeneity of OCD

There is growing recognition that OCD is a heterogenous condition that is likely composed of multiple subtypes that are unique in terms of their etiological pathways and their psychological correlates. For example, considerable evidence suggests that early-onset OCD is distinct from adult onset OCD (Eichstedt & Arnold, 2001). Likewise, Pigott et al. (1996) posit three distinct subtypes of OCD: altered risk assessment disorder; incompleteness/habit-spectrum disorder; and psychotic-spectmm disorder. In contrast, empirical work on memory and attention have largely ignored the possibility that cognitive disturbances will vary across subtypes. The few studies that have examined such heterogeneity have only compared OCD checkers and washers. Future research needs to examine and compare OCD patients with different subtypes on measures of cognitive bias and deficit.

3.3. Recommendation 3: idiographic stimuli

Related to Recommendation 2 above, given the variability across patients with OCD in terms of their primary concerns, future research may benefit from the use of idiographically tailored stimuli. In other studies, stimuli used in memory or attention tasks would be individually generated for each participant. Indeed recent studies have taken this approach with some success (e.g., Hermans et al., 2003; Tolin et al., 2001). Although this approach has the potential of increasing the relevance of stimuli used, researchers need to be mindful of the fact that participants are not exposed to the same stimuli and that stimuli may vary in terms of important characteristics such as word length, number of syllables, and frequency of usage.

3.4. Recommendation 4: comorbid depression in OCD

Comorbid psychopathology is another potentially important form of heterogeneity in OCD. For example, epidemiological studies have found that approximately 30% of individuals with OCD also meet criteria for a major depressive episode (Karno, Golding, Sorenson, & Burnam, 1988). In this regard, it is possible that OCD memory biases for threat-related information results from comorbid depression (see Moritz et al., 2001; Wilhem et al., 1997). That is, because depression is associated with memory biases for negative information (see Gotlib et al., 1996 for a review), OCD patients with comorbid depression may be responsible for overall group differences; memory biases may be largely absent in those with pure OCD. Future research needs to determine the degree to which cognitive effects are unique to OCD versus the result of shared variance with depression. In contrast, some evidence suggests that comorbid depression can *mask* attentional biases in Generalized Anxiety Disorder (Bradley, Mogg, Millar, & White, 1996) and Social Phobia (Musa, Lepine, Clark, Mansell, & Ehlers, 2003). In these studies, individuals with pure anxiety disorders demonstrated attentional biases, whereas those with comorbid depression did not. It is possible that comorbid depression effects memory and attention in distinct ways, specifically by enhancing memory biases and deficits, while simultaneously attenuating attentional biases.

3.5. Recommendation 5: sample size and statistical power

As discussed earlier, another major concern with this literature is statistical power. The majority of studies reviewed are based on samples that range in size between 10 and 20 OCD participants. Consequently, null results can easily be attributed to Type II error. Thus, it is quite possible that null results reported by many of these studies were due to a lack of statistical power to identify true differences between OCD participants and controls. Effects that are small to moderate in magnitude would have been extremely difficult to detect. Because it

may be difficult to recruit sufficiently large numbers of patients with OCD, cross-site collaborative studies may be necessary in order to reach suitable sample sizes. Examination of effect sizes and meta-analytic summaries can also be helpful (e.g., Woods et al., 2002).

3.6. Recommendation 6: memory confidence

Although the research reviewed consistently demonstrated low memory confidence among patients with OCD, a number of issues remain. First, tests should be done to clarify whether memory confidence is affected by the nature of the stimuli being recalled. In particular, is memory confidence more diminished among OCD patients for threat-relevant material than for non-threatening material? Relatedly, we might expect that memory confidence would be associated with perceived responsibility for the outcome of checks. In particular, is memory confidence more diminished when the individual feels personally responsible for the outcome of the particular check?

In addition, although the bulk of the evidence suggests that OCD patients suffer from reduced confidence in memories, it is important to point out much of this evidence is based on self-report measures of confidence. Use of self-report confidence measures is especially problematic in OCD because "doubt" is a prominent symptom of this disorder. Therefore, we propose that future studies in this domain utilize alternative methods for measuring confidence in OCD patients. One such method may involve the use of reaction times for making recognition decisions (e.g., MacDonald et al., 1997). Ultimately such research might lead to cognitive-behavioral interventions that specifically target patients' confidence regarding their ability to remember information; it is likely that treatments that improve memory confidence may help to relieve the symptoms of some OCD patients. Such interventions will likely be particularly helpful for patients with an inflated sense of responsibility who catastrophize about the repercussions of mistakes in memory. Such interventions also would likely target the catastrophizing itself.

3.7. Recommendation 7: examining interrelations among cognitive variables

At present interrelations between different cognitive variables in OCD have not been investigated; such research could prove quite fertile. It is possible, for example, that attentional biases towards threat-related information in OCD individuals fuels obsessional doubt and decreases memory confidence. An individual with OCD who is hypervigilant towards threat stimuli would be constantly reminded of the danger that could result from memory failures. Relatedly, it may prove useful for future studies to examine the possible interactive effects of different aspects of memory and attention. For example, it may be that the combination of deficits in cognitive inhibition and beliefs about personal responsibility are particularly important in generating negative attentional and memory

biases in OCD. Specifically, individuals who tend to take inappropriate levels or responsibility *and* who have difficulty controlling the resulting guilty definitions may be most hypervigilant for threatening information. To address such issues, it would be important for future studies to employ measures of different aspects of information processing in the same sample.

3.8. Recommendation 8: causal role of cognitive biases and deficits in OCD?

At present, it is not known whether deficits or biases in memory and attention play any role in the onset and maintenance of OCD symptomatology, treatment response, or relapse. Longitudinal research is required to address such issues. Such research is crucial in terms of demonstrating that these cognitive processes play a key role in the generation of OCD symptomatology.

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References

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed. Text Revision). Washington, DC: American Psychiatric Association.

Aronowitz, B. R., Hollander, E., DeCaria, C., Cohen, L., Saoud, J. B., Stein, D. et al. (1994). Neuropsychology of Obsessive–Compulsive Disorder. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, *7*, 81–86.

Beech, A. R., & Claridge, G. S. (1987). Individual differences in negative priming. Relations with schizotypal personality traits. *British Journal of Clinical Psychology*, *78*, 349–356.

Beech, A. R., Powell, T. J., McWilliam, J., & Claridge, G. S. (1989). Evidence of reduced cognitive inhibition in schizophrtenia. *British Journal of Clinical Psychology*, *28*, 109–116.

Boone, K. B., Ananth, J., Philpott, L., Kaur, A., & Djenderjian, A. (1991). Neuropsychological characteristics of nondepressed adults with Obsessive–Compulsive Disorder. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, *4*, 96–109.

Bradley, B. P., Mogg, K., Millar, N., & White, J. (1996). Selective processing of negative information: effects of clinical anxiety, concurrent depression and awareness. *Journal of Abnormal Psychology*, *104*, 532–536.

Brown, H. D., Koslyn, S. M., Breiter, H. C., Baer, L., & Jenike, M. A. (1994). Can patients with obsessive–compulsive disorder discriminate between percepts and mental images? A signal detection analysis. *Journal of Abnormal Psychology*, *103*, 445–454.

Buckley, T. C., Blanchard, E. B., & Neill, W. T. (2000). Information processing and PTSD: a review of the empirical literature. *Clinical Psychology Review*, *20*, 1041–1065.

Burgess, J. S., Jones, L. N., Robertson, S. A., Radcliffe, W. N., Emerson, E., Lawler, P. et al. (1981). The degree of control exerted by phobic and nonphobic verbal stimuli over the recognition behavior of phobic and nonphobic subjects. *Behaviour Research and Therapy*, *19*, 223–234.

Calamari, J. E., Wiegarrt, P. S., & Janeck, A. S. (1999). Obsessive–compulsive disorder subgroups: a symptom-based clustering approach. *Behaviour Research and Therapy*, *37*, 113–125.

Ceschi, G., der Linden, M. V., Dunker, D., Perroud, A., & Bredart, S. (2003). Further exploration memory bias in compulsive washers. *Behaviour Research and Therapy*, *41*, 737–747.

Christensen, K. J., Kim, S. W., Dyksen, M. W., & Hoover, K. M. (1992). Neuropsychological performance in obsessive–compulsive disorder. *Biological Psychiatry*, *31*, 4–18.

Clayton, I. C., Richards, J. C., & Edwards, C. J. (1999). Selective attention in obsessive–compulsive disorder. *Journal of Abnormal Psychology*, *108*, 171–175.

Constans, J. I., Foa, E. B., Franklin, M. E., & Mathews, A. (1995). Memory for actual and imagined events in OC checkers. *Behavior Research and Therapy*, *33*, 665–671.

Dawkins, K., & Furnham, A. (1989). The colour naming of emotional words. *British Journal of Psychology*, *80*, 383–389.

Deckersbach, T., Otto, M. W., Savage, C. R., Baer, L., & Jenike, M. A. (2000). The relationship between semantic organization and memory in obsessive–compulsive disorder. *Psychotherapy and Psychosomatics*, *69*, 101–107.

Direnfeld, D. M., Pato, M. T., & Roberts, J. E. (2001). *Attentional biases in obsessive compulsive disorder: relationship to symptomatology and treatment*. Poster presented at the 2001 Meeting of the Association for the Advancement of Behavior Therapy.

Dirson, S., Bouvard, M., Cottraux, J., & Martin, R. (1995). Visual memory impairment in patients with obsessive–compulsive disorder: a controlled study. *Psychotherapy and Psychosomatics*, *63*, 22–31.

Ecker, W., & Engelkamp, J. (1995). Memory for actions in obsessive–compulsive disorder. *Behavioural and Cognitive Psychotherapy*, *23*, 349–371.

Eichstedt, J. A., & Arnold, S. L. (2001). Childhood-onset obsessive–compulsive disorder: a tic-related subtype of OCD? *Clinical Psychology Review*, *21*, 137–157.

Enright, S. J., & Beech, A. R. (1990). Obsessional states: anxiety disorders or schizotypes? An information processing and personality assessment. *Psychological Medicine*, *20*, 621–627.

Enright, S. J., & Beech, A. R. (1993a). Further evidence of reduced inhibition in obsessive–compulsive disorder. *Personality and Individual Differences*, *14*, 387–395.

Enright, S. J., & Beech, A. R. (1993b). Reduced cognitive inhibition in obsessive compuslvie disorder. *British Journal of Clinical Pyschology*, *32*, 67–74.

Enright, S. J., Beech, A. R., & Claridge, G. S. (1995). A further investigation of cognitive inhibition in obsessive–compulsive disorder and other anxiety disorders. *Personailty and Individual Differences*, *19*, 535–542.

Eysenck, M. W. (1992). *Anxiety: the cognitive perspective*. Hove, UK: Lawrence Erlbaum.

Foa, E. B., Amir, N., Gershuny, B., Molnar, C., & Kozak, M. J. (1997). Implicit and explicit memory in obsessive–compulsive disorder. *Journal of Anxiety Disorders*, *11*, 119–129.

Foa, E. B., Ilai, D., McCarthy, P. R., Shoyer, B., & Murdock, T. (1993). Information processing in Obsessive–Compulsive Disorder. *Cognitive Therapy and Research*, *17*, 173–189.

Foa, E. B., & McNally, R. J. (1986). Sensitivity to feared stimuli in obsessive–compulsives: a dichotic listening analysis. *Cognitive Therapy and Research*, *10*, 477–485.

Fox, E. (1994). Attentional bias in anxiety: a defective inhibition hypothesis. *Cognition and Emotion*, *8*, 165–195.

Gotlib, I. H., Roberts, J. E., & Gilboa, I. E. (1996). Cognitive interference in depression. In: I. G. Sarason (Ed.), *Cognitive interference: theories, methods, and findings. The LEA sedes in personality and clinical psychology* (pp. 347–377). Hillsdale, NJ: Erlbaum.

Graf, P., & Schacter, D. L. (1985). Implicit and explicit memory for new associations in normal and amnesic subjects. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *11*, 501–518.

Greisberg, S., & Mckay, D. (2003). Neuropsychology of obsessive–compulsive disorder: a review and treatment implications. *Cilnical Psychology Review*, *23*, 95–117.

Grusec, J. E., Lockhart, R. S., & Walters, G. C. (1990). *Foundations of psychology*. Mississauga, Ont.: Copp Clark Pitman.

Heinrichs, N., & Hofmann, S. G. (2001). Information processing in social phobia: a critical review. *Clinical Psychology Review*, *21*, 751–770.

Hermans, D., Martens, K., De Cort, K., Pieters, G., & Eelen, P. (2003). Reality monitoring and metacognitive beliefs related to cognitive confidence in obsessive–compulsive disorder. *Behaviour Research and Therapy*, *41*, 383–401.

Hyman, I., & Pentland, J. (1996). The role of mental imagery in the creation of false memories. *Journal of Memory and Language*, *35*, 101–117.

Jenike, M. A., Baer, L., & Minichiello, W. E. (1990). *Obsessive compulsive disorders: theory and management* (2nd ed.). Chicago: Yearbook Publishers.

Johnson, M. K., & Raye, C. L. (1981). Reality monitoring. *Psychological Review*, *88*, 67–85.

Kampman, M., Keijsers, G. P. J., Verbraak, M. J. P. M., Naring, G., & Hoogduin, C. A. L. (2002). The emotional Stroop: a comparison of panic disorder patients, obsessive–compulsive patients, and normal controls, in two experiments. *Journal of Anxiety Disorders*, *16*, 425–441.

Karno, M. G., Golding, J. M., Sorenson, S. B., & Burnam, A. (1988). The epidemiology of Obsessive Compulsive Disorder in five U.S. communities. *Archives of General Psychiatry*, *45*, 1094–1099.

Kyrios, M., & lob, M. A. (1998). Automatic and strategic processing in obsessive-compulsive disorder: attentional bias, cognitive avoidance or more complex phenomena. *Journal of Anxiety Disorders*, *12*, 271–292.

Lavy, E., van Oppen, P., & van den Hout, M. N. (1994). Selective processing of emotional information in obsessive compulsive disorder. *Behaviour Research and Therapy*, *32*, 243–246.

Lavy, E. H., & van den Hout, M. A. (1994). Cognitive avoidance and attentional bias: causal relationships. *Cognitive Therapy and Research*, *18*, 170–191.

Leckman, J. F., Grice, D. E., Boardman, J., Zhang, H., Vitale, A., Bondi, C. et al. (1997). Symptoms of obsessive–compulsive disorder. *American Journal of Psychiatry*, *154*, 911–917.

MacDonald, P. A., Antony, M. M., MacLeod, C. M., & Richter, M. M. (1997). Memory and confidence in memory judgments among individuals with obsessive compulsive disorder and non-clinical controls. *Behaviour Research and Therapy*, *35*, 497–505.

MacLeod, C. (1996). Anxiety and cognitive processes. In: I. G. Sarason, G. R. Pierce, & B. R. Sarason (Eds.), *Cognitive interferences: theories, methods and findings* (pp. 47–76). Mahwah, NJ: Lawrence Erlbaum.

MacLeod, C., & Mathews, A. (1988). Anxiety and the allocation of attention to threat. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, *40*, 653–670.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology*, *95*, 15–20.

MacQueen, G. M., Tipper, S. P., & Levitt, A. J. (2000). Impaired distractor inhibition on a selective attention task in unmedicated depressed subjects. *Psychological Medicine*, *30*, 557–564.

Maki, W. S., O'Neill, H. K., & O'Neill, G. W. (1994). Do nonclinical checkers exhibit deficits in cognitive control? Tests of an inhibitory control hypothesis. *Behaviour Research and Therapy*, *32*, 183–192.

Martinot, J. L., Allilaire, J. F., Mazoyer, B. M., Hantouche, E., Huret, J. D., Legaut-Demare, F. et al. (1990). Obsessive–compulsive disorder: a clinical, neuropsychological and positron emission tomography study. *Acta Psychiatdca Scandinivia*, *82*, 233–242.

McNally, R. J. (1998a). Experimental approaches to cognitive abnormality in posttraumatic stress disorder. *Clinical Psychology Review*, *18*, 971–982.

McNally, R. J. (1998b). lnformation-processing abnormalities in anxiety disorders: implications for cognitive neuroscience. *Cognition and Emotion*, *12*, 479–495.

McNally, R. J., Amir, N., Louro, C. E., Lukach, B. M., Riemann, B. C., & Calamari, J. E. (1994). Cognitive processing of idiographic emotional information in panic disorder. *Behaviour Research and Therapy*, *32*, 119–122.

McNally, R. J., & Kohlbeck, P. A. (1993). Reality monitoring in obsessive–compulsive disorder. *Behaviour Research and Therapy*, *31*, 249–253.

McNally, R. J., Riemann, B. C., Luro, C. E., Lukach, B. M., & Kim, E. (1992). Cognitive processing of emotional information in panic disorder. *Behaviour Research and Therapy*, *30*, 143–149.

McNally, R. J., Wilhelm, S., Buhlmann, U., & Shin, L. M. (2001). Cognitive inhibition in obsessive–compulsive disorder: application of a valence-based negative priming paradigm. *Behavioural and Cognitive Psychotherapy*, *29*, 103–106.

Merchelbach, H., & Wessel, I. (2000). Memory for actions and dissociation in obsessive–compulsive disorder. *Journal of Nervous & Mental Disease*, *188*, 846–848.

Mogg, K., Mathews, A., & Eysenck, M. (1992). Attentional bias to threat in clinical anxiety states. *Cognition & Emotion*, *6*, 149–159.

Mogg, K., Millar, N., & Bradley, B. P. (2000). Biases in eye movements to threatening facial expressions in generalized anxiety disorder and depressive disorder. *Journal of Abnormal Psychology*, *109*, 695–704.

Moritz, S., Birkner, C., Kloss, M., Jacobsen, D., Fricke, S., Bothern, A. et al. (2001). Impact of comorbid depressive symptoms on neuropsychological performance in Obsessive–Compulsive Disorder. *Journal of Abnormal Psychology*, *110*, 653–658.

Musa, C., Lepine, J. P., Clark, D. M., Mansell, W., & Ehlers, A. (2003). Selective attention in social phobia and the moderating effect of a concurrent depressive disorder. *Behaviour Research and Therapy*, *41*, 1043–1054.

Neill, W. T. (1977). Inhibitory and tacilitatory processes in selective attention. *Journal of Experimental Psychology: Human Perception and Performance*, *3*, 444–450.

Pigott, T. A., Myers, K. R., & Williams, D. A. (1996). Obsessive–compulsive disorder: a neuropsychiatric perspective. In: R. M. Rapee (Ed.), *Current controversies in the anxiety disorders* (pp. 134–160). New York: Guiltord.

Purcell, R., Maruff, P., Kyrios, M., & Pantelis, C. (1998). Neuropsychological deficits in obsessive–compulsive disorder: a comparison with unipolar depression, panic disorder. *Archives of General Psychiatry*, *55*, 415–423.

Purdon, C. L. (1999). Thought suppression and psychopathology. *Behaviour Research and Therapy*, *37*, 1029–1054.

Rachman, S. (1997). A cognitive theory of obsessions. *Behaviour Research and Therapy*, *35*, 793–802.

Rachman, S. (1998). A cognitive theory of obsessions: elaborations. *Behaviour Research and Therapy*, *36*, 385–401.

Radomsky, A. S., & Rachmen, S. (1999). Memory bias in obsessive–compulsive disorder (OCD). *Behaviour Research and Therapy*, *37*, 605–618.

Radomsky, A. S., Rachman, S., & Hammond, D. (2001). Memory bias, confidence and responsibility in compulsive checking. *Behaviour Research and Therapy*, *39*, 813–822.

Riggs, D. S., & Foa, E. B. (1993). Obsessive–Compulsive Disorder. In: D. H. Barlow (Ed.), *Clinical handbook of psychological disorders: a step-by-step treatment manual* (pp. 189–239). New York: Guilford.

Roediger, H. L. (1990). Implicit memory: retention without remembering. *American Psychologist*, *45*, 1043–1056.

Roper, G., & Rachman, S. (1976). Obsessional-compulsive checking: experimental replication and development. *Behaviour Research and Therapy*, *14*, 25–32.

Rubenstein, C. S., Peynirdoglu, Z. F., Chambless, D. L., & Pigott, T. A. (1993). Memory in sub-clinical obsessive–compulsive checkers. *Behaviour Research and Therapy*, *31*, 759–765.

Salkovskis, P. M. (1985). Obsessional compulsive problems: a cognitive-behavioral analysis. *Behaviour Research and Therapy*, *23*, 571–583.

Salkovskis, P. M. (1996). Cognitive-behavioral approaches to understanding obsessional problems. In: R. M. Rapee (Ed.), *Current controversies in the anxiety disorders* (pp. 103–133). New York: Guilford.

Savage, C. R. (1998). Neuropsychology of OCD: research findings and treatment implications. In: M. A. Jenike, L. Baer, & W. E. Minichiello (Eds.), *Obsessive–Compulsive Disorders: practical management* (3rd ed., pp. 254–275). St. Louis, MO: Mosby.

Savage, C. R., Baer, L., Keuthen, N., Brown, H. D., Rauch, S. L., & Jenike, M. A. (1999). Organizational strategies mediate nonverbal memory impairment in obsessive–compulsive disorder. *Biological Psychiatry*, *45*, 905–916.

Savage, C. R., Deckersbach, T., Sabine, W., Rausch, S. L., Baer, L., Reid, T. et al. (2000). Strategic processing and episodic memory impairment in Obsessive Compulsive Disorder. *Neuropsychology*, *14*, 141–151.

Savage, C. R., Keuthen, N. J., Jenike, M. A., Brown, H. D., Baer, L., Kendrick, A. D. et al. (1996). Recall and recognition memory in Obsessive–Compulsive Disorder. *Journal of Neuropsychiatry*, *8*, 99–103.

Shapiro, A. M., & Roberts, J. E. (2004). Ruminative attention in depression: deficts in inhibition? Manuscript submitted for publication.

Sher, K. J., Frost, R. O., Kushner, M., Crews, T. M., & Alexander, J. E. (1989). Memory deficits in compulsive checkers: replication and extension in a clinical sample. *Behaviour Research and Therapy*, *27*, 65–69.

Sher, K. J., Frost, R. O., & Otto, R. (1983). Cognitive deficits in compulsive checkers: an exploratory study. *Behaviour Research and Therapy*, *21*, 357–363.

Sher, K. J., Mann, B., & Frost, R. O. (1984). Cognitive dysfunction in compulsive checkers: further explorations. *Behaviour Research and Therapy*, *22*, 493–502.

Squire, L. R. (1992). Memory and the hippocampus: a synthesis from findings with rats, monkeys, and humans. *Psychological Review*, *993*, 195–231.

Summerfeldt, L. J., & Endler, N. S. (1998). Examining the evidence for anxiety-related cognitive biases in Obsessive–Compulsive Disorder. *Journal of Anxiety Disorders*, *12*, 579–598.

Tallis, F. (1997). The neuropsychology of obsessive–compulsive disorder: a review and consideration of clinical implications. *British Journal of Clinical Psychology*, *36*, 3–20.

Tallis, F., Pratt, P., & Jamani, N. (1999). Obsessive compulsive disorder, checking, and non-verbal memory: a neuropsychological investigation. *Behaviour Research and Therapy*, *37*, 161–166.

Tata, P. R., Leibowitz, J. A., Pmnty, M. J., Cameron, M., & Pickering, A. D. (1996). Attentional bias in obsessional compulsive disorder. *Behaviour Research and Therapy*, *34*, 53–60.

Tipper, S. P. (1985). The negative priming effect: inhibitory priming by ignored objects. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, *37*, 571–590.

Tipper, S. P., & Cranston, M. (1985). Selective attention and priming: inhibitory and facilitatory effects of ignored primes. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, *37*, 591–611.

Tolin, D. F., Abramowitz, J. S., Bartholomew, D. B., Amir, N., Street, G. P., & Foa, E. B. (2001). Memory and memory confidence in obsessive–compulsive disorder. *Behaviour Research and Therapy*, *39*, 913–927.

Tolin, D. F., Hamlin, C., & Foa, E. B. (2002). Directed forgetting in obsessive–compulsive disorder: replication and extension. *Behaviour Research and Therapy*, *40*, 793–803.

Treisman, A., & Geffen, G. (1964). Selective attention: perception or response? *Quarterly Journal of Experimental Psychology*, *19*, 1–16.

Tulving, E., & Schacter, D. L. (1990). Priming and human memory systems. *Science*, *247*, 301–305.

van den Hout, M., & Kindt, M. (2003). Repeated checking causes memory distrust. *Behaviour Research and Therapy*, *41*, 301–316.

Wegner, D. M., Schneider, D. J., Carter, S. R., & White, T. L. (1987). Paradoxical effects of thought suppression. *Journal of Personality and Social Psychology*, *53*, 5–13.

Wilhem, S., McNally, R. J., Baer, L., & Florin, I. (1996). Directed forgetting compulsive disorder. *Behaviour Research and Therapy*, *34*, 633–641.

Wilhem, S., McNally, R. J., Baer, L., & Florin, I. (1997). Autobiographical memory in Obsessive–Compulsive Disorder. *British Journal of Clinical Psychology*, *36*, 21–31.

Williams, J. M. G. (1992). Autiobiographical memory and emotional disorders. In: S. Christianson (Ed.), *The handbook of emotion and memory: research and theory*. Hillsdale, NJ: Lawrence Erlbaum.

Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin*, *120*, 3–24.

Williams, J. M. G., Watts, F. N., Macleod, C., & Mathews, A. (1997). *Cognitive psychology and emotional disorders* (2nd ed.). Chichester, UK: Wiley.

Woods, C. M., Vevea, J. L., Chambless, D. L., & Bayen, U. J. (2002). Are compulsive checkers impaired in memory? A meta-analytic review. *Cilnical Psychology: Science and Practice*, *9*, 353–366.

Zielinski, C. M., Taylor, M. A., & Juzwin, K. R. (1991). Neuropsychological deficits in obsessive–compulsive disorder. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, *4*, 110–126.

Zitterl, W., Urban, C., Linzmayer, L., Aigner, M., Demal, U. et al. (2001). Memory deficits in patients with DSM-IV obsessive–compulsive disorder. *Psychopathology*, *34*, 113–117.