RETRIEVAL INDUCED FORGETTING IN COMPULSIVE CHECKERS

by

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(Under the Direction of Nader Amir)

ABSTRACT

Researchers have found that repeated checking causes a paradoxical decrease in memory confidence in healthy participants (van den Hout & Kindt, 2003; 2004) as well as in individuals with obsessive compulsive disorder (Tolin et al., 2001). The current study examines a mechanism of learning that may contribute to memory mistrust in compulsive checkers. Specifically, cognitive psychologists have found that repeated retrieval of specific information from memory inhibits retrieval of related information in what has been termed "retrieval-induced forgetting" (RIF; Anderson et al., 1994). This process may allow one to recall recently accessed information efficiently and with greater certainty by "suppressing" related, but unimportant, search targets. Thus, memory mistrust in compulsive checkers may be related to a lack of RIF for checking relevant information. Contrary to hypothesis, checkers exhibited lower rates of recall overall but exhibited no cognitive bias for threat in the RIF task.

INDEX WORDS: compulsive checking, memory, retrieval-induced forgetting

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Chapter 1

Introduction

Purpose of Study

Repetitive checking has been identified as the most common compulsion performed by individuals with obsessive compulsive disorder (OCD) and thus, may be crucial to our understanding of OCD in general (Rasmussen & Eisen, 1988). Some researchers propose that pathological checking is driven by brain dysfunction that disrupts memory (Sher, Frost & Otto, 1983; Sher, Mann & Frost, 1984; Sher, Frost, Kushner, Crews & Alexander, 1989) and that impaired organizational strategies (e.g., using categorical similarities between words on a list to enhance encoding and retrieval) may be especially relevant in OCD (Savage, Baer, Keuthen, et al., 1999; Savage, Deckersbach, Wilhelm, et al., 2000). However, other researchers have failed to find deficits in memory performance and suggest individuals with OCD suffer from biased cognitive processing, including an inflated sense of responsibility and overestimation of danger (Rachman, 2002; Salkovskis, 1985). Cognitive research provides evidence in support of perceived rather than actual memory deficits in OCD (Constans, Foa, Franklin, & Mathews, 1995; Foa, Amir, Gershuny, Molnar, & Kozak, 1997; McNally & Kohlbeck, 1993; Radomsky & Rachman, 1999; Radomsky, Rachman, & Hammond, 2001). Specifically, low memory confidence may distinguish OC checkers from non-checkers (MacDonald, Antony, MacLeod, & Richter, 1997), and this difference may increase with repeated attempts at

recall (Tolin, Abramowitz, Brigidi, Amir, Street, & Foa, 2001). The purpose of the current study was to examine the effect of retrieval practice on actual and perceived memory performance in a group of compulsive checkers.

Cognitive psychologists have found that retrieval of specific information from memory impedes retrieval of related information in what has been termed "retrieval-induced forgetting" (RIF; Anderson, Bjork, & Bjork, 1994). This process is assumed to be beneficial as it may allow one to recall recently accessed information efficiently and with *greater* certainty by making related, but unimportant, search targets less accessible. Therefore, a disruption in RIF might be expected to result in poor memory for recently practiced items as well as low memory confidence because search targets seem less distinct. As such, RIF may provide a useful mechanism for understanding memory dysfunction in compulsive checking. The current study examined the hypothesis that compulsive checkers would exhibit reduced RIF for checking relevant information. The results were interpreted within the context of both general deficit theories and cognitive theories of OCD.

Obsessive Compulsive Disorder

Obsessive compulsive disorder (OCD) is characterized by the presence of distressing intrusive thoughts, images, or urges (i.e., obsessions) and repetitive behaviors or mental acts one feels compelled to perform (i.e., compulsions or rituals). The compulsions are either clearly excessive or not logically connected to the obsessional content or dreaded event (American Psychiatric Association, 2000). For example, one may develop an elaborate checking routine around the

house that requires more than an hour of concentrated effort and is meant to decrease the likelihood that a loved one will be harmed. OCD affects approximately 2-3% of the population (Bland, Newman, & Orn, 1988; Robins, Helzer, Weissman, et al., 1984). Adult onset is typically characterized by minor OCD symptoms which gradually develop into full diagnoses (Rasmussen & Eisen, 1998), whereas, child/adolescent onset is often more acute (Swedo & Leonard, 1994). Research shows that individuals with OCD experience a wide range of social and occupational impairment and that family members may also experience isolation and distress in their attempts to accommodate the disorder (see Steketee (1997) for a review).

The content of obsessions commonly involves fears of harming oneself or others, contamination, unpleasant sexual images or impulses, blasphemy, or need for exactness. Common compulsions include excessive checking, cleaning, repeating, counting, ordering, and hoarding. Individuals with OCD tend to exhibit several types of compulsions but have one that predominates. For example, Calamari, Wiegartz, and Janeck (1999) conducted a cluster analysis with 106 patients diagnosed with OCD which revealed five OCD subtypes. Checking and cleaning compulsions were common across all subtypes but were most prevalent in the “harming” and “contamination” clusters, respectively. Similarly, Rasmussen and Eisen (1988) collected data on the frequency of various rituals in 560 individuals with OCD and found that most engaged in checking (61%) and washing (50%). Therefore, understanding the mechanisms

involved in excessive checking may be particularly important as it appears to be the most prevalent compulsion.

Compulsive checking has also been identified as a common problem among non-clinical samples with prevalence estimates ranging between 6-13% (Frost, Sher, & Green, 1986; Rubenstein, Peynirdoglu, Chambless, & Pigott, 1993; Sher et al., 1983). While most of these individuals would not meet full diagnostic criteria for OCD, non-clinical checkers endorse symptoms similar to OCD patients (Sher, Martin, Raskin, & Perigo, 1991) and report interference as a result of their compulsions, such as taking longer to complete exams (Frost & Sher, 1989) and endorsing significantly higher levels of anxiety and depression than non-checkers (Frost, Sher, & Green, 1986). Consequently, researchers have utilized analogue samples as an important resource for learning more about mechanisms involved in compulsive checking (Maki, O'Neill, & O'Neill, 1994).

Jenike (1998) estimated the existence of at least 20 different theories related to the etiology of OCD. The following section reviews the neurobiological, neuropsychological, and cognitive theories of OCD most relevant to the current proposal. Specifically, this review will emphasize the contribution of each theory to the general deficit versus cognitive bias account of OCD.

Neurobiological Theories of OCD

The most prominent neurobiological models of OCD emphasize the role of dysfunction in the basal ganglia and corticostriatal areas of the brain. Corticostriatal (CS) circuitry broadly refers to the striatum (i.e., caudate nucleus, putamen, and nucleus accumbens) and its connections with orbitofrontal cortex,

thalamus, and anterior cingulate. Alexander and colleagues detailed a number of circuits among these regions that mediate functions that would seem important in OCD, including affective and sensorimotor function, response inhibition, and working memory (Alexander, Crutcher, & DeLong, 1990; Alexander, DeLong, & Strick, 1986). Further, the striatum is believed to promote efficiency by filtering information and mediating stereotyped behavioral routines through non-conscious processes (Graybiel, 1995; Rauch, Savage, & Alpert, et al., 1995). Thus, researchers have examined both structural and functional differences in the CS circuitry of individuals with OCD.

Research on structural differences has found that patients with OCD tend to have slightly smaller caudate volumes compared to controls (Rauch & Baxter, 1998). Functional neuroimaging studies have shown increased activation of orbitofrontal cortex, anterior cingulate cortex, and caudate nucleus in OCD patients compared to controls (Breiter, Rauch, Kwong, et al., 1996; McGuire, Bench, Frith, et al., 1994; Rauch, Jenike, Alpert, et al., 1994). This activation has been shown to attenuate following effective treatment with medication or behavior therapy (Baxter, Schwartz, Bergman, et al., 1992).

Rauch, Savage, Alpert, et al. (1997) showed that individuals with OCD relied on regions of the brain devoted to explicit (i.e., conscious, effortful) memory to complete implicit (i.e., outside awareness) learning tasks, such as the Serial Reaction Time (SRT) task. In the SRT task, participants display evidence of implicit learning by faster reaction times to a repeated sequence of stimuli, despite being unable to detect the sequence itself. Interestingly, OCD

participants performed equally well but did not exhibit normal striatal activation seen in controls. This may explain why procedural tasks that may draw on implicit processes (e.g., locking the door) become the focus of deliberate action in OCD checkers.

Provocation studies have also been used to examine activation in corticostriatal regions as a function of anxiety response in individuals with OCD. In these studies, patients with OCD are presented with threat and non-threat stimuli (e.g., “clean” or “contaminated” object) during PET or fMRI brain scans. Results of several studies showed that patients with OCD experienced increased activation in caudate, orbitofrontal cortex, and paralimbic regions when presented with threatening stimuli compared to controls (Breiter et al., 1996; McGuire et al., 1994; Rauch et al., 1994; summarized in Rauch & Baxter, 1998). However, this pattern of activation may be explained by a generic anxiety response rather than one specific to OCD. This criticism is addressed by studies that have examined brain activation in response to provocation in other anxiety disorders such as specific phobia and PTSD. In these studies, anxious individuals showed increased activation in paralimbic regions but not in the caudate or orbitofrontal regions (Rauch et al., 1995; Rauch, van der Kolk, Fisler, et al., 1996). Thus, individuals with OCD were distinguished from those with other anxiety disorders by activation in the caudate and orbitofrontal cortex. Neuropsychological models have also implicated the role of corticostriatal dysfunction in OCD based on performance on psychological tasks that require recruitment of these brain regions.

Neuropsychological Theory

Neuropsychological theories view OCD as a consequence of executive functioning deficits stemming from the brain dysfunction discussed above (Savage, 1998). Thus, individuals with OCD would be expected to perform poorly on tasks that require self-monitoring, planning, or adapting behavior such as the Wisconsin Card Sort Test (WCST) or Tower of London (ToL) task.

The WCST requires an individual to match cards based on an unstated rule by learning from their mistakes. After ten consecutive correct responses, the rule changes and they must adapt accordingly. Individuals with OCD (OCs) make more perseverative responses after a rule change which may indicate indecisiveness or a difficulty in set shifting (Savage, 1998). However, some studies have failed to find differences on WCST between OCs and non-anxious controls (Abbruzzese, Ferri, Bellodi, & Scarone, 1995; Abbruzzese, Ferri, & Scarone, 1995).

Recently, van den Heuvel et al. (2005) examined performance on the Tower of London (ToL) task in OCs and controls. This task requires one to mentally plan how to rearrange stacks of blocks into a given configuration with the least number of moves. These authors collected behavioral data as well as fMRI scans of participants engaging in this task. OCs performed significantly worse than controls and exhibited decreased activation in dorsolateral prefrontal cortex (DLPFC), believed to be important in planning. Other regions showed *increased* activation, such as the anterior cingulate and ventrolateral prefrontal cortex, suggesting OCs experienced a greater working memory load. Thus,

individuals with OCD may rely on other brain structures to compensate for brain dysfunction in CS circuitry.

According to neuropsychological theory, the executive deficits above lead to secondary memory problems. Specifically, problems with planning and organizational strategies may result in poor non-verbal memory on visuospatial tasks, such as the Rey-Osterrieth Complex Figure Test (RCFT; Osterrieth, 1944). Neuropsychological testing in OCD has revealed evidence in support of this notion. In the RCFT task, participants are presented with a diagram and must first copy it and then later draw it from memory. The copy portion can provide a measure of organizational memory by applying a scoring system to how participants reconstruct the diagram. Individuals with OCD tended to score lower on this measure, as a result of attending to small details rather than large, organizing aspects of the figure, such as rectangles or vertical and horizontal lines (Savage et al., 1999; 2000). In these studies, immediate recall (i.e., drawing the figure from memory without distraction) was also lower for OCs than controls, but this effect was mediated by scores on organizational strategy. These results are consistent with the notion that deficits in executive functioning may be at the root of problems in non-verbal memory rather than actual memory deficits per se.

The results of verbal memory tests have revealed few differences between OCs and controls (Muller & Roberts, 2005). However, Savage et al. (2000) suggests previous studies were unable to detect such differences by using verbal learning tests that did not tap organizational memory strategies. These

researchers addressed this issue by examining verbal learning using the California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan, & Ober, 1987), which includes lists of words from given categories. Thus, the CVLT includes an embedded semantic structure that can be used to improve recall. Like the RCFT, organizational strategy can be scored based on whether words from given category are recalled together. Consistent with results from the RCFT studies, OCs exhibited worse recall than controls on the CVLT, and this effect was mediated by poor organizational strategies. Again, this may suggest that memory problems in OCD are a secondary consequence of executive problems and difficulty appreciating the larger context.

Penadés, Catalán, Andrés, Salamero, and Gastó (2005) recently examined performance on a number of neuropsychological tests on individuals with OCD. Results indicated that OCs had poorer performance on RCFT copy organization and immediate recall similar to the studies by Savage and colleagues (1999; 2000). In addition, these researchers found evidence of greater Stroop task interference and set shifting difficulty on the Trails Making Test (i.e., connecting lettered and numbered circles in alternating order). Mediational analyses revealed that copy organization had the greatest explanatory power for the observed effects. No differences on memory performance were found on the faces test of the Wechsler Memory Scale (WMS-III; Wechsler, 1998), which presumably involves the lowest recruitment of executive and organizational resources. On the faces test, individuals view a series of 24 faces and are told to remember them. Immediately after, they are

presented with the same faces mixed in with 24 distracters and must distinguish the original faces from distracters. This recognition task is repeated after a 30-minute delay. The authors conclude that performance on memory tasks is likely not the direct result of a memory deficit but rather problems in executive functioning and organizational memory that may disrupt memory retrieval. Cognitive theorists have criticized "general deficit" theories related to corticostriatal circuitry and executive functioning in OCD on a number of grounds (Salkovskis, 1996).

Cognitive theory

Cognitive theories acknowledge the results of studies showing differential brain activation between OCD and control participants but maintain that neurophysiological correlates of a disorder are not sufficient to explain OCD (Salkovskis, 1996). Indeed, treatment studies have shown changes in brain activation following medication or behavior therapy (Baxter et al., 1992; Schwartz, Stoessel, Baxter, Martin, & Phelps, 1996), illustrating the potential for psychological and behavioral processes to cause patterns of brain activation obtained in the above studies. Furthermore, Salkovskis (1996) suggests that general deficit theories cannot explain why OCD concerns are so highly specific (e.g., fear of contamination by a particular object or person) or why the presence of trusted others can alleviate the urge to check.

Cognitive theorists suggest that individuals with OCD misinterpret the significance of intrusive thoughts and feel overly responsible for imagined outcomes. Therefore, they respond differently to intrusive thoughts compared to

non-anxious individuals. Consistent with this notion, research shows that 90% of people experience unwanted or unacceptable intrusive thoughts (Rachman & de Silva, 1978; Salkovskis & Harrison, 1984). Additionally, the range of normal and abnormal compulsive behavior has been shown to be similar in content in OCs and non-anxious controls (NACs) but different in terms of frequency and the level of association with distressing thoughts (Muris, Merckelbach, & Clavan, 1997).

Cognitive theories implicate an elevated sense of responsibility for preventing harm and uncertainty regarding the success of protective measures as important in compulsive checking (Rachman, 2002). Consistent with this hypothesis, research shows symptoms of obsessive-compulsive disorder are correlated with an inflated sense of responsibility (Wilson & Chambless, 1999) and that lowering perception of responsibility decreases urges to check in compulsive checkers (Lopatka & Rachman, 1995). Other studies have shown OC checkers experience inflated sense of responsibility when asked to consider how they would react to relatively low-risk scenarios (e.g., “You see a piece of string on the ground.”) compared to other OC individuals without checking concerns (Foa, Sacks, Tolin, Prezworski, & Amir, 2002). Finally, OC checkers exhibit a positive memory bias for threat-relevant information under conditions of high responsibility, which disappears when responsibility is removed (Radomsky et al., 2001). These data suggest a clear relationship between responsibility and urges to check but do not directly address the unrelenting nature of bouts of checking.

Rachman (2002) describes the components of a self-perpetuating mechanism that may account for the repetitive nature of compulsive checking. For instance, the sense of personal responsibility felt by OC individuals seems to increase after completed checks (Lopatka & Rachman, 1995), perhaps making them more likely to reinitiate checking. In addition, the perceived threats associated with harming obsessions are often unlimited in time and space and may not have a clearly identified victim. This may preclude the identification of a "natural terminus" for checking behaviors. Finally, repeated checking has been shown to degrade memory confidence (Tolin et al., 2001), an effect also observed in healthy individuals (van den Hout & Kindt, 2003; 2004). As the frequency of checking increases, one becomes less certain of having performed the most recent check adequately (i.e., proactive interference). Compulsive checkers may then misinterpret the significance of such proactive interference as evidence of a true memory failure, further supporting the need to check.

The chronic course of OCD may be understood in light of basic learning principles incorporated into cognitive theory. Specifically, negative reinforcement may promote long term usage of checking as a strategy for reducing anxiety/uncertainty. Rachman, de Silva, and Roper (1976) demonstrated that rituals reduce anxiety after exposure to feared stimuli in OC checkers. Importantly, they also showed that anxiety reduced in the absence of rituals over time, supporting the use of exposure and response prevention (ERP) in treating OCD. However, there is some indication that ERP may not be as effective with OC checkers as with washers, indicating that basic reinforcement principles

cannot satisfactorily explain the development and persistence of compulsive checking (Watts, 1995).

In summary, neurobiological and neuropsychological theories suggest compulsive checking is a general deficit (i.e., brain dysfunction) of executive functioning. Disruptions in memory retrieval are considered secondary to deficits in planning and organizational strategies. In contrast, cognitive theories argue that the clinical presentation of OCD is inconsistent with a general deficit in functioning, since difficulties appear limited to content and situational factors. Furthermore, individuals with OCD often demonstrate perceived rather than actual deficits in memory performance.

The current study examined the effect of retrieval practice on recall and memory confidence in an undergraduate sample of compulsive checkers. Results were interpreted in relation to competing theories of OCD and compulsive checking. I will begin with a review of experimental approaches to memory in compulsive checking. I will then argue that retrieval-induced forgetting paradigms may contribute valuable knowledge to this area of study in their potential to address both general deficit and cognitive theories of OCD.

Memory in Compulsive Checking

A number of lines of research have addressed the debate over perceived versus actual memory deficits in OCD and compulsive checking. The current review will focus on studies that have examined episodic memory, as compulsive checkers complain of inadequate memory for particular events (e.g., checking the stove). In addition, studies that examine memory confidence will be

reviewed, as perception of memory performance also seems critical to our understanding of OCD.

Memory for Actions

Compulsive checkers' frequent complaints of an inability to remember having completed particular actions led researchers to examine their memory for actions. The first studies in this area were concerned with many types of memory and included a wide array of neuropsychological assessment and experimental tasks. After a full testing session, researchers asked participants to record as many of the tasks they could remember. Checking status was determined based on participants' scores on the checking subscale of the Maudsley Obsessional Compulsive Inventory (MOCI; Hodgson & Rachman, 1977). In a non-clinical sample, Sher et al. (1983) found that compulsive checkers recalled fewer activities from a testing session than a group of compulsive washers or non-anxious controls. In a replication and extension of this study, Sher and colleagues (1984) found that everyday checking frequency was associated with lower composite scores of memory (i.e., Memory Quotient; MQ) from the Wechsler Memory Scale (WMS; Wechsler & Stone, 1945). However, the relationship between checking status (i.e., frequent, occasional, infrequent, or non-checker) and memory for experimental procedures in this study was only marginally significant.

The results of these two studies were replicated in a clinical sample of compulsive checkers, who showed lower performance on the WMS and poorer recall for recently completed actions (Sher et al., 1989). However, none of the

patients in this study were diagnosed with OCD. Furthermore, poor recall performance may be indicative of information loss (i.e., insufficient encoding or maintenance) or difficulty accessing information stores (i.e., problematic retrieval strategies).

Recognition tasks provide a method for testing these competing hypotheses by presenting previously learned material along with new information (e.g., distracters). Poorly encoded information is difficult to recognize because the mental representation no longer exists. However, information that is encoded but difficult to retrieve is accessed readily with the help of a cue (e.g., remembering what you ordered for dinner by reviewing a restaurant's menu). Sher and colleagues measured recognition by asking participants to identify whether or not words on a list had been presented previously (Sher et al., 1984) or to select which activities they had completed from a stack of index cards with activities written on them (Sher et al., 1989). No differences on recognition emerged in either study. This finding has since been replicated in a sample of OCD patients (Deckersbach, Otto, Savage, Baer, & Jenike, 2000). Thus, memory problems in these studies seem specifically related to the ability to retrieve information.

Rubenstein et al., (1993) conducted a study in undergraduates who scored high or low on the MOCI checking subscale. Similar to the studies by Sher and colleagues (1983; 1984; 1989), participants completed many experimental tasks and were tested on their memory for these actions. In one task, participants were provided with a list of 90 actions that were to be written,

observed, or performed. After completing the list, checkers remembered significantly fewer actions and had greater difficulty remembering the modality of actions (Experiment 1). In another task, checkers were more likely to confuse whether they had read (e.g, nation : country) or generated (e.g., evening : ni---) a list of synonyms (Experiment 3). However, recognition in Experiment 3 was *better* in checkers compared to non-checkers. These results were interpreted as further evidence in support of problematic retrieval processes and emphasized the potential importance of reality monitoring in checkers.

Reality monitoring has been defined as the ability to distinguish between memories of imagined and real events (Johnson & Raye, 1981). Sher et al. (1983) also examined reality monitoring using a similar word pair task and found no differences between checkers and non-checkers. However, these researchers noted that checkers reported being less confident about their responses on the reality monitoring task. McNally and Kohlbeck (1993) found similar results in study using a clinical sample (i.e., OCD checkers and non-checkers compared to NACs). In this study, participants either traced, imagined tracing, or studied drawings and words. No group differences emerged on tests of recall for modality, but OCs exhibited significantly lower memory confidence than NACs. These findings were replicated in another sample of patients with OCD (Merckelbach & Wessel, 2000).

These early studies suggest compulsive checkers have poor recall for actions but no deficits in recognition. The evidence fails to support the notion that checkers have difficulty distinguishing between memories of real and

imagined events but highlights the importance of low memory confidence in these individuals. However, none of the studies mentioned above used stimuli that might be considered relevant to compulsive checking.

Memory for Threat

Several studies have addressed this limitation by including ecologically valid stimuli. For example, Constans et al. (1995) compared OC checkers to controls on recall and reality monitoring for situations that were anxiety-provoking (e.g., plug-in and unplug an iron) or neutral (e.g., open and close a book). Participants were asked to complete a brief action sequence with each of 20 objects and then asked to recall the final state of each object. Some actions were performed (e.g., “Light the candle.”), while others were imagined (e.g., “Close your eyes and imagine blowing out the candle.”). Reality monitoring was assessed by asking the participant to also state whether the last action of each sequence was real or imagined. Contrary to their prediction, OC checkers exhibited *better* recall of their last action for checking relevant situations. No differences emerged on reality monitoring. Although no differences were found on memory confidence ratings, OCs differed significantly from controls in their desire for greater vividness in memory, which may be a similar metamemory construct.

Hermans, Martens, De Cort, Pieters, and Eelen (2003) extended reality monitoring paradigms further by using ideographically selected stimuli in a group of OCD patients and controls. This allowed the researchers to examine actual compulsions relevant to a given participant (e.g., checking electrical outlets for

presence of water) as well as ecologically valid, but irrelevant compulsions for each participant. Neutral actions (e.g., opening a book) were also included. Consistent with Constans et al. (1995), no group differences emerged on reality monitoring or memory confidence for checking relevant actions. However, OCs did show reduced confidence for neutral actions. Together, these studies rule out reality monitoring as a plausible mechanism for compulsive checking in individuals with OCD. Instead, memory for actions and memory confidence may be more useful constructs for understanding compulsive checking.

Radomsky et al. (2001) specifically examined the hypothesis that perceived responsibility would impact recall and memory confidence for threat relevant actions in OC checkers. In this study, OC checkers were video taped in their home performing tasks that would elicit anxiety if a check were not performed (e.g., turn stove on and off). Participants then completed checks under varying levels of responsibility and were interviewed immediately after to assess memory and memory confidence. The level of responsibility was manipulated by asking participants to sign contracts delegating full responsibility for the check to either the patient (i.e., high) or the experimenter (i.e., low). The "no responsibility" condition was achieved by bringing participants into the lab after one week to watch the video and complete the same interview. Results indicate that OC checkers have better memory for details of the check (i.e., how many times they touched the stove) than for irrelevant information they were told to remember (e.g., the color of the experimenter's pen). This positive memory bias for threat information disappeared under conditions of "no responsibility."

Paradoxically, memory confidence decreased with greater responsibility despite *better* memory performance for threat under conditions of high responsibility. The authors concluded that because contextual features (e.g., irrelevant information) are less salient under these conditions, checkers have fewer retrieval cues that might improve memory clarity.

Evidence supporting a memory bias (i.e., enhanced memory for threat) in OCD is mixed. For example, Radomsky & Rachman (1999) found evidence of memory bias for contamination in OCD patients by touching various objects with either a “contaminated” or a “clean” cloth. Both control and OC participants remembered the same total number of objects, but OCs remembered significantly more contaminated items. However, Tolin et al., (2001) was unable to replicate these findings using a similar design in which OCD patients rated the level of contamination of certain objects and were later presented with an assortment of objects ranging in their threat values. No memory differences were observed on recall in this study, but over repeated trials, memory confidence declined in patients with OCD. This was particularly true for OC checkers who had significantly lower confidence ratings after one week compared to OC washers.

In summary, research on memory performance in OCD and compulsive checking is mixed. The studies included in this review differ in their materials and experimental paradigms, suggesting memory performance in compulsive checking may be particularly sensitive to contextual factors. This may explain why studies tend to find no memory differences when adequate cues are

provided, i.e., recognition tasks, compared to tests of free recall. In addition, differing sample characteristics may have contributed to the mixed results on memory performance. In contrast, tests of memory confidence are generally consistent across studies. Therefore, it becomes critically important to investigate mechanisms that specifically address the causes of low memory confidence.

Repeated Checking and Memory Confidence

In the Tolin et al. (2001) study, patients with OCD exhibited reduced memory confidence over six learning trials in which they studied and then recalled a number of objects presented to them. OC checkers were particularly vulnerable to decrements in memory confidence, illustrated by their significantly lower memory confidence for their recall of these items after one week compared to controls and OC washers. This study raises two important issues. First, repeated bouts of rehearsal and recall seem to hurt memory confidence in individuals with OCD. Second, this effect seems particularly salient for OC checkers.

van den Hout and Kindt (2003; 2004) conducted a series of experiments to examine the role of repeated checking on memory confidence. They developed a computer program in which the gas burners of an interactive, virtual stove could be turned on and off. The participant simply moves the mouse over the virtual knobs and turns them with a click and drag motion. The sensitivity of this motion was adjusted so that great care must be applied to avoid making mistakes when turning the burners off. In addition, they constructed a similar

program in which virtual light bulbs could be turned on and off with the same sensitivity specifications. All participants in these studies consisted of non-anxious undergraduate students.

The study began with a training phase for both the virtual stove and light bulb panel, during which an alarm sounded if the burners or light bulbs were not turned off completely. After the training phase, all participants completed a pre-test on the virtual stove in which they were asked to turn off specific burners without feedback. Participants were given an opportunity to check the status of the burners or bulbs after each trial. In the practice phase, half the participants completed a “relevant” checking task, consisting of 20 additional trials with the virtual stove. The remaining participants completed an “irrelevant” checking task, consisting of 20 trials with the virtual light bulb panel. Both groups completed a post-test on the virtual gas stove. At the conclusion of each phase, participants were asked to recall which knob had been turned off during the final check (i.e., memory accuracy). They also were asked to rate the level of vividness, detail, and confidence of their memory. Memory accuracy did not change from pre- to post-test for either group. However, the group that conducted “relevant” checks experienced a dramatic decrease in the level of vividness, detail, and confidence in their memory. In contrast, the group that conducted “irrelevant” checks experienced no change on these variables over time. Therefore, the authors suggest that repeated checking of relevant information increases familiarity and degrades one’s certainty for a specific check. They further conclude that

uncertainty in OCD checkers may operate in much the same way and need not be explained by a deficit in functioning.

However, this model does not offer a mechanism for explaining why checking continues beyond one or two checks in the first place. van den Hout and Kindt (2003) suggest that most people achieve maximal certainty after checking once or twice but that individuals with OCD overshoot this mark by immediately checking several times. They attribute this tendency to low tolerance for uncertainty and inflated sense of responsibility. This remains a plausible, yet untested, hypothesis that the virtual stove paradigm might adequately address if crossed with the Radomsky et al. (2001) responsibility manipulation while assessing urge to check. Alternatively, people (e.g., surgeons) might experience low tolerance for uncertainty and a great deal of responsibility but avoid this paradoxical cycle. Furthermore, low memory confidence is a consistent finding across studies that do not include repeated checking or recall attempts. Thus, another mechanism may be needed to explain this phenomenon in compulsive checkers.

Cognitive psychologists suggest that retrieval of specific information from memory impedes retrieval of related information in what has been termed "retrieval-induced forgetting" (RIF; Anderson et al., 1994). This process is assumed to be beneficial as it may allow one to recall recently accessed information efficiently and with *greater* certainty by making related, but unimportant, search targets less accessible. Thus, a relative lack of RIF might be expected to result in poor recall for recent events due to competition between

relevant (e.g., Did I lock the door?) and irrelevant (e.g., How did it feel as I turned the lock?) information. As such, RIF may provide a useful mechanism for understanding how the process of reviewing a completed check may result in reduced confidence in checkers compared to non-checkers.

Retrieval-induced forgetting

The current proposal will be based on a simple procedure created by Anderson et al. (1994) to measure retrieval-induced forgetting in healthy volunteers. In this methodology, participants are asked to study a list of word pairs, each consisting of a category label and an exemplar (e.g., fruit - orange). Participants then practice recalling 50% the word pairs from 50% the categories by completing category – word stem pairs (e.g., fruit – or___). This procedure results in three classes of stimuli based on retrieval status: 1) Words from practiced categories that received retrieval practice (Rp+), 2) words from practiced categories that did not receive retrieval practice (Rp-), and 3) words from unpracticed categories in which none of the words received retrieval practice (Nrp). After a distraction task, participants are provided with the category labels one at a time for 30 seconds and asked to recall as many exemplars of each category as possible. Rates of recall of Nrp words is used as a measure of baseline recall performance.

Anderson et al. (1994) found that retrieval practice enhanced recall of practiced items (Rp+ = 73.6%) compared to baseline (Nrp = 48.4%). More importantly, recall for the remaining items in the practiced categories was impaired (Rp- = 37.5%) relative to baseline. Because Rp- and Nrp items

received the same amount of practice, this suggests retrieval of items from a particular category hurt recall for non-practiced items within that same category. Thus, the hallmark of retrieval-induced forgetting is a relationship between practice condition and percent recall, such that recall for Rp+ > Nrp > Rp-. Additional studies have replicated this finding in healthy individuals and provided further evidence that the RIF effect is likely due to retrieval processes (Anderson & Spellman, 1995; Anderson, Bjork, & Bjork, 2000).

There has been only one study to my knowledge that examined RIF in a clinical sample. Amir, Coles, Brigidi, and Foa (2001) conducted a study with individuals diagnosed with social anxiety disorder and non-anxious controls using positive and negative social words as well as non-social words. These researchers found the standard RIF effect for all participants and all stimulus types, except negative social words. Socially anxious individuals did not benefit as much from retrieval practice of these words compared to controls, and memory performance for unpracticed negative social words was not hindered by retrieval practice. The authors suggest this lack of RIF may result in multiple, partial representations of negative aspects of social events that require later interpretation. This may, in turn, encourage one to allocate processing resources to negative aspects of previous social interactions in favor of positive or neutral information. Similarly, lack of RIF in compulsive checkers may encourage repeated checking. One potential difference between these groups may be that socially anxious individuals would be unrealistically certain that a social interaction went poorly, while compulsive checkers would be plagued by chronic

uncertainty regarding the adequacy of checking behavior. Thus, memory confidence in clinical samples may vary according to content area, while healthy participants' confidence ratings should be a function of the RIF effect (i.e., Rp+ > Nrp > Rp-). Therefore, the addition of confidence ratings to the RIF paradigm may be important in studies involving clinical samples.

Rationale for the Current Study

The RIF paradigm may be particularly well suited to studying verbal memory in compulsive checking and addressing important theoretical issues in this area. In sum, memory studies in OCD have been mixed, creating two major theoretical perspectives which dominate the literature. The general deficit theory of OCD cites studies suggesting individuals with OCD have poorer memory performance overall (Sher et al., 1983; 1984; 1989) and may have executive deficits that result in poor non-verbal memory (Behar, Rapoport, Berg, et al., 1984; Boone, Ananth, Philpott, Kaur, & Djenderjian, 1991; Savage et al. 1999). Other researchers have found that problems also emerge on tests of verbal memory when they include an embedded semantic structure, as in the CVLT (Savage et al., 2000).

Cognitive theorists reject general deficit theories and suggest that individuals do not have general memory deficits but rather, problems with perceived memory failure. These researchers cite studies that show mixed memory performance in OCD, including some with *better* memory for threat (Constans et al., 1995; Radomsky et al., 2001), but consistently lower memory confidence (Foa, Amir, Gershuny, Molnar, & Kozak, 1997; McNally & Kohlbeck,

1993; Radomsky & Rachman, 1999; Radomsky et al., 2001). In particular, evidence has implicated the role of repeated attempts at recall as contributing to lower memory confidence in OC checkers (Tolin et al., 2001). Finally, cognitive researchers suggest that even healthy individuals who repeatedly check exhibit lowered memory confidence (van den Hout & Kindt, 2003; 2004).

The RIF paradigm includes aspects that may allow the examination of memory in relation to these competing views. Specifically, RIF paradigms include an embedded semantic structure and measure recall performance as a function of retrieval attempts. This latter consideration also carries an underlying assumption about the impact of retrieval practice on memory confidence important for any study of memory in compulsive checking. According to theory, RIF enhances recall efficiency and certainty by strengthening the association between practiced items and memory cues. However, RIF studies have not included a measure of memory confidence to verify this assumption. By including a measure of memory confidence, it may be possible to determine if low memory confidence in checkers is related to lack of RIF or a general phenomenon in these individuals.

The current study examined RIF in compulsive checkers compared to other anxious individuals, and a healthy control group. General deficit theories of compulsive checking were addressed by including checking (i.e., threat and non-threat) and non-checking (i.e., neutral) stimuli. If a general deficit exists, memory performance should be uniformly impaired and should be related to measures of real-world memory failures (Cognitive Failures Questionnaire (CFQ); Broadbent,

Cooper, Fitzgerald, & Parkes, 1982). On the other hand, if compulsive checkers have normal memory but specific cognitive processing biases for threatening material, they should exhibit memory differences only for checking related words. This specificity was examined further by comparing compulsive checkers to a group of anxious as well as non-anxious controls.

The experimental procedure was similar to Amir et al. (2001), with the addition of memory confidence ratings. The current study directly tested the following primary hypotheses regarding memory performance:

1) All groups will show the standard RIF effect for neutral (e.g., fruit – orange) and non-threat (e.g., appliances - cordless) word associations, evidenced by significant paired t-tests showing better recall for Rp+ compared to Nrp and poorer recall for Rp- compared to Nrp.

2) Compulsive checkers will show reduced RIF for threat (e.g., appliances – spark) word associations compared to NACs, evidenced by significant independent samples t-tests showing poorer recall of Rp+ words for checkers compared to NACs and better recall of Rp- for checkers compared to NACs.

In addition, the current proposal will test a number of secondary hypotheses regarding memory confidence:

3) OCD symptom severity will be negatively correlated with memory confidence for correctly recalled words, regardless of practice category or word type.

4) Checkers will experience a decrease in memory confidence for correctly recalled Rp+ threat words, evidenced by lower confidence at recall compared to the retrieval practice phase.

CHAPTER 2

METHOD

Participants

Participants were selected from 334 University of Georgia undergraduates who volunteered in exchange for partial course credit. Participants were excluded from the data analysis if they reported memory problems, vision problems, or if they spoke English as a second language. This resulted in a net loss of 38 individuals from total sample (N = 296). All experimental procedures were conducted in eight large group testings. Consent was obtained at the beginning of the experiment following a description of all experimental procedures. Participants completed the retrieval induced forgetting task as well as a series of questionnaires in a single experimental session.

Three groups were created based on self-reported symptoms of OCD, anxiety, and depression. Specifically, participants completed the Maudsley Obsessive-Compulsive Inventory (MOCI; Hodgson & Rachman, 1977), the Beck Depression Inventory (BDI; Beck & Steer, 1987), the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), and the Cognitive Failures Questionnaire (CFQ; Broadbent et al., 1982).

The MOCI is a 30-item true-false questionnaire developed to assess obsessive-compulsive symptoms in both clinical and non-clinical samples (Hodgson & Rachman, 1977). The mean for clinical populations ranges from 16

to 20 (Frost, Steketee, Krause, & Trepanier, 1995). The MOCI has good test-retest reliability and internal consistency (Rachman & Hodgson, 1980) and has been shown to have predictive validity over a 6-month period in a non-clinical sample (Sternberger & Burns, 1990). More recently, Emmelkamp, Kraaijkamp, and van den Hout (1999) examined the psychometric properties of MOCI in Dutch OCD patients, patients with other diagnoses (i.e., anxiety, depression, anorexia), and undergraduate students. These authors reported high internal consistency overall (α = .89) and within each sample (α = .70, .72, and .65, respectively). Test-retest reliability was also high over a one-month period (*r* = .92).

The BDI is a 21-item scale that assesses depressive symptoms over the previous week (Beck & Steer, 1987). The BDI is a reliable measure (*r* ranges from .48 to .86) that has been shown to have high internal consistency (α = .86, Beck, Steer, & Garbin, 1988).

The STAI-T (Spielberger et al., 1983) is comprised of 20-items that measure trait anxiety. This measure has high test-retest reliability over a 20-day period (*r* = .86, males; *r* = .76, females; Spielberger et al., 1983).

The CFQ is a 25-item self-report scale that assesses real-world lapses in perception, memory, and motor control (Broadbent et al., 1982). Previous studies have found this measure to be positively correlated with interference scores on selective attention tasks (Tipper & Baylis, 1987). The CFQ was included to measure real-world cognitive functioning.

Compulsive Checking Group

The compulsive checking group (OC) consisted of 39 individuals (44% female) who endorsed four or more items on the MOCI checking subscale (MOCI-Ck) and scored above one standard deviation of the mean on the MOCI total score (Hodgson & Rachman, 1977; Rachman & Hodgson, 1980). These criteria have been used in previous studies examining memory in non-clinical checkers (Rubenstein et al., 1993; Sher et al., 1991).

Control Groups

All control participants scored at or below the mean of the sample on MOCI total score (i.e., less than nine) and less than two on the MOCI-Ck subscale. The anxious control group (ANX) consisted of 30 individuals (67% female) matched to the OC group on state and trait anxiety (i.e., STAI). Anxious controls were less depressed than OCs and scored lower on the MOCI total score, checking subscale, and the Cognitive Failures Questionnaire (CFQ). The non-anxious control group (NAC) consisted of 46 individuals (48% female) scoring at or below the sample mean on state and trait anxiety (i.e., STAI) as well as depression (i.e., BDI). Non-anxious controls scored significantly lower on all measures compared to OCs and were significantly less anxious and depressed compared to ANXs. Groups did not differ in terms of age or education. Gender was marginally significant between OCs and ANXs ($t(67) = 1.93$, $p = .06$). Demographic information as well as means and standard deviations for the above scales are presented in Table 1.

Materials

RIF Paradigm

Table 2 presents the materials used in the RIF task. Checking categories were inspired by the content of the Everyday Checking Behaviors Scale (ECBS) that was developed on non-clinical samples by Sher and colleagues (1983; 1984). In undergraduates, individuals scoring 5 or higher on the MOCI checking subscale endorsed significantly more daily checking behaviors on the ECBS than non-checkers (Sher et al., 1983). In the current study, checking exemplars were created to convey threat and non-threat associations with the checking category headings. Exemplars were based on clinical experience as well as stimuli from previous studies (McNally, Wilhelm, Buhlmann, & Shin, 2001; Wilhelm, McNally, Baer, & Florin, 1996; Lavy, van Oppen, & van den Hout,1994). Nine original categories were created with associated threat and non-threat exemplars. Then, a number of expert OCD researchers and clinicians matched the exemplars (presented in a random list) with their respective category headings. The final stimulus set was based on consenus of the original pairings, and the pairings of the OCD experts. This resulted in four checking categories (i.e., documents, appliances, door, and alarmclock) each with six threat and six non-threat exemplars. Non-checking (i.e., neutral) categories and exemplars were taken from Anderson et al. (1994).

The experimental stimuli were divided into Set A and Set B and counterbalanced across two presentations, such that categories that received retrieval practice in one presentation were unpracticed categories in the other.

Procedure

After reading and signing the consent form, participants completed the retrieval induced forgetting task (RIF) followed by a packet of questionnaires. The RIF task was presented first to eliminate any priming effects due to OCD related content found in the questionnaires.

RIF Task

The RIF task consisted of four phases: study, retrieval practice, distraction task, and test. In the study phase, participants viewed a series of category-exemplar word pairs (e.g., fruit-orange) presented on a projector screen. Word pairs comprised eight categories (4 checking, 4 non-checking) containing 12 exemplars each (8x12 = 96 word pairs). Each word pair was presented for five seconds, and participants were instructed to spend the entire time relating each exemplar to its category.

In the retrieval practice phase, participants viewed trials consisting of three parts. In the first part, a category-word stem pair (e.g., fruit-or___) was presented for seven seconds, and participants wrote the correct exemplar in their test booklet. Next, participants were presented with the correct answer (e.g., fruit-orange) for two seconds of additional study. Finally, the category-word stem pair (e.g., fruit-or___) was presented again for five seconds of additional retrieval practice. Participants were instructed to record their response only at the first opportunity of each trial and to use the rest of the trial to improve their memory. After completing all retrieval practice trials, participants were asked to rate their memory confidence (0-100% confident) for all responses. They were reminded

not to correct their answers or erase misspelled words. Only half the word pairs from half the categories were practiced during this phase (i.e., 6 word pairs x 4 categories = 24 practice pairs).

The study phase included 12 distracter word pairs as fillers to create a quasi-randomized presentation in which no category was repeated in succession. In the retrieval practice phase, participants practiced recalling the distracter exemplars on the first three and last three trials to remove any contaminating effects of primacy or recency on recall performance. After the retrieval practice phase, participants were asked to engage in a brief task designed to remove recency effects. This task was to list as many states and state capitals as possible in five minutes.

In the final phase of the experiment, participants completed a cued recall test. Category headings were presented one at a time for 30 seconds, and participants were asked to write as many of the exemplars as they could remember from each category within that time. Response blanks for each catgory were on separate pages of the test booklet. After completing the cued recall for all eight experimental categories, the participants were asked to start with the first category and record their memory confidence (0-100% confident) for each response.

Participants began the questionnaire portion of the experiment after materials from the RIF task were collected. Responses to questionnaires were recorded on scantron forms that contained no identifying information (only the participant number provided to them on the day of the screening). Once

completed, participants turned in the testing materials and signed out. All participants received two hours of research credit.

CHAPTER 3

RESULTS

Participants' responses to the memory task were corrected for mistakes in spelling (e.g., "refridgerator"), plurality (e.g., lemons), and changes in tense (e.g., overslept vs. oversleep). Memory performance was measured by percent recall calculated for each participant by word type and practice condition. Mean confidence ratings were calculated for each participant by word type and practice condition for correctly recalled words only. Means and standard deviations of the raw data for memory performance and confidence ratings are presented in Tables 3 and 4, respectively.

Memory Performance

Percent recall was entered into a 3 (group: OC, ANX, NAC) X 3 (practice condition: Rp+, Rp-, Nrp) X 3 (word type: checking threat, checking non-threat, neutral) mixed design Analysis of Variance (ANOVA). This analysis revealed significant main effects of group [$F(2, 112) = 4.96$, $p < .01$], practice condition [$F(2, 112) = 457.15$, $p < .001$], and word type [$F(2, 112) = 87.97$, $p < .001$]. The interaction of word type X practice condition was also significant [$F(4, 224) = 10.84$, $p < .001$]. However, the predicted three-way interaction of group X practice condition X word type was not significant [$F(8, 448) = .64$, *ns*].

Examination of the main effect of group indicated that OCs had worse memory regardless of word type or practice condition compared to ANXs ($t(67) =$

3.11, $p < .01$) and NACs ($t(83) = 2.52$, $p < .05$). The two control groups did not differ in overall memory performance ($t(74) = .40$, *ns*). OCs were significantly more depressed than anxious and non-anxious controls, which may contribute to a general memory deficit. However, the results of an Analysis of Covariance (ANCOVA) using BDI score as the covariate did not eliminate the main effect of group ($F(2, 111) = 6.32$, $p < .01$).

The interaction of word type X practice condition was explored via simple effects analysis. Simple effects of word type revealed consistent practice effects (Rp+ > Nrp) for threat ($t(114) = 8.25$, $p < .001$), non-threat ($t(114) = 12.50$, $p < .001$), and neutral ($t(114) = 23.64$, $p < .001$) words. More importantly, retrieval induced forgetting (Nrp > Rp-) was observed for threat ($t(114) = 7.55$, $p < .001$) and neutral ($t(114) = 4.88$, $p < .001$) words. The retrieval induced forgetting (RIF) effect for non-threat checking words was non-significant ($t(114) = 1.39$, *ns*).

Simple effects of practice condition indicate that the level of association between exemplars and their respective categories differed according to word type. For practiced words (Rp+), neutral words were recalled more frequently than non-threat checking words ($t(114) = 7.60$, $p < .001$) which were in turn recalled more frequently than threat checking words ($t(114) = 3.4$, $p < .001$). For unpracticed words from unpracticed categories (Nrp), neutral words were recalled more frequently than non-threat checking words ($t(114) = 4.86$, $p < .001$). However, recall for non-threat and threat checking words was not significantly different ($t(114) = .56$, *ns*). Finally, unpracticed words from practiced categories (Rp-) revealed the opposite pattern. No difference in recall emerged

between neutral and non-threat words ($t(114) = .28$, *ns*), but non-threat words were recalled better than threat words ($t(114) = 4.43$, $p < .001$). Neutral words were always recalled at a higher rate than threat checking words, which had the lowest recall rates in all practice conditions. These results are illustrated in Figure1.

Hypothesis 2 predicted compulsive checkers would differ in RIF compared to non-anxious controls. Specifically, OCs were hypothesized to have worse memory for Rp+ threat words and better memory for Rp- threat words compared to non-anxious controls. This hypothesis cannot be formally tested in the proposed statistical model because the three-way interaction of group X word type X practice condition was not significant. However, given the theoretical importance of this hypothesis in the current study, I tested this prediction directly via independent samples t-tests for Rp+ and Rp-. No significant differences emerged between checkers and non-anxious controls on memory for Rp+ threat words ($t(83) = .88$, *ns*) or Rp- threat words ($t(83) = .52$, *ns*).

Memory Confidence

Hypothesis 3 predicted a significant negative correlation between OCD symptomatology and overall memory confidence. This was examined via Pearson's product moment correlation between MOCI total score and mean confidence rating across all word types and practice conditions for the entire sample of 296 participants. MOCI total score was not significantly correlated with overall memory confidence ($r = .05$), failing to support this hypothesis. Exploratory analyses revealed significant correlations between scores on the

Cognitive Failures Questionnaire (CFQ) and MOCI total scores ($r = .35$, $p < .001$) as well as checking subscale scores ($r = .29$, $p < .001$).

Hypothesis 4 predicted OCs would show decreased memory confidence for Rp+ threat words as a result of retrieval practice (i.e., from practice phase to recall phase). Accordingly, mean memory confidence ratings were submitted to a 3 (group) X 2 (study phase: retrieval practice, recall) mixed ANOVA for each word type. Participants' memory confidence improved from practice to recall for neutral ($F(1, 72) = 9.96$, $p < .01$) and non-threat checking ($F(1, 68) = 7.74$, $p < .01$) words but not threat words. All other main effects and interactions were non-significant. Thus, Hypothesis 4 was not supported.

In addition, exploratory independent samples t-tests were conducted among the three groups for mean confidence ratings at practice as well as recall. The only significant difference was between checkers and non-anxious controls during practice ($t(83) = 1.97$, $p < .05$), indicating memory confidence was lower for checkers.

CHAPTER 4

DISCUSSION

Memory difficulties are commonly observed in OCD (Rachman, 2002). Competing theories of OCD suggest complaints of memory difficulty may stem from actual memory deficits including poor organizational strategies (Savage et al., 1999; 2000) or cognitive biases including inflated sense of responsibility and low memory confidence (Tolin et al., 2001; Radomsky et al., 2001). The current study addressed this theoretical debate by using a paradigm that includes a semantic structure that may tap organizational strategies as well as threat-relevant information and memory confidence ratings. I hypothesized that compulsive checkers would show a lack of RIF for threat relevant information only, consistent with a cognitive bias for threat in these individuals. Such a finding might indicate greater competition between Rp+ and Rp- threat words at recall (perhaps akin to intrusive thoughts) which might explain low memory confidence as well as urges to repeatedly check. Contrary to my hypothesis, results suggest that compulsive checkers have worse memory in general compared to anxious and non-anxious controls and do not exhibit a cognitive bias for threat related information.

Retrieval Induced Forgetting

To my knowledge, only one study has examined the retrieval induced forgetting (RIF) effect in a clinical sample (Amir et al., 2001). Therefore, further

evidence in support of the RIF in anxious individuals is important if this paradigm is to be used in experimental psychopathology research. The RIF effect was robust in the current study, regardless of group membership. Specifically, recall for practiced words was facilitated compared to unpracticed words from unpracticed categories (i.e., Rp+ > Nrp) for all word types. Establishing this effect ensures that participants were adequately attending to the task during the practice phase. More importantly, recall for the unpracticed words from practiced categories was disrupted relative to words from unpracticed categories (Nrp > Rp-) for neutral and threat word types, the hallmark of RIF. This latter effect was not found for non-threat checking words.

The rationale for Hypothesis 1 was to ensure that RIF could be obtained for artificial categories. This hypothesis was supported by the presence of RIF for threat checking words in addition to neutral words. Therefore, null results regarding the predicted three-way interaction of group by practice condition by word type were not the result of a failure to produce RIF with non-natural categories. Rather, the lack of personal relevance of threat words to checkers in this sample and possible inter-item associations among non-threat checking words may have interfered with the predicted effects (see Limitations section for further discussion).

General Deficit vs. Cognitive Bias

Hypothesis 2 predicted compulsive checkers would lack RIF for threat words only compared to non-anxious controls, consistent with cognitive bias theory. This would be exhibited in Rp- threat words gaining significantly greater

retrieval access in OCs, while Rp+ threat words would be recalled significantly less. Contrary to prediction, the interaction of group by retrieval-induced forgetting effect was not significant, and specific comparisons revealed no significant differences between checkers and non-anxious controls for recall of Rp+ or Rp- threat words. Instead, checkers exhibited a general deficit in memory compared to both anxious and non-anxious controls regardless of word type or practice condition. Moreover, because these control groups did not differ from one another, I conclude that checkers' lower rate of recall was not due to a general effect of anxiety. This level of specificity extends previous studies on memory in compulsive checking that did not include an anxious control group (see Muller & Roberts, 2005 for a review).

Cognitive bias theory also suggests that checkers may suffer from low memory confidence (Radomsky et al., 2001) that may, paradoxically, worsen with repeated recall attempts (Tolin et al., 2001). However, the current study failed to find evidence to support these two related hypotheses. Specifically, total scores on the MOCI were not correlated with memory confidence (Hypothesis 3), and checkers did not show decrements in memory confidence as a result of repeated retrieval (Hypothesis 4). Rather, memory confidence improved for neutral and non-threat checking words but not threat words, regardless of group membership. However, exploratory analyses indicate checkers had significantly lower memory confidence during the practice phase compared to NACs, suggesting these individuals may initially doubt their memory.

Organizational Strategy and Memory Performance

Group differences in the current study may be attributed to problematic organizational strategies in compulsive checkers. According to the general deficit theory of OCD, brain dysfunction in frontal-striatal areas may interfere with executive aspects of memory such as utilizing central features of non-verbal stimuli or categorical similarities among words in a list to aid memory (see Savage, 1998 for a review). For example, in the California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan, & Ober, 1987), participants are asked to remember a list of 16 groceries items that each belong to one of four categories. The items are read aloud five times with free recall after each reading (i.e., learning trials). Participants are not told about the embedded category structure and score points for recalling items from the same category in succession (i.e., semantic clustering).

Savage et al. (2000) tested patients with OCD and controls on the CVLT and found that scores on semantic clustering during the learning trials mediated group differences on the final recall test. These results suggest patients with OCD were less able to take advantage of the embedded semantic structure to aid retrieval of list items. The RIF paradigm is similar to the CVLT in that it requires participants to remember a list of words associated with various categories. Thus, compulsive checkers may have exhibited worse memory in the current study because they were not able to capitalize on the semantic structure to the same degree as controls.

Furthermore, checkers may have been at a disadvantage on this task in light of a recent study that suggests the RIF effect itself is caused by strategy disruption. Dodd, Castel, & Roberts (2006) tested three versions of the RIF paradigm that differed in the retrieval practice phase. The “random” retrieval practice condition was the standard procedure used in the current study and other RIF studies. The “serial position” retrieval practice condition required participants to practice the last half of the original list with its order preserved, and the “every other word” retrieval practice condition required participants to practice every other word in the original list with the order preserved. Retrieval induced forgetting was found only in the random retrieval practice condition despite using identical stimuli in each version. The authors conclude that the RIF effect occurs only when the organizational strategy used to encode the original list is disrupted.

In sum, compulsive checkers might be expected to have lower rates of recall than controls on the RIF paradigm for two reasons. First, checkers may not benefit from the semantic structure of the stimuli as a result of problems with executive aspects of memory (Savage et al., 2000). Second, retrieval practice in the RIF paradigm disrupts the organizational strategy used to encode the original list in healthy participants, and thus, checkers may be particularly vulnerable to such a disruption given preexisting deficits in their ability to organize the contents of memory.

Limitations

The RIF paradigm was originally chosen because it would allow both general deficit and cognitive bias theories to be evaluated (i.e., embedded semantic structure, neutral and OC-relevant words, retrieval practice, confidence ratings). However, there are a number of factors that may have made it difficult to detect a cognitive bias in the current study.

Relevance of Stimuli

According to cognitive theories of compulsive checking, most checking occurs within the person's own home and becomes more intense when the person feels responsible for the checking behavior (Rachman, 2002). Indeed, this is central to the arguments against general deficit theory which suggest that compulsive checkers do not complain about memory in general but only memory in specific situations. The current study addressed this important consideration by consulting the literature as well as expert OCD researchers and clinicians when constructing categories and exemplars. However, it is not clear whether the stimuli were relevant to the checkers who completed the task.

Hermans et al. (2002) illustrated this point in their study which included ideographic stimulus selection in a group of OCD patients and controls. These authors created three categories of experimental tasks to be completed by participants. Relevant compulsive actions were those behaviors selected by the individual participant to elicit anxiety (e.g., checking electrical outlets for condensation), and neutral actions were simple tasks generally unrelated to most checking concerns (e.g., open and close a book). The third category was

irrelevant compulsive actions which consisted of the relevant compulsive actions of other OCD participants. Participants rated neutral and irrelevant compulsions as equally anxiety provoking and well below ratings for relevant compulsions. Thus, despite the face validity of the irrelevant compulsions, they failed to provoke anxiety responses.

The current study may have been limited in its ability to detect evidence in support of a cognitive bias in checkers because the stimuli did not adequately capture personally relevant aspects of checking domains. This may also explain the lack of significant findings related to confidence ratings in the current study.

Radomsky et al. (2001) conducted a study which tested the effect of responsibility on memory bias and memory confidence for in vivo checking behaviors. These researchers asked OCD patients with compulsive checking to complete checking behaviors in their own homes under varying conditions of responsibility. Memory confidence was relatively high under low or no responsibility but declined when patients signed a contract accepting full responsibility for the checking routines. Participants in the current study incurred no responsibility for whether or not word pairs were correctly recalled and thus, would not be expected to show lower memory confidence.

Despite the obvious importance of using personally relevant stimuli, other studies have found lower memory confidence in tasks using generic OC-relevant stimuli (Foa et al., 1997; MacDonald et al., 1997; McNally & Kohlbeck, 1993). However, the current study was unique in that participants rated memory confidence in their own *written* responses, which may have improved their

confidence by default. Differences in memory confidence may have resulted for a more difficult confidence rating task, such as rating an independent list of words. However, lower confidence ratings for an independent list of exemplars may have been confounded by group differences in overall memory performance. Alternatively, it might have been more informative to ask participants to rate their confidence at final recall as to whether or not they had practiced each word previously.

Construction of Checking Categories

The RIF effect was not replicated for non-threat checking words, indicating a potential problem with the stimuli. Inspection of the raw data from each category revealed unusually high rates of recall for Rp- non-threat words from the categories “door” and “alarmclock,” especially for controls. These categories were unique in that they represent single objects, and the non-threat exemplars consisted mainly of their components (e.g., handle, radio). This may have encouraged participants to create exemplar to exemplar associations, e.g., imagining the “radio” button next to the “snooze” button. Anderson and McCulloch (1999) showed that such inter-item associations counteract retrieval-induced forgetting. Alternatively, participants may have recalled Rp- words from these categories more easily by simply envisioning a prototype and noting its characteristics (e.g., a door is made of “wood” and has a “handle” and “screen”). In this case, the category prompt itself would act as an excellent retrieval cue, enhancing recall.

Implications and Future Directions

Cognitive failures are mistakes made on simple tasks (e.g., placing the milk in the cupboard after making a bowl of cereal) and have been shown to occur with greater frequency under conditions of boredom, worry, or divided attention (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). The Cognitive Failures Questionnaire (CFQ) is a measure of one's proneness to making these kinds of mistakes. In the current study, there was a significant correlation between daily cognitive slips on the CFQ and both MOCI total scores and MOCI-Ck subscale scores.

This finding may have implications for the application of exposure and response prevention (ERP) for compulsive checking. In this treatment, patients repeatedly activate their greatest fears and refrain from engaging in compulsions. The therapist offers a rationale that suggests the patient is succumbing to irrational fears of harm by repeatedly checking. Thus, current results indicating that OCs have actual memory deficits and may be prone to cognitive slips seem inconsistent with this rationale. However, compulsive checkers repeat checking loops that are non-productive and self-defeating, and their risk assessment is often inflated. Therefore, refraining from extra checking in the context of ERP treatment would far outweigh the consequences of a cognitive slip. Instead, these results suggest ERP for compulsive checking may be augmented by teaching patients how to improve memory for the first check, since standard ERP may not be as effective for this problem (Watts, 1995).

A number of modifications may improve future studies using RIF to examine general deficit and cognitive bias in OCD. First, a group of treatment seeking checkers should be included. Many researchers have studied compulsive checking in undergraduate samples and documented areas of interference in non-clinical groups. However, it is possible that cognitive biases for threat are what distinguish patients with OCD from sub-clinical cases. Second, the materials used in the current study may not have been relevant to compulsive checkers. Thus, materials should be developed with direct input from participants. Word pair ratings prior to the task could determine the composition of categories. However, efforts to develop a generic set of OC-relevant stimuli (lexical and pictorial) may be useful.

Finally, actual checking routines or memories of such routines could be used as stimuli in an RIF task. Barnier, Hung and Conway (2004) conducted an RIF task with healthy participants in which participants recalled (positive, negative, and neutral) autobiographical memories. These memories were then used as stimuli for an RIF task in which cues were provided and participants were asked to elaborate on various memories. These researchers found the standard RIF effect for memories, but the interaction of RIF and emotional valence was not significant. This modification may be a more efficient method of extracting personally relevant stimuli for use in an RIF task without traveling to participants' homes to perform checking rituals. For instance, participants could be asked about recent bouts of checking as well as more neutral activities from the day and provided with an opportunity to elaborate on a subset of these

memories. Alternatively, participants could be lead through a series of actions falling into several categories as did Constans et al. (1995) and asked to review a subset of these prior to a final recall test.

In summary, repetitive checking has been identified as the most common compulsion performed by individuals with obsessive compulsive disorder (OCD) and thus, may be crucial to our understanding of OCD in general (Rasmussen & Eisen, 1988). Some researchers propose that pathological checking is driven by brain dysfunction that disrupts memory (Sher et al., 1983; 1984; 1989) and that impaired organizational strategies (e.g., using categorical similarities between words on a list to enhance encoding and retrieval) may be especially relevant in OCD (Savage et al., 1999; 2000). The current study supports this general deficit theory, as checkers exhibited worse memory overall compared to anxious and non-anxious controls but exhibited no memory bias for threat-relevant information.

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	Compulsive Checkers		Anxious Controls		Non-Anxious Controls	
Variable	Mean	(SD)	Mean	(SD)	Mean	(SD)
Age	19.00	(0.8)	19.50	(1.4)	19.87	(4.3)
Education	13.31	(1.0)	13.67	(1.0)	13.61	(1.1)
% Female	44		67		48	
STAI-State	44.00	(10.0)	46.50	(7.9)	28.15	(4.0)
STAI-Trait	47.77	(10.3)	44.97	(5.9)	28.20	(4.0)
BDI	13.18	(10.1)	8.17	(5.9)	1.96	(1.7)
MOCI	17.21	(3.0)	3.70	(2.1)	4.07	(2.0)
MOCI-Ck	5.00	(1.0)	0.27	(0.5)	0.37	(0.5)
CFQ	57.85	(14.2)	45.38	(10.1)	41.48	(19.0)

Table 1. Means and standard deviations for demographic information and self-report data.

Checking Words				
Category	Threat		Non-threat	
Appliances	burner	spark	automated	dishwasher
	malfunction	unsafe	convenient	mixer
	melt	accident	cordless	refrigerator
Door	burglar	deadbolt	wood	handle
	crime	unlocked	entrance	screen
	intruder	ajar	doorknob	glass
Documents	illegal	lawsuit	complete	safe
	important	misspelling	letter	secure
	inaccurate	destroyed	record	statement
Alarmclock	inaudible	slow	bedside	radio
	oversleep	flashing	digital	snooze
	tardy	forget	morning	travel
Non-checking Words				
Category	Set A		Set B	
Furniture	painting	curtain	shelf	mirror
	lamp	couch	desk	chaise
	carpet	dustbin	computer	drawer
Fruit	kiwi	coconut	raisin	orange
	mango	tomato	strawberry	lemon
	nectarine	apricot	banana	pineapple
Drinks	sake	sherry	vodka	bourbon
	tequila	cognac	scotch	schnapps
	daiquiri	martini	beer	whiskey
Countries	zimbabwe	algeria	spain	france
	cameroon	rumania	mexico	sweden
	syria	equador	canada	greece

Table 2. Experimental stimuli.

	Compulsive Checkers		Anxious Controls		Non-anxious Controls	
Variable	Mean	(SD)	Mean	(SD)	Mean	(SD)
Neutral						
Rp+	68	(16)	71	(11)	69	(14)
Nrp	31	(13)	38	(11)	34	(13)
Rp-	22	(16)	26	(19)	28	(17)
Non-threat						
Rp+	50	(22)	57	(21)	57	(19)
Nrp	23	(15)	29	(13)	30	(14)
Rp-	17	(17)	30	(22)	27	(19)
Threat						
Rp+	43	(24)	46	(22)	48	(24)
Nrp	22	(13)	31	(13)	27	(16)
Rp-	13	(15)	14	(15)	14	(15)

Table 3. Memory performance (% correct) at final recall. Rp+ = practiced words; Nrp = unpracticed words from unpracticed categories; Rp- = unpracticed words from practiced categories.

	Compulsive Checkers		Anxious Controls		Non-anxious Controls	
Variable	Mean	(SD)	Mean	(SD)	Mean	(SD)
Neutral						
Practice	95	(9)	94	(9)	96	(7)
Rp+	99	(3)	97	(5)	98	(6)
Nrp	92	(13)	95	(6)	98	(3)
Rp-	89	(21)	96	(6)	93	(15)
Non-threat						
Practice	87	(17)	93	(14)	93	(12)
Rp+	96	(11)	98	(7)	99	(3)
Nrp	92	(12)	96	(8)	91	(14)
Rp-	97	(7)	96	(8)	89	(25)
Threat						
Practice	83	(25)	89	(21)	92	(14)
Rp+	95	(9)	93	(10)	96	(8)
Nrp	92	(13)	95	(8)	89	(21)
Rp-	92	(14)	94	(15)	92	(19)

Table 4. Confidence ratings (0-100%) for correct responses at practice and final recall.

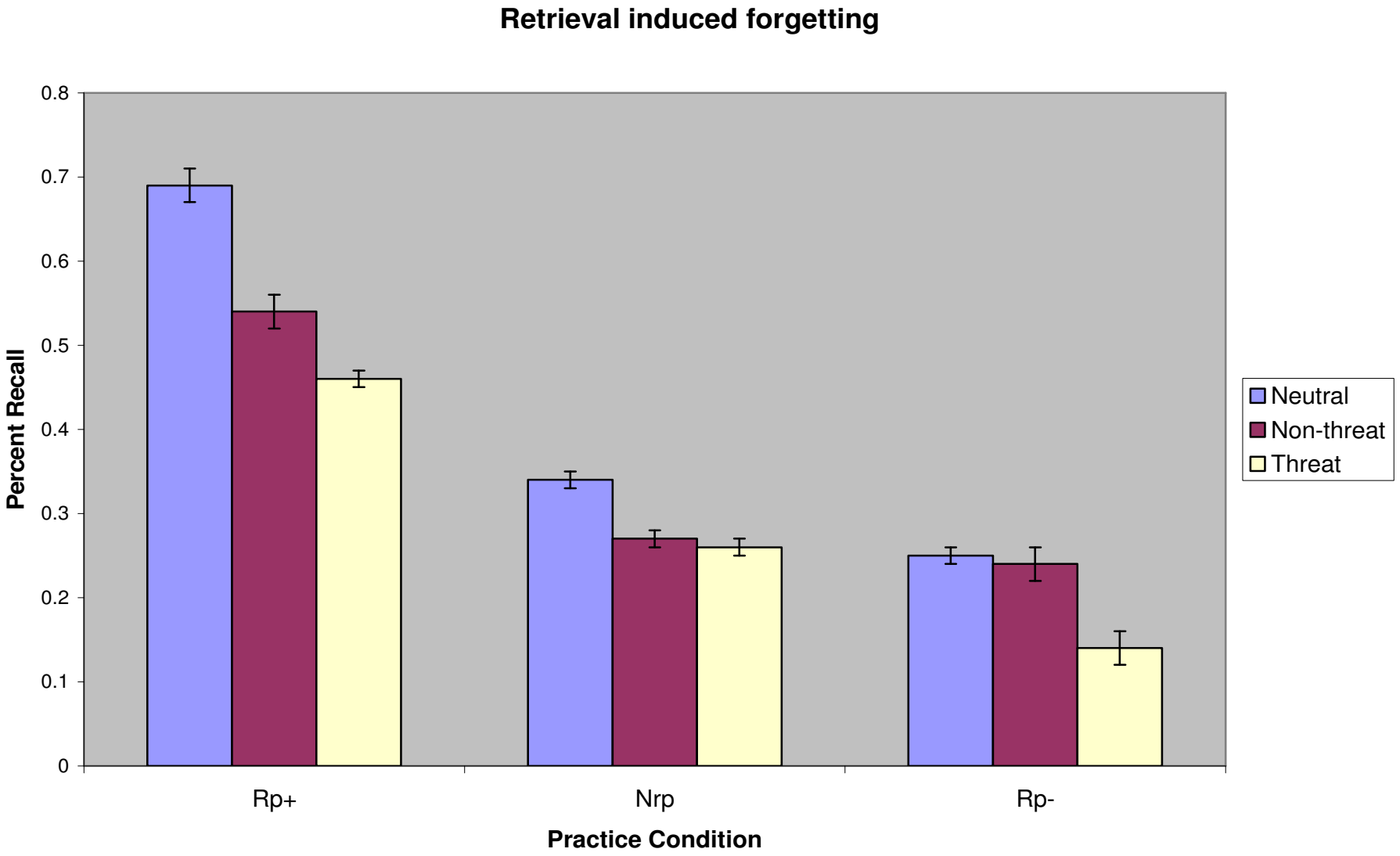

Figure 1. Recall by practice condition and word type. Rp+ = practiced words from practiced categories; Nrp = unpracticed words from unpracticed categories; Rp- = unpracticed words from practiced categories.

Spielberger State-Trait Anxiety Inventory (STAI-S)

A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle on your answer sheet to indicate how you feel RIGHT NOW, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

a) Not at all b) Somewhat c) Moderately so d) Very much so

1. I feel calm
2. I feel secure
3. I am tense
4. I feel strained
5. I feel at ease
6. I feel upset
7. I am presently worrying over possible misfortunes
8. I feel satisfied
9. I feel frightened
10. I feel comfortable
11. I feel self-confident
12. I feel nervous
13. I am jittery
14. I feel indecisive
15. I am relaxed
16. I feel content
17. I am worried
18. I feel confused
19. I feel steady
20. I feel pleasant

Spielberger State-Trait Anxiety Inventory (STAI-T)

A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle on your answer sheet to indicate how you GENERALLY feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

a) Not at all b) Somewhat c) Moderately so d) Very much so

21. I feel pleasant
22. I feel nervous and restless
23. I feel satisfied with myself
24. I wish I could be as happy as others seem to be
25. I feel like a failure
26. I feel rested
27. I am "calm, cool, and collected"
28. I feel that difficulties are piling up so that I cannot overcome them
29. I worry too much over something that really doesn't matter
30. I am happy
31. I have disturbing thoughts
32. I lack self-confidence
33. I feel secure
34. I make decisions easily
35. I feel inadequate
36. I am content
37. Some unimportant thought runs through my mind and bothers me
38. I take disappointments so keenly that I can't put them out of my mind
39. I am a steady person
40. I get in a state of tension or turmoil as I think over my recent concerns

Maudsley Obessional Compulsive Inventory

Please answer each question by marking TRUE (A) or FALSE (B). There are no right or wrong answers, and no trick questions. Work quickly and do not think too long about the exact meaning for the question.

(A) TRUE (B) FALSE

41. I avoid using public telephones because of possible contamination.

42. I frequently get nasty thoughts and have difficulty in getting rid of them.
43. I am more concerned than most people about honesty.
44. I am often late because I can't seem to get through everything on time.
45. I don't worry unduly about contamination if I touch an animal.
46. I frequently have to check things (e.g., gas or water taps, doors, etc.) several times.
47. I have a very strict conscience.
48. I find that almost everyday I am upset by unpleasant thoughts that come into my mind against my will.
49. I do not worry unduly if I accidentally bump into somebody.
50. I usually have serious doubts about the simple everyday things I do.
51. Neither of my parents was strict during my childhood.
52. I tend to get behind in my work because I repeat things over and over again.
53. I use only an average amount of soap.
54. Some numbers are extremely unlucky.
55. I do not check letters over and over again before posting them.
56. I do not take a long time to dress in the morning.
57. I am not excessively concerned about cleanliness.
58. One of my major problems is that I pay too much attention to detail.
59. I can use well-kept toilets without any hesitation.
60. My major problem is repeated checking.
61. I am not unduly concerned about germs and disease.
62. I do not tend to check things more than once.
63. I do not stick to a very strict routine when doing ordinary things.
64. My hands do not feel dirty after touching money.
65. I do not usually count when doing a routine task.
66. I take rather a long time to complete my washing in the morning.
67. I do not use a great deal of antiseptics.
68. I spend a lot of time everyday checking things over and over again.
69. Hanging and folding my clothes at night does not take up a lot of time.
70. Even when I do something very carefully I often feel that it is not quite right.

Beck Depression Inventory (BDI)- Page 1

This questionnaire consists of 22 groups of statements. After reading each group of statements carefully choose the letter (a, b, c or d) for each question which best describes the way you have been feeling the PAST WEEK, including today. If more than one statement applies, choose the last letter. (If (c) and (d) apply, choose (d).)

Be sure to read all the statements in each group before making your choice.

71. a) I do not feel sad.
    b) I feel sad.
    c) I am sad all the time and I can't snap out of it.
    d) I am so sad or unhappy that I can't stand it.

72. a) I am not particularly discouraged about the future.
    b) I feel discouraged about the future.
    c) I feel I have nothing to look forward to.
    d) I feel that the future is hopeless and that things cannot improve.

73. a) I do not feel like a failure.
    b) I feel I have failed more than the average person.
    c) As I look back on my life, all I can see is a lot of failures.
    d) I feel I am a complete failure as a person.

74. a) I get as much satisfaction out of things as I used to.
    b) I don't enjoy things the way I used to.
    c) I don't get real satisfaction out of anything anymore.
    d) I am dissatisfied or bored with everything.

75. a) I don't feel particularly guilty.
    b) I feel guilty a good part of the time.
    c) I feel quite guilty most of the time.
    d) I feel guilty all of the time.

76. a) I don't feel I am being punished.
    b) I feel I may be punished.
    c) I expect to be punished.
    d) I feel I am being punished.

77. a) I don't feel disappointed in myself.
    b) I am disappointed in myself.
    c) I am disgusted with myself.
    d) I hate myself.

78. a) I don't feel I am any worse than anybody else.
    b) I am critical of myself for my weaknesses or mistakes.
    c) I blame myself all the time for my faults.
    d) I blame myself for everything bad that happens.

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79. a) I don't have any thoughts of killing myself.
b) I have thoughts of killing myself, but I would not carry them out.
c) I would like to kill myself.
d) I would kill myself if I had the chance.

80. a) I don't cry any more than usual.
b) I cry more now than I used to.
c) I cry all the time now.
d) I used to be able to cry, but now I can't cry even though I want to.

81. a) I am no more irritated now than I ever am.
b) I get annoyed or irritated more easily than I used to.
c) I feel irritated all the time now.
d) I don't get irritated at all by the things that used to irritate me.

82. a) I have not lost interest in other people.
b) I am less interested in other people than I used to be.
c) I have lost most of my interest in other people.
d) I have lost all of my interest in other people.

83. a) I make decisions about as well as I ever could.
b) I put off making decisions more than I used to.
c) I have greater difficulty in making decisions than before.
d) I can't make decisions at all anymore.

84. a) I don't feel I look any worse than I used to.
b) I am worried that I am looking old or unattractive.
c) I feel that there are permanent changes in my appearance that make me look unattractive.
d) I believe that I look ugly.

85. a) I can work about as well as before.
b) It takes an extra effort to get started at doing something.
c) I have to push myself very hard to do anything.
d) I can't do any work at all.

86. a) I can sleep as well as usual.
b) I don't sleep as well as I used to.
c) I wake up 1-2 hours earlier than usual and find it hard to get back to sleep.
d) I wake up several hours earlier than I used to and cannot get back to sleep.

87. a) I don't get more tired than usual.
b) I get tired more easily than I used to.
c) I get tired from doing almost anything.
d) I am too tired to do anything.

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88. a) My appetite is no worse than usual.
b) My appetite is not as good as it used to be.
c) My appetite is much worse now, I have no appetite at all anymore.
d) I have no appetite at all anymore.

89. a) I haven't lost much weight, if any, lately.
b) I have lost more than 5 pounds.
c) I have lost more than 10 pounds.
d) I have lost more than 15 pounds.

90. a) I am purposely trying to lose weight by eating less.
b) I am not purposely trying to lose weight by eating less.

91. a) I am no more worried about my health than usual.
b) I am worried about physical problems such as aches and pains, or upset stomach, or constipation.
c) I am very worried about physical problems, and it's hard to think of much else.
d) I am so worried about my physical problems that I cannot think about anything else.

92. a) I have not noticed any recent change in my interest in sex.
b) I am less interested in sex than I used to be.
c) I am much less interested in sex now.
d) I have lost interest in sex completely.

Cognitive Failures Questionnaire

The following questions are about minor mistakes which everyone makes from time to time, but some of which happen more often than others. We want to know how often these things have happened to your in the past 6 months. Please circle the appropriate number.

		Very often	Quite often	Occasionally	Very rarely	Never
93.	Do you read something and find you haven't been thinking about it and must read it again?	4	3	2	1	0
94.	Do you find you forget why you went from one part of the house to the other?	4	3	2	1	0
95.	Do you fail to notice signposts on the road?	4	3	2	1	0
96.	Do you find you confuse right and left when giving directions?	4	3	2	1	0
97.	Do you bump into people?	4	3	2	1	0
98.	Do you find you forget whether you've turned off a light or a fire or locked the door?	4	3	2	1	0
99.	Do you fail to listen to people's names when you are meeting them?	4	3	2	1	0
100.	Do you say something and realize afterwards that it might be taken as insulting?	4	3	2	1	0
101.	Do you fail to hear people speaking to you when you are doing something else?	4	3	2	1	0
102.	Do you lose your temper and regret it?	4	3	2	1	0
103.	Do you leave important letters unanswered for days?	4	3	2	1	0
104.	Do you find you forget which way to turn on a road you know well but rarely use?	4	3	2	1	0
105.	Do you fail to see what you want in a supermarket (although it's there)?	4	3	2	1	0
106.	Do you find yourself suddenly wondering whether you've used a word correctly?	4	3	2	1	0
107.	Do you have trouble making up your mind?	4	3	2	1	0
108.	Do you find you forget appointments?	4	3	2	1	0
109.	Do you forget where you put something like a newspaper or a book?	4	3	2	1	0
110.	Do you find you accidentally throw away the thing you want and keep what you meant to throw away – as in the example of throwing away the matchbox and putting the used match in your pocket?	4	3	2	1	0
111.	Do you daydream when you ought to be listening to something?	4	3	2	1	0

112.	Do you find you forget people's names?	4	3	2	1	0
113.	Do you start doing one thing at home and get distracted into doing something else (unintentionally)?	4	3	2	1	0
114.	Do you find you can't quite remember something although it's "on the tip of your tongue"?	4	3	2	1	0
115.	Do you find you forget what you came to the shops to buy?	4	3	2	1	0
116.	Do you drop things?	4	3	2	1	0
117.	Do you find you can't think of anything to say?	4	3	2	1	0