ATTENTIONAL FOCUS DURING REPEATED CHECKING INFLUENCES MEMORY BUT NOT METAMEMORY

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Abstract

Attentional Focus During Repeated Checking Influences Memory but Not Metamemory

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Numerous studies demonstrate that compulsive checking is associated with reduced memory confidence (Muller & Roberts, in press; Woods, Vivea, Chambless, & Bayen, 2003). Some researchers have suggested that the act of repeated checking may result in decreased encoding and therefore decreased memory vividness and detail at recall. This in turn is proposed to lead to decreased confidence in one's memory (Radomsky, Rachman, & Hammond, 2001; Van den Hout & Kindt, 2003). It was therefore hypothesized that instructions to focus attention on one's surroundings as well as one's actions during a repeated checking task may attenuate decreases in memory confidence. Prior to a repeated checking task, 14 high checkers and 56 low checkers were instructed to focus not only on their actions but also on their surroundings (Peripheral condition), and 14 high checkers and 55 low checkers to focus only on their actions (Central condition). Contrary to expectations, peripheral focus instructions did not result in increased memory confidence compared with those who received central focus instructions. Peripheral instructions did, however, result in greater memory accuracy. Furthermore, the effect of peripheral focus on memory accuracy was largest for high checkers. Following a single check, high checkers exhibited lower memory confidence and a trend towards greater memory accuracy than low checkers, but surprisingly differences between the two groups disappeared following 30 checking trials. The implications of this are discussed in relation to cognitive models of OCD and compulsive checking.

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ATTENTIONAL FOCUS DURING REPEATED CHECKING INFLUENCES MEMORY BUT NOT METAMEMORY

Introduction

Obsessive compulsive disorder (OCD) is characterized by recurrent thoughts, images or impulses, and repetitive behaviour (APA, 2000). The disorder can lead to considerable distress and can often cause interference in social and occupational functioning (APA, 2000). Epidemiological studies estimate the one month prevalence of OCD in the community to be between 0.6 % and 1.5 % (Bebbington, 1998; Stein, Forde, Anderson, & Walker, 1997). Some of the most common obsessions are pathological doubts that some action was carried out correctly, whereas some of the most common compulsions include repeated checking (Stein et al., 1997; Taylor, 2002). Compulsive checking is characterized by the urge to repeatedly verify that an action aimed to prevent harm has been completed (Rachman & Hodgson, 1980). Research examining specific phenomenology of compulsive checking has frequently examined memory processes in both compulsive and non-clinical checkers.

It has been argued that compulsive checking occurs as a result of poor memory. Investigators have indeed demonstrated that clinical and non-clinical checkers have impaired memory for actions, as demonstrated by a decreased ability to recall a series of tasks performed earlier (Rubenstein, Peynircioglu, Chambless, & Pigott, 1993; Sher, Frost & Otto, 1983; Sher, Mann, & Frost, 1984; Sher, Frost, Kushner, Crews & Alexander, 1989). However, other researchers using neuropsychological tests, such as spatial span, have not detected evidence of impaired memory for actions (Tallis, Pratt, &

Jamani, 1999). Several reviews of current research examining memory and OCD suggest that OCD may indeed be related to deficits in memory for actions as well as visual memory, although all of these reviews emphasize the inconsistencies in the literature (Coles & Heimberg, 2002; Greisberg & McKay, 2003; Muller & Roberts, in press; Tallis, 1997).

Several researchers have recently challenged these findings, proposing that traditional memory tests may examine memory out of context. Memory accuracy may be differentially influenced by ecologically valid conditions, such as during compulsive urges to check, than in a laboratory setting where the majority of memory research in OCD has be conducted (Radomsky & Rachman, in press). Researchers have demonstrated that the memory deficits found in neuropsychological laboratory tests do not exist under threat relevant conditions and when the to be remembered material is related to the individual's fear or perceived threat (Ceschi, Van der Linden, Dunker, Perroud, & Brédart, 2003; Foa, Amir, Gershuny, Molnar, & Kozak, 1997; Radomsky & Rachman, 1999). In fact several studies demonstrate that under personally relevant or anxiety provoking circumstances, individuals with symptoms of OCD actually have a more accurate memory (Constans, Foa, Franklin, & Mathews, 1995; Radomsky & Rachman, 1999; Radomsky, Rachman, & Hammond, 2001; Tolin, Abramowitz, Brigidi, Amir, Street, & Foa, 2001; Wilhelm, McNally, Baer, & Florin, 1996).

Few studies have examined memory specifically in compulsive checkers under contextually relevant conditions. Constans et al. (1995) had OCD checkers and controls either imagine or actually perform a group of actions (e.g., Light the candle). Participants were asked to recall the final status of the stimuli (e.g., Candle Lit or Candle Out) and

also recall if they had performed or imagined the action. Although they did not find any differences in memory accuracy for object status between checkers and non-checkers, the researchers did find that under situations of high anxiety, checkers exhibited a more accurate recall of the final status of the action when compared to non-checkers.

Similarly, Radomsky and colleagues (2001) had compulsive checkers check an item in their home that caused him/her the most distress if left unchecked. This was performed under conditions of high responsibility, where the participant took responsibility for the outcome of the check, under conditions of low responsibility, where the experimenter took responsibility for the outcome of the check, and under conditions of no responsibility, in which participants merely watched a videotape of themselves checking. They found that individuals with checking OCD remembered more threat-relevant information than threat-irrelevant information, especially under conditions of high responsibility.

Furthermore, Savage and colleagues (2000) demonstrated that the memory problems exhibited by individuals with OCD in more traditional memory tests may be mediated by organizational strategy during learning trials. Compared to control participants, individuals with OCD exhibited less structural grouping according to semantic or perceptual features and more detail oriented (less effective) encoding strategies. This factor mediated the decrease in free recall ability in individuals with OCD (Savage et al., 2000). Furthermore, when participants were provided with more effective strategies, neuropsychological memory deficits were undetectable (Savage, 2002). Thus, memory differences in individuals with OCD may be due to initial ineffective and inefficient processing and encoding of the material that is to be learned.

Furthermore, these memory differences may be most apparent under conditions of personally relevant threat.

Although the literature related to actual memory is relatively inconsistent, one increasingly consistent finding from this research is that individuals who compulsively check tend to have less confidence in their memory for checking than individuals who do not compulsively check (Foa et al., 1997; MacDonald, Antony, MacLeod, & Richter, 1997; McNally & Kohlbeck, 1993; Tolin et al., 2001; Zitterl, Urban, Linzmayer, Aigner, Demal, Semler, & Zitterl-Eglseer, 2001). This decrease in memory confidence appears to be most salient under conditions of high responsibility (Radomsky et al., 2001). In fact, in a recent meta-analysis of memory research and compulsive checking, Woods, Vivea, Chambless and Bayehn (2002) found that the effect size for memory confidence was larger than the effect sizes for various different kinds of memory.

Van den Hout and Kindt (2003a, 2003b) recently demonstrated that this decrease in memory confidence can even be induced in non-checkers. Van den Hout and Kindt (2003a) examined if low memory confidence was caused by increases in familiarity of the checking event. They hypothesized that increased familiarity caused by repeated checking may lead to decreased encoding of the event and subsequent lowered confidence in memory at later recall. They had undergraduate students repeatedly turn on, turn off, and check random combinations of either computer simulated light bulbs or a computer simulated gas stove. In the "irrelevant checking" condition participants turned on, turned off, and checked the light bulbs 20 times and then on the last trial participants checked the stove. In the "relevant checking" condition participants turned on, turned off, and checked the stove 20 times and also checked the stove on the last trial.

Van den Hout and Kindt (2003a) found that under the "relevant checking" condition participants reported significantly decreased vividness and detail of memory and decreased memory confidence compared to participants in the "irrelevant checking" condition. They argued the conditions of high familiarity, such as those produced by the "relevant checking" condition in their study, inhibits processing of the perceptual features of a stimulus which in turn decreases the vividness and detail of later recollections. This subsequently deflates the confidence in that recollection. These results have been replicated by Van den Hout and Kindt (2003b) in a second study using the computer simulated gas stove and light bulbs, and by Radomsky, Gilchrist, and Dussault (2003) in a real kitchen. Van den Hout and Kindt (2003b) also demonstrated that repeated checking leads to a shift in memory source from Tulving's (1985) concept of specifically "remembering" the act of checking to generally "knowing" that one has completed the task. One limitation of these studies however, is that since individuals in the "relevant checking" condition were continually checking the stove, a potentially dangerous object, and those in the "irrelevant checking" condition were checking the light bulbs, a less dangerous object, it is difficult to rule out the possibility that decrease in memory vividness, detail, and confidence were not due to increased familiarity, but rather increased responsibility or threat estimation.

In fact, an alternate, although not incompatible, hypothesis as to why decrements in memory confidence occur is that under conditions of high anxiety, individuals tend to focus on threat relevant cues and ignore threat irrelevant cues, which in turn leads to decreased memory vividness and detail, and ultimately decreased memory confidence (Rachman, 2002; Radomsky et al., 2001). Importantly, both models suggest that less

detailed encoding of the checking event leads to decreased vividness and detail which in turn leads to decreased memory confidence.

Theories of cue utilization suggest that, under conditions of high emotional arousal, individuals will allocate more attention towards central cues surrounding an event as opposed to peripheral cues (Easterbrook, 1959). These individuals will therefore have a better memory for central as opposed to peripheral information (Easterbrook, 1959). Indeed, some studies examining memory for central (e.g. The colour of an injured woman's coat) versus peripheral (e.g. The colour of a car in the distant background) cues for an arousing event (e.g. A woman in a bicycle accident) demonstrate that individuals in fact have a better memory for central cues (Christianson & Loftus, 1987; Christianson & Loftus 1991; Christianson, Loftus, Hoffman, & Loftus, 1991). However, the research is inconsistent, and some studies have also found that individuals have a better memory for peripheral and central cues for an arousing event (Heuer & Reisberg, 1990; Libkuman, Nichols-Whitehead, Griffith, & Thomas, 1999).

There is reason to believe, however, that individuals with compulsive checking, do exhibit narrowing of focus. In the study discussed above by Radomsky and colleagues (2001), individuals with compulsive checking diagnosed with OCD remembered more threat relevant than irrelevant information under conditions of high responsibility. This bias was weaker under conditions of low responsibility, and non-existent under conditions of no responsibility. Furthermore, several researchers have demonstrated that individuals with OCD exhibit attentional biases towards negative-threat relevant information (Lavy, van Oppen, & van den Hout, 1994; Tata, Leibowitz, Prunty, Cameron, & Pickering, 1996).

Thus it may be that individuals with checking compulsions have decreased memory confidence under threat relevant conditions because they focus on threat relevant central information to the detriment of threat irrelevant peripheral information. This hypothetically could result in decreased vividness and detail of memory, which may cause individuals to have low confidence in their memory. This suggests that if one were to increase the processing of peripheral information, this may increase memory detail and vividness and subsequently increase memory confidence.

Research in the area of memory and aging has demonstrated that increasing the amount of detail encoded improves memory. Levy, Jennings, and Langer (2001) asked older participants to either simply pay attention to a series of pictures or to specifically note 3 or 5 distinctions in a series of pictures. They found that the groups asked to note distinctions in the picture remembered significantly more pictures than the group only asked to attend to the pictures. Furthermore, other studies that required adults to ignore irrelevant stimuli and only focus on central stimuli found no improvements in attention (McDowd & Filion, 1992). This suggests that indeed paying attention not only to the main components of an image but also the details of an image will improve memory for that image. Such an approach could be applied to research examining repeated checking to assess the impact of focusing more on specific peripheral details during checking on memory accuracy for the last check and on memory confidence.

Although decrements in memory confidence following repeated checking have been well demonstrated, there is a need for research in which manipulations of the proposed mechanisms underlying memory confidence are evaluated. The purpose of this study is to manipulate how much detail is encoded during repeated checking to see if the

increased encoding of detail will indeed lead to increased memory confidence, vividness, and detail in individuals instructed to repeatedly check. When participants were instructed to focus only on their actions, it was anticipated that high checkers would report less memory detail, vividness, and confidence than low checkers following repeated checking. The differences in memory confidence, vividness, and detail between the high checkers and low checkers were expected to become attenuated when participants were instructed to focus not only on their actions but also on their surroundings. In general, it was predicted that increasing the amount of detail encoded during the act of repeated checking would lead to increased overall memory detail, vividness and confidence.

Methods

Participants

Participants were recruited from undergraduate classes at Concordia University. A total of 152 participants were tested. As compensation for participating in the study, students had their name entered in a draw for one of five cash prizes. Twelve participants were removed from analyses because they left several of the answers to the memory question blank. One half of the participants were randomly assigned to a peripheral focus condition, and the remaining participants were assigned to a central focus condition.

The mean age of participants in the peripheral condition was 24.49 (SD = .76) years, with a range from 18 to 55 years. In the central condition the mean age of participants was 24.29 (SD = .78) years, with a range of 19 to 49 years. Seventy-seven percent of participants in the peripheral condition and 69% in the central condition were

female. There were no differences between the conditions in age, t (138) = .18, n.s., or gender distribution, χ^2 (3, N = 140) = 1.3, n.s.

After the study was completed, participants were divided into high and low checking groups. Group assignment was based upon scores on the Vancouver Obsessive Compulsive Inventory checking subscale (VOCI; Thordarson, et al., in press), with participants in the top quintile classified as 'high checkers' and the remaining participants classified as 'low checkers'. One participant was eliminated due to missing VOCI data. There were fourteen high checkers each in the peripheral and central conditions, 55 low checkers in the central condition and 56 low checkers in the peripheral condition. The mean age of high checkers was 22.68 (SD = .94) years, with a range of 19 to 46 years. The mean age of low checkers was 24.62 (SD = .63) years, with a range of 18 and 55 years. In the high checking group, 82% of participants were female, whereas in the low checking group, 70% of participants were female. There were no significant differences between high and low checkers in terms of age, t (137) = -1.45, n.s., or gender distribution, χ^2 (3, N = 139) = 1.59, n.s.

Measures

Vancouver Obsessional Compulsive Inventory (VOCI) (Thordarson et al., in press): The VOCI is a 55-item self-report questionnaire that assesses a variety of symptoms associated with OCD. The VOCI was used to assess OCD symptomatology in the participants, and to separate participants into high and low checking groups. Along with a total score, the VOCI also contains 6 subscales, each assessing a specific symptom area of OCD. The contamination subscale assesses an individual's preoccupation with cleanliness, and avoidance of germs and other perceived sources of contamination. The

checking subscale assesses an individual's urge to repeatedly check objects. The obsessions subscale assesses unwanted, intrusive, and distressing thoughts, including aggressive, blasphemous, and sexual thoughts. The hoarding subscale assesses an individual's urge to obsessively collect objects and difficulty with discarding unnecessary objects. The "just right" subscale assesses an individual's need to continue carrying out an action until an internal sense of perfection or feeling of 'just rightness' has been achieved. Finally, the indecisiveness subscale assesses difficulty with making decisions, as well as anxiety and worry associated with making decisions.

The VOCI exhibited good internal consistency and good test-retest reliability within a clinical population of people with OCD. Good internal consistency was established in a student population, however, test-retest reliability within a student population is poorer. Furthermore, the VOCI exhibits good convergent and divergent validity in both a clinical and student population (Thordarson et al., in press).

Beck Anxiety Inventory (BAI) (Beck, Epstein, Brown, & Steer, 1988): The BAI is a 21-item self-report questionnaire that measures physiological and cognitive symptoms associated with anxiety. The scale is designed to specifically discriminate anxiety from depression. It was used as a measure of general anxiety. The BAI demonstrates good internal consistency, both within individuals with clinical anxiety and those without clinical anxiety, with alphas ranging from .90 to .94 (Creamer, Foran, & Bell, 1995; Fydrich, Dowdall, & Chambless, 1992). Test retest reliability, however is only moderate in both clinical and non-clinical groups (Creamer et al., 1995; Fydrich et al., 1992). Not only does the BAI exhibit superior divergent validity compared to other measures of

anxiety, it also shows acceptable convergent validity (Creamer et al., 1995; Fydrich, et al., 1992).

Beck Depression Inventory (BDI-II) (Beck, Steer, & Brown, 1996): The BDI-II is a 21-item self-report questionnaire measuring depressive symptomatology and was used as a measure of depression for this study. The BDI-II exhibits high internal consistency and excellent test-retest reliability (Beck et al., 1996). Furthermore, this measure demonstrates good convergent and divergent validity (Beck et al., 1996).

Obsessive Beliefs Questionnaire-44 (OBQ-44) (Obsessive Compulsive Cognitions Working Group (OCCWG), under review): The OBQ-44 is a 44-item self-report questionnaire developed by leading researchers into cognitions related to OCD. It is designed to assess general belief domains related to OCD and contains three empirically derived subscales. Responsibility/Threat Estimation measures beliefs about harm happening to oneself or others and beliefs about responsibility and the consequences of inaction. Perfectionism/Certainty measures beliefs related to intolerance of uncertainty and rigid high standards of achievement. Finally, Importance/Control of Thoughts measures the consequences of having thoughts, thought-action fusion, and the need to rid oneself of intrusive thoughts. The OBQ-44 was administered to assess cognitive beliefs related to compulsive checking symptomatology and served to establish that the high and low checking groups not only differed in predicted ways in regards to behavioural symptomatology but also in terms of cognitions related to OCD. The OBQ-44 demonstrates acceptable internal consistency, known groups validity and divergent validity. Furthermore, compared to the longer theoretically based version of the same questionnaire, the OBQ-87, the OBQ-44 subscales exhibit less overlap (OCCWG, under

review). Because the OBQ-44 is a new questionnaire with limited data regarding its validity and reliability, it was decided to assess belief domains related to OCD and compulsive checking using other well established measures in addition to the OBQ-44.

Responsibility Attitudes Scale (RAS): (Salkovskis, et al., 2000): The RAS is a 26-item self-report questionnaire designed to assess general attitudes and beliefs about responsibility. The domains assessed in this scale are similar to domains assessed in the Responsibility/Threat Estimation subscale of the OBQ-44. The RAS has good internal consistency, with an alpha of .92 reported in the original validation study. Furthermore, it demonstrates good test-retest reliability (Salkovskis et al., 2000). The RAS demonstrates acceptable predictive validity, with individuals with OCD scoring higher on the RAS than individuals without OCD (Salkovskis et al., 2000).

Intolerance of Uncertainty Scale (IUS) (Buhr & Dugas, 2002; Freeston, Rhéaume, Letarte, Dugas, & Ladouceur, 1994): The IUS is a 27-item self-report questionnaire designed to assess the extent to which an individual has difficulty tolerating uncertainty, including the idea that uncertainty is stressful and upsetting, that it leads to an inability to act, that uncertain events are negative, and that uncertainty is unfair. The domain assessed by the IUS is similar to some of the beliefs assessed in the Perfectionism/Uncertainty subscale of the OBQ-44. The English version of the IUS has excellent internal consistency and good test-retest reliability (Buhr & Dugas, 2002). Furthermore, the scale exhibits good predictive validity (Buhr & Dugas, 2002).

Procedure

Participants first completed a questionnaire package which included the measures described above. To control for order effects, there were two different ordered versions

of the questionnaire package. After completing the questionnaires, participants where taken into a real working kitchen (Figure 1), where the checking task took place.

Operation of the stove was demonstrated by the experimenter. Participants were shown how to turn on, turn off, and check various combinations of two out of six stove knobs (Figure 2). To increase the difficulty of the task only one knob handle was used. Thus participants had to pull the knob handle off the knob they had just manipulated in order to use it to control the next knob. To make sure the checking task was both ritualized and standardized, participants were provided with specific instructions on how to operate the stove. To turn on the knobs participants were asked to turn the knob on half way between the medium and maximum position. To turn off the knobs participants were asked to turn the knob to the off position and wiggle it back and forth to make sure it was turned off. To check to see if the knob was turned off participants were asked to wiggle the knob between the minimum and maximum positions.

Participants were told that the experimenter would not be watching them check the stove, and that the experimenter would provide instructions to the participant via an intercom. The use of the intercom was then demonstrated. To increase responsibility and to increase the threatening nature of the task, it was emphasized that the stove knobs were unreliable. That is the knobs were sometimes mistaken for being off when they were still on, and that it was the participants' responsibility for ensuring that the knobs were really off.

For all trials, the experimenter, via the intercom, first asked the participants to turn on a combination of two stove elements, saying "Now I'd like you to turn on knobs X and Y." Once participants had completed this, they were instructed, once again via the

intercom to turn off those same knobs, saying "Now I'd like you to turn off knobs X and Y." Finally, after completing this participants were instructed to check those same knobs, saying "Now I'd like you to check them."

Prior to receiving the attention manipulation instructions, all participants completed a single checking trial. Following this single check participants were immediately taken into another room and asked to write down in order which two knobs they checked. In addition to this, participants were also asked to rate how confident, vivid and detailed their memory was from 0 (not at all confident, vivid or detailed) to 100 (extremely confident, vivid, or detailed). Confidence was defined for participants as referring to "how confident you are that your memory was accurate." Vividness was defined for participants as referring to "the clarity or intensity of your memory," and detail was defined for participants as referring to "the particular visual features of your memory" (See Appendix A for the Single Check Questionnaire). All definitions were based upon the definitions provided to participants in the repeated checking study by Van den Hout and Kindt (2001a).

Participants were told that while they were completing these questions the experimenter would check to see if the knobs were properly turned off. After participants had completed answering the questions they were brought back into the kitchen and informed that one of the burners was not properly turned off. The importance of making sure the burners are turned off was emphasized, by reminding them that "an unchecked stove can cause a fire." This was done to increase the perceived seriousness of harm of the task. Participants were then told that they would now be going through a series of checking trials and that it would likely get more difficult to remember which knobs they

turned on and off, and they were then offered a technique to help them remember which knobs they had indeed used. Participants in the central condition were instructed to attend only to the act of checking. These participants were told that:

> Research demonstrates that focusing only on the actions of a task will improve your memory for the task at hand. When you check the stove we want you to focus on only the act of checking the stove. This means that if you only focus on your actions, your memory for checking the stove will improve. It is very important for you to use this strategy of just focusing on the act of checking the stove throughout the set of operations.

Participants in the peripheral condition were instructed to attend not only to the act of checking but also to their surroundings. These participants were told:

> Research demonstrates that focusing not only on the task at hand, but also on the surrounding context of that task will improve your memory for the task. When you check the stove we would like you to divide your attention equally between focusing on checking the stove and focusing on your surroundings. This means that if you focus on the act checking the stove and also on the objects in the room, your memory will improve. It is very important for you to use this strategy of focusing on the act of checking the stove and focusing on everything else in the room throughout the set of operations.

The experimenter then left the room and proceeded to administer 30 checking trials via the intercom. Participants were randomly assigned to one of two randomized

trial sequences to control for order effects. After each block of 10 checking trials, participants were reminded of their focus strategy to ensure that the strategy was maintained throughout all trials. The 30th and final trial for all participants was the same (Knobs # 1 and # 6).

Once the 30 trials were completed, the experimenter immediately went into the kitchen, announced that the checking trials were now over and brought the participant into another room. It was possible that the questions answered following the initial single checking trial check may have cued participants to attempt to actively remember which knobs they checked during the subsequent 30 trials. Participants were therefore asked to count backwards in sevens from 4321 out loud for 30 seconds as a distractor task to ensure the knobs they checked were not held in short term memory. After this was completed, participants were asked to recall specific central details surrounding the check, including which two knobs they checked last. Participants were also asked to recall specific peripheral details of the room (See Appendix B for the Repeated Checking Questionnaire). In addition to recalling specific items, participants were once again asked to rate their memory confidence, vividness, and detail for these items.

Finally, as a manipulation check, participants were asked to rate how their attention was divided on a 10 inch (25.4 cm) visual analog scale (VAS). One end of the VAS scale was anchored with "I was paying attention to only the actions I was doing, and not at all to the surrounding environment." The other end was anchored with "I was paying attention only to my surrounding environment, and not at all to my actions," with the midpoint anchored by "My attention was equally divided between the actions I was doing and the surrounding environment."

A 10 inch (25.4 cm) VAS scale was also used to assess how difficult the task was to determine if the cognitive load for peripheral and central groups was similar. One end of this VAS scale was anchored by a very simple task, "Writing your full name in your dominant hand," and the other end with a very difficult task, "Writing your full name in your dominant hand while spelling/saying the letters of your full name in reverse order." The mid point was anchored by a moderately difficult task, "Writing your full name in your dominant hand while spelling/saying the letters of your name in order" (See Appendix C for the Manipulation Check Questions).

Data Analysis

In order to minimize the number of analyses, thereby reducing the chance of committing a type 1 error, a number of composite measures were calculated. The items that were assigned to each category are listed in Table 1. Memory accuracy was calculated as the percentage of correct answers. For single checking trial memory accuracy was calculated as the percentage of knobs correctly recalled. For the repeated checking trials, memory accuracy was divided into a number of subcategories. Because memory and metamemory for checking the knobs was the primary interest, it was decided to analyze memory accuracy for the last two knobs checked separately from the rest of the data. Thus memory accuracy for the knobs (following repeated checking) was calculated as the percentage correctly recalled knobs. It was decided to analyze memory accuracy separately for the peripheral and the remaining central items. Memory accuracy for the other central items consisted of the percentage of correct recall of 3 central items and memory accuracy for peripheral items consisted of the percentage of correct recall of 5 peripheral items.

Corresponding metamemory measures were calculated for memory for the knobs following a single check, memory for the knobs, for other central items, and for peripheral items following multiple checks. Memory confidence was calculated for each category by computing the mean memory confidence score of items contributing to a specific memory accuracy score. For example, memory confidence for peripheral items was the average memory confidence rating for the 5 items contributing to memory accuracy for peripheral items. Scores for memory vividness and memory detail were calculated in the same manner.

Memory and metamemory following a single check for the knobs, and following repeated checking for the knobs, other central items, and for peripheral items were analyzed separately. For each, a 2 X 2 MANOVA was calculated with checking status (high checkers versus low checkers) and condition (peripheral versus central) as the between participant factors, and memory accuracy, memory confidence, memory vividness, and memory detail as the dependent variables. Significant results were followed up with Univariate ANOVAs and with paired comparisons. Alpha was set at $p = .05$.

Missing Data

Missing data was dealt with on a per analysis basis. A participant was excluded from an analysis if he/she had not answered a question relevant to a given analysis. However, he/she was not eliminated from other analyses.

Results

Participants

Peripheral and central conditions.

To establish that the peripheral and central groups were appropriately randomized and to confirm the non-clinical nature of the sample, scores on the BDI-II, the BAI, the VOCI and its subscales were examined. There were no significant differences between the central and peripheral conditions on scores on the BDI-II, t (137) = .96, n.s., BAI, t (137) = -.14, n.s., VOCI total, t (137) = -.06, n.s., VOCI contamination, t (137) = .57, n.s., VOCI checking, t (137) = .03, n.s., VOCI obsessions, t (137) = -.12, n.s., VOCI hoarding, t (137) = -.22, n.s., VOCI just right, t (137) = .04, n.s., or VOCI indecisiveness subscales t (137) = -.96, n.s.. There were also no significant differences between the two groups on measures of cognitive processes related to OCD, including scores on the responsibility/threat estimation subscale of the OBQ, t (137) = - 0.81, n.s., the perfectionism/uncertainty subscale of the OBQ, t (137) = - 0.57, n.s., the importance/control of thoughts subscale of the OBQ, t (137) = -1.146, n.s., the RAS, t (137) = .77, n.s., and the IUS, t (138) = - 0.93, n.s..

High and low checkers.

Scores on measures of OCD, anxiety, and depressive symptomatology were also compared between high and low checkers. Mean scores on the BDI-II, BAI, VOCI total and VOCI subscales for high checkers and low checkers are presented in Table 2. All t-tests were checked for equality of variance. In the event that the variances between the two groups were not equal, the degree of freedom for that given t-test was adjusted. As was expected of individuals exhibiting symptoms of OCD, high checkers scored

significantly higher on the BDI-II, t (137) = 3.74, $p < .001$, the BAI, t (33.84) = 3.54, $p < .001$, the VOCI total, t (30.90) = 6.54, $p < .001$, VOCI contamination, t (31.21) = 3.75, $p < .001$, VOCI checking, t (27.30) = 7.73, $p < .001$, VOCI obsessions, t (29.92) = 3.65, $p < .001$, VOCI hoarding, t (34.68) = 2.39, $p < .05$, VOCI just right, t (30.95) = 5.76, $p < .001$, and VOCI indecisiveness subscales t (31.94) = 4.14, $p < .001$. Furthermore, to establish that high checkers were different from low checkers, not only in symptomatology, but also in aspects of cognition related to OCD, the two groups were compared on scores on the OBQ, RAS, and IUS, which are presented in Table 3. High checkers scored significantly higher on the responsibility/threat estimation subscale of the OBQ, t (137) = 3.39, $p < .001$, the perfectionism/uncertainty subscale of the OBQ, t (137) = 4.22, $p < .001$, the importance/control of thoughts subscale of the OBQ, t (137) = 2.74, $p < .01$, the IUS, t (137) = 4.18, $p < .001$, and scored significantly lower on the RAS, t (137) = - 4.12, $p < .001$ than low checkers.

Manipulation Check

Attention.

To establish that the manipulation of attentional focus was effective, participants' ratings of attention on the VAS were compared using a 2 X 2 ANOVA with checking status and condition as the between participant factors. There were seven individuals eliminated from this analysis due to the fact that these individuals did not appear to understand the question. Low scores on the VAS scale indicate more attention towards one's actions whereas high scores indicate more attention towards the surroundings, and intermediate scores indicate attention was divided between actions and surroundings. The range of the scale was from 0 to 10. It was predicted that participants in the

peripheral condition would score in the middle of the VAS scale, whereas participants in the central condition would score lower on the VAS scale. As expected, there was a significant main effect for condition, $F(1, 128) = 41.21, p < .001$, with the peripheral group dividing their attention equally between focusing on the task and focusing on their surroundings ($M = 4.47$, $SD = 1.34$), and the central group focused more on the task than on their surroundings ($M = 2.54$, $SD = 1.58$). There were no significant differences between the checking groups for how attention was divided during the task, $F(1, 128) = .433$, n.s., nor was there a significant interaction between checking status and condition, $F(1, 128) = .57$, n.s.

A second, more objective measure, indicating whether the peripheral group attended more to the surrounding environment than the central group is participants' memory accuracy for peripheral items, as well as the confidence, vividness, and detail with which they remembered these items. A 2 X 2 MANOVA was therefore calculated with accuracy, confidence, vividness, and detail for peripheral items as the dependent variables and condition and checking status as the independent variables. For the purpose of this analysis, 5 participants were eliminated due to missing data. It was predicted that participants in the peripheral condition would have a more accurate memory for peripheral items, as well as greater confidence, vividness, and detail for these memories compared to the central group. The MANOVA demonstrated this with a significant main effect for focus condition, $F(4, 127) = 12.93, p < .001$, indicating that there may be univariate differences between the two focus conditions for some of the dependent variables. Unexpectedly, there was also a significant main effect for checking status, $F(4, 127) = 4.63, p < .01$, indicating that there may also be univariate differences between

high and low checkers for some of the dependent variables related to peripheral items recalled. The checking status by condition interaction was not significant, F (4, 127) = 1.40, n.s.. The significant main effects were followed up with separate Univariate ANOVAs for memory accuracy, confidence, vividness, and detail. As shown in Table 4, the peripheral group correctly recalled a greater percentage of peripheral items than the central group, F (1, 130) = 30.59, $p < .001$, and also gave higher ratings of memory confidence, F (1, 130) = 33.00, $p < .001$, memory vividness, F (1, 130) = 32.51, $p < .001$, and memory detail, F (1, 130) = 32.74, $p < .001$. Thus instructions to the peripheral and central groups indeed appear to have been effective in manipulating attention. There were no significant differences between the checking groups for accuracy, F (1, 130) = .189, n.s., memory confidence, F (1, 128) = .33, n.s., memory vividness, F (1, 130) = .07, n.s., or memory detail, F (1, 130) = 1.55, n.s., for peripheral items. Thus, although high checkers were significantly different from low checkers when all of the variables were considered together, when each variable is considered separately high checkers are not different from low checkers in terms of memory accuracy, confidence, vividness, and detail for peripheral items.

Task difficulty.

One possible confound of this study was that the checking task for participants in the peripheral condition may have been more difficult than the checking task for participants in the central condition because the peripheral condition required participants to attend both to the checking task and the surroundings. A 2 X 2 repeated measures ANOVA with condition and checking status as the between participant factors was calculated to see if there were any differences between groups in VAS ratings of

difficulty. There were 7 individuals eliminated from this analysis due to the fact that these individuals did not appear to understand the question. The main effect for condition was not significant, F (1, 128) = .15, n.s., indicating that participants in the peripheral and central conditions found the checking task to be of about the same difficulty. Furthermore, the high and low checkers perceived the task to be of similar difficult as demonstrated by the non-significant main effect for checking status, F (1, 128) = 2.76, n.s.. These main effects were not moderated by an interaction between the focus condition participants were in and the participant's checking status, F (1, 128) = .06, n.s.. Thus participants in the peripheral condition did not find the task more difficult than participants in the central condition, despite the fact that they were asked to attend to both their actions and their surroundings.

Changes in Memory and Metamemory Following Repeated Checking

To examine if repeated checking resulted in significant changes in memory accuracy, memory confidence, vividness, and detail for the knobs checked from a single checking trial to repeated checking trials a Repeated Measures MANOVA with number of checks (Single Check vs. Repeated Check) as the within participant factor and focus condition (peripheral vs. central) as the between participant factor was calculated. There was a significant main effect for the number of checks, F (4, 135) = 102,13, $p < .001$, indicating that there may be univariate differences in memory accuracy, memory confidence, vividness, or detail between completing a single check and completing repeated checks. There was no significant main effect for focus condition, F (4, 135) = 1.87, n.s., nor was there a significant interaction, F (4, 135) = 1.14, n.s. Follow-up univariate ANOVAs indicate that there were significant decreases in memory accuracy, F

(1, 138) = 51.34, p < .001, memory confidence, F (1, 138) = 406.38, p < .001, memory vividness, F (1, 138) = 348.08, p < .001, and memory detail, F (1, 138) = 334.87, p < .001 following repeated checking, compared to a single check.

Memory and Metamemory Following a Single Check

To establish that participants in the peripheral condition performed equivalently to participants in the central condition prior to the manipulation, memory accuracy, memory confidence, vividness, and detail for the two knobs following a single check were compared. It was also of interest to examine if high checkers reported lower memory confidence for checking than low checkers following a single check. A 2 X 2 MANOVA with condition and checking status as the between participant factors, and memory accuracy, memory confidence, vividness, and detail for the pretest burners as the dependent variables. The MANOVA revealed a significant main effect for checking status, F (4, 132) = 2.45, p < .05, indicating that there may be univariate differences between high and low checkers in memory accuracy, confidence, vividness, or detail for the knobs checked a single time. The main effect for condition, F (4, 132) = .84, n.s., and the condition by checking status interaction, F (4, 132) = 1.19, n.s., were not significant. The main effect for checking was followed up with univariate ANOVAs for each of the dependent variables. Table 5 presents the means and standard deviations for memory accuracy, confidence, vividness, and detail for the knobs following a single check.

As anticipated, high checkers reported significantly lower memory confidence than low checkers following a single check, F (1, 135) = 4.15, p < .05. Surprisingly, the main effect of checking status for memory accuracy also approached significance, F (1, 135) = 3.67, p < .10. That is, there was a trend for high checkers to be more accurate

than low checkers in recalling which knobs they checked following a single checking trial. There were no differences between high and low checkers for memory vividness, F (1, 135) = .41, n.s., or memory detail, F (1, 135) = .08, n.s., for the knobs following a single checking trial.

Memory and Metamemory Following Repeated Checking

Memory and metamemory for the knobs.

A 2 X 2 MANOVA with checking status and focus condition as the between participant factors and memory accuracy, confidence, vividness, and detail for the last two knobs checked as the dependent variables was conducted. Analyses revealed a significant main effect for focus condition, F (4, 132) = 3.56, $p < .01$, indicating that there may be univariate differences in memory accuracy, confidence, vividness, and detail for focus condition. There was no significant main effect for checking status, F (4, 132) = 1.48, n.s. The checking status by focus condition interaction also was not significant, F (4, 132) = 1.50, n.s. Given the *a priori* hypothesis that the difference in memory confidence between high and low checkers for memory confidence for the knobs would be attenuated in the peripheral condition, it was decided to examine the focus condition x checking status interaction as well as the focus condition main effect. Follow-up univariate ANOVAs with focus condition and checking status as the between participant factors were calculated for each of the dependent variables. Analyses revealed a significant main effect of condition for memory accuracy, F (1, 135) = 5.11, $p < .05$. As shown in Table 6, participants in the peripheral group were more accurate in their memory for the knobs checked than participants in the central group. However, contrary to expectations, the main effects of focus condition for memory confidence, F

(1, 135) = 2.07, n.s., vividness, F (1, 135) = 3.03, $p < .10$, and detail, F (1, 135) = 1.16, n.s., were not significant. In fact the slight trend for memory vividness was in the opposite direction than what was predicted. That is, individuals in the central condition tended to report a more vivid memory for the knobs checked than individuals in the peripheral condition. There was a trend towards an interaction between focus condition and checking status for memory accuracy, F (1, 135) = 3.00, $p < .10$. Paired comparisons revealed that high checkers in the peripheral condition tended to have a more accurate memory for the knobs than all other participants. Interactions between focus condition and checking status for memory confidence, F (1, 135) = .23, n.s., vividness, F (1, 135) = .76, n.s., and detail, F (1, 135) = .29, n.s., were not significant.

Memory for other central items.

A MANOVA with checking status and focus condition as the between participant factors and memory accuracy, confidence, vividness, and detail related for other central items as the dependent variables was calculated for the remaining central items. One participant was eliminated from analysis due to missing data. As predicted, there was a significant main effect for condition, F (4, 131) = 2.43, $p < .05$, indicating that there may be univariate differences between participants in the peripheral and central focus conditions for memory accuracy, confidence, vividness, or detail for other central items. There was also a significant condition by checking status interaction, F (4, 131) = 2.89, $p < .05$, showing that differences between focus conditions may be moderated by checking status for memory accuracy, confidence, vividness, or detail for other central items. The main effect for checking status was not significant, F (4, 131) = .80, n.s. As shown in Table 7, follow-up univariate ANOVAs for memory accuracy, confidence, vividness, and

detail revealed that participants in the peripheral focus condition were more accurate at recalling other central items than participants in the central focus condition, F (1, 134) = 5.53, $p < .05$. Participants in the peripheral focus condition also had significantly greater memory confidence than participants in the central focus condition for other central items, F (1, 134) = 5.68, $p < .05$. There were no differences between peripheral and central focus conditions for memory vividness, F (1, 134) = 2.13, n.s., or memory detail, F (1, 134) = 1.89, n.s. The interaction between checking status and focus condition for memory accuracy for other central items was also significant, F (1, 134) = 4.94, $p < .05$. Follow up paired comparisons revealed that high checkers in the peripheral condition had a more accurate memory for other central items than low checkers in the central condition, but not the peripheral condition. The interactions for memory confidence, F (1, 134) = 1.20, n.s., vividness, F (1, 134) = 2.13, n.s., and detail, F (1, 134) = .15, n.s., were not significant.

Discussion

Instructions to focus not only on one's actions but also on one's surroundings did not lead to improved memory confidence for recalling which knobs were last checked compared to instructions to focus only on one's actions. In fact there were no differences between the peripheral and central groups for any metamemory measure related to recalling the last knobs checked following a repeated checking task. Interestingly, instructions to focus not only on one's actions but also the surrounding details of those actions resulted in increased memory accuracy for the last two knobs checked, as well as for central and peripheral items surrounding the check, compared to instructions to focus only one's actions. That is, a peripheral focus led to more accurate memory for all types

of items tested (i.e. the knobs checked, other central items, and peripheral items) compared to central focus. High checkers in the peripheral focus condition more accurately recalled other central items and were also marginally more accurate in recalling which knobs they checked compared to high checkers in the central focus condition, and all low checkers, however they did not differ from other groups on any measure of metamemory. However, metamemory differences were apparent following only a single check. High checkers were less confident for their memory of the knobs they checked than low checkers, but were marginally more accurate in their recollection than low checkers following a single check. All participants exhibited decreases in memory confidence, vividness, and detail following repeated checking, compared to a single check.

Effects of Repeated Checking in General

The observed decreases in memory confidence, vividness, and detail following repeated checking are consistent with the findings of several other studies examining repeated checking (Radomsky et al., 2003, Van den Hout & Kindt, 2003a, Van den Hout & Kindt, 2003b). In each of these studies repeated checking resulted in lowered memory confidence, vividness, and detail. These findings are consistent with Rachman's (2002) model of compulsive checking which proposes that the act of repeated checking results in lowered memory confidence, which in turn contributes the checker's belief that his/her memory is somehow deficient and makes certainty appear more unlikely. This self-perpetuating mechanism, however, does not appear to be specific to individuals inclined to repeatedly check, as both high and low checkers in this study exhibited decreases in

memory confidence when asked to repeatedly check the stove, regardless of checking status.

Contrary to findings by Radomsky et al. (2003), and Van den Hout and Kindt (2003a, 2003b), this study found that repeated checking resulted in declines in memory accuracy as well as metamemory. The fact that this study had participants repeatedly check various combinations of 2 knobs 30 times whereas the other studies had participants repeatedly check various combinations of 3 knobs 20 times may have contributed to this discrepancy. The change in protocol from previous studies was necessary, however, in order to make the difficulty of the repeatedly checking task equivalent for the peripheral and central conditions. Additionally, in previous studies, participants' memory for the knobs checked was tested by having participants circle on a diagram, which knobs they last checked, and thus participants, were not required to recall the order in which the knobs were checked. The increased demand of recalling not only which knobs were checked but also the order in which they were checked may have also contributed to the decrease in memory accuracy.

Effects of Peripheral Focus on Repeated Checking

The decline in memory accuracy was influenced by the attentional focus instructions. Instructions to focus not only on the checking task but also on the surrounding environment, resulted in better memory accuracy for the knobs checked, other central items, and for peripheral items compared to instructions to focus only on the act of checking. A possible reason why the peripheral focus group exhibited greater memory accuracy for central items than the central focus group is that when attending to central details, the peripheral focus group may have had fewer involuntary rest pauses

(IRP) than the central focus group. An IRP is defined as a pause in performance which is hypothesized to occur in order to dissipate reactive inhibition during some task (Eysenck, 1967). Studies using vigilance tasks suggest that missed responses on such tasks are a result of an IRP occurring concurrently with the stimulus. It may be that instructions to focusing on specific details served as a forced rest pause, thereby reducing the necessity to take an IRP during central focus. This hypothesis is consistent with findings that adding a secondary vigilance task results in improvements in a primary vigilance task (Bakan, 1959). Thus memory for central detail may have improved in the peripheral focus condition because of a decreased need for IRPs.

Importantly for the purpose of this study, however, although memory accuracy was better for central details in the peripheral focus condition, memory confidence was not improved for recalling the knobs checked. One explanation may be that the manipulation of focus of attention did not work. This explanation, however, seems unlikely. Participants in the peripheral focus condition indicated using a VAS scale that they were dividing their attention between focusing on their actions and focusing on their surroundings, whereas participants in the central focus condition indicated that they were primarily focusing on their actions. Furthermore, participants in the peripheral focus condition did in fact exhibit better memory accuracy for peripheral items than participants in the central focus condition. This suggests that participants in the peripheral focus condition did indeed focus more on their surroundings than participants in the central focus condition. As mentioned earlier, participants in the peripheral focus condition were also more accurate in remembering items related to the act of checking

than participants in the central focus condition. This suggests that participants in the peripheral focus condition indeed attended to both their surroundings and their actions.

As rival second hypothesis is that although focus of attention was manipulated, it was not manipulated in a manner consistent with the hypotheses of the study. Wachtel (1967) describes how attention can be modulated in different ways. Specifically, he suggests that attention can be defined as narrow or broad in relation to the width of attention. A second way that attention can be broadened or narrowed is in relation to scanning, or the movement of attention from one location to another. Our instruction to "divide your attention equally between focusing on checking the stove and focusing on your surroundings" may have been interpreted by participants to mean that they should increase scanning around the room rather than to increase their width of attention. Participants in the peripheral condition may have increased attention towards various items in the room, without necessarily increasing the width of attention to include the context of checking. Thus when asked to recall items in the room, increased scanning in peripheral focus group may have helped in the recall of a greater number of items in the room. However, merely recalling more items in the room may not sufficiently increase contextual memory for the act of checking, and therefore memory confidence following repeated checking may not have changed compared to individuals who only focused on their actions. Perhaps different instructions to focus carefully on the context of checking would influence memory confidence more than instructions to focus on checking and to focus on one's surroundings.

A third rival hypothesis as to why participants in the peripheral condition did not have better memory confidence for the knobs than participants in the central condition is

that memory confidence is influenced by factors other than decreased encoding of perceptual details, particularly in individuals who compulsively check. Consideration of several additional findings from this study may offer clues as to additional factors that may have influenced memory confidence.

Differences Between High and Low Checkers

As predicted, at pretest high checkers were significantly less confident in their memory of checking the stove than were low checkers. They did not differ from each other in memory vividness or detail at pretest. Surprisingly these differences that were present at pretest were no longer apparent following 30 trials of repeated checking.

Various cognitive processes related to OCD, such as inflated responsibility for harm and intolerance for uncertainty, may have made high checkers in this study less confident in their memory before they even began to repeatedly check. Indeed prior to completing any checking task, high checkers scored higher on measures of responsibility, perfectionism, intolerance of uncertainty, importance and control of thoughts, and threat estimation. Some of these factors were manipulated in between the single checking trial and the 30 checking trials. By telling participants that it was entirely their responsibility to make sure the checking occurred properly their sense of responsibility was increased. By reminding participants that an unchecked stove can cause a fire, their estimation of threat may have been increased, and by telling participants that they did not properly turn off the stove, their tolerance of uncertainty may have decreased. These manipulations may have affected cognition in low checkers as well as high checkers, making the differences between the groups in terms of memory confidence less clear. Radomsky and colleagues (2001) demonstrated that memory

confidence decreases the most under conditions of high responsibility in individuals with checking compulsions. It may be that conditions of high responsibility also decrease memory confidence in low checkers. It would be interesting to examine in a non-clinical sample how specific manipulations of these various cognitive processes influence memory confidence for repeated checking. These findings are also consistent with Rachman's (2002) model of compulsive checking which also proposes that certain 'multipliers,' such as inflated responsibility for preventing harm, predispose some people to repeatedly check and to trust their memory less.

At pretest, high checkers also exhibited greater memory accuracy for the knobs they checked than low checkers. High checkers may have remembered more accurately not only which knobs they checked but also the order in which they checked them, which was not assessed by earlier studies using a similar method of inducing repeated checking (Radomsky et al., 2003; Van den Hout & Kindt, 2003a; Van den Hout & Kindt, 2003b). This memory bias is consistent with other studies that demonstrate a memory bias for threat relevant information (i.e. checking to make sure the stove is off) under ecologically valid conditions (Radomsky & Rachman, 1999; Radomsky et al., 2001). It is also is consistent with models of emotion processing such as those proposed by Bower (1981) and Teasdale (1993), suggesting that individuals preferentially process information that is consistent with one's current mental or mood state.

Peripheral focus instructions seemed to have a larger effect on high checkers than low checkers. When high checkers were instructed to focus not only on their actions but also their surroundings they exhibited a more accurate memory for which knobs they checked and for central items related to the act of checking compared to high checkers

instructed to focus only on their actions and low checkers instructed to focus either on their actions or on their actions and surroundings. This once again may be an artifact of increased scanning rather than widened attention. Savage and colleagues (2000) demonstrated that individuals with OCD tend to focus on the details of a complex figure as opposed to focusing on the overall structure of the figure. He also demonstrated that this strategy results in poorer recall of a complex figure (Savage et al., 2000). However, in our study, participants were not asked to recall the kitchen as a whole, but were rather asked to recall specific items in the kitchen. Focusing on the specific details may have improved recall for these details. Thus, our instructions may have actually encouraged high checkers to use encoding strategies they already employ rather than encouraging them to focus on the context of checking as an integrated whole.

Summary

The fact that memory accuracy and metamemory decreased for all participants following repeated checking suggests that actual memory influences metamemory. However, it is important to note that the decrease in memory accuracy was lower in the peripheral focus condition than in the central focus condition. This suggests that other factors beyond actual memory, such as the focus of attention, also may influence metamemory. Cognitive biases may also play an important role in memory confidence, since high checkers, who also reported more inflated responsibility, intolerance of uncertainty, and other cognitive biases related to OCD, had greater memory accuracy, but lower memory confidence following a single check.

There are some limitations to this study that warrant mention. First, as already discussed, the instructions to focus on the surroundings may not have had the desired

effect. Furthermore, our sample consisted of undergraduate students. The mean VOCI checking subscale score of the high checking group fell just below the mean VOCI checking subscale score of compulsive checkers in the initial validation of the VOCI and above the mean in a non-clinical student sample (Thordarson et al., in press), suggesting that the sample of high checkers fall in the non-clinical range. Despite the fact that OCD likely exists along a continuum with non-clinical manifestations of OCD (Rachman & de Silva, 1978; Gibbs, 1996), it may be that more severe clinical compulsive checking would have been more influenced by our manipulation than non-clinical checkers. Future research should examine the effect of repeated checking in clinical checkers.

Despite the fact that participants were from a non-clinical sample, this study does have some clinical implications for the treatment of compulsive checking. Strategies to increase memory confidence may help to reduce urges to check. This study as well as several others (i.e. Radomsky et al., 2003; Van den Hout & Kindt, 2003a, Van den Hout & Kindt, 2003b) have consistently demonstrated that the act of repeated checking results in decreases in memory confidence, and this study also suggests it may result in decreased memory accuracy as well. These results emphasize the importance of response prevention for treatment. Having participants simply stop repeatedly check objects may help to reduce decreases in memory confidence and subsequent urges to check. The fact that research is increasingly finding evidence that checkers may have a more accurate memory for threat related information under certain situations could be emphasized to clients, and clients should be encouraged to actively test this hypothesis as well. This may also help increase memory confidence in checkers and thus help reduce urges to check.

In summary results suggest that although repeated checking does indeed contribute to decrements in memory confidence, it also suggests that memory confidence is influenced by factors above and beyond the mere act of checking. The pattern of improved memory accuracy coupled with lower memory confidence prior to repeated checking in high but not low checkers suggests that other processes may be influencing metamemory and perhaps also memory accuracy. It may be that cognitive processes related to compulsive checking play an important role in decreasing memory confidence and may also influence memory accuracy. The results of this study indicate that memory and metamemory in compulsive checkers are a complex phenomenon, influenced by both cognitive and behavioural processes.

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Figure 1

Testing kitchen.

Figure 2

Layout of stove knobs.

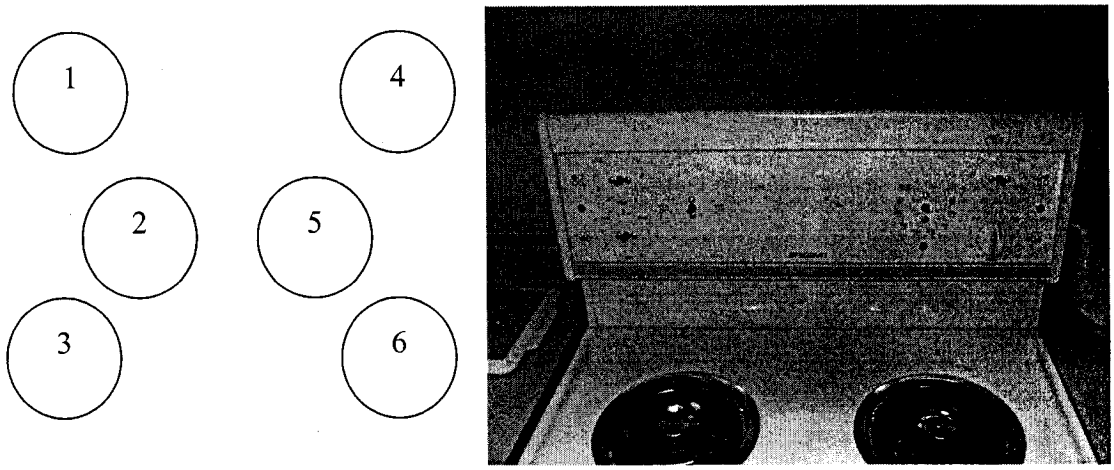


Table 1.

Items included within each category.

Category	Question	Correct Answer
Knobs Checked	On the last trial, which knob did you check first?	Knob # 6
	On the last trial, which knob did you check second?	Knob # 1
Peripheral Items	What kind of food or drink was by the stove?	Coke can
	How many electrical plugs were on the stove?	1
	What colour was the tea towel on the stove?	Pink
	What pattern was on the tea pot	Flowers
	How many cups were there in the sink?	4
Other Central Items	Which knob did *not* click loudly	2
	Did any burners glow/red/orange while you were in the kitchen?	No
	Did the stove beep at anytime?	No
Single Check	Which knob did you check first?	Knob # 2
	Which knob did you check second?	Knob # 5

Table 2.

Mean scores (SD) on measures of OCD symptomatology, anxiety, and depression in high and low checkers.

	High Checkers			Low Checkers			Total
	Peripheral	Central	Total	Peripheral	Central	Total	
Measures	n = 14	n = 14	n = 28	n = 56	n = 55	n = 111	N = 139
VOCI [a] Total	55.36	58.29	56.82	18.81	18.27	18.55	26.26
	(31.44)	(29.50)	(29.95)	(17.13)	(14.55)	(15.84)	(24.75)
VOCI Checking	9.43	8.57	9.00	0.40	0.56	0.48	2.20
	(6.26)	(5.54)	(5.81)	(0.81)	(0.89)	(0.86)	(4.35)
VOCI Contamination	11.07	9.43	10.25	3.96	3.57	3.76	5.07
	(8.91)	(9.01)	(8.83)	(5.61)	(3.97)	(4.84)	(6.39)
VOCI Obsessions	7.64	9.50	8.57	2.75	2.40	2.58	3.78
	(6.28)	(10.38)	(8.47)	(4.42)	(3.28)	(3.88)	(5.65)
VOCI Hoarding	5.86	5.93	5.89	3.16	3.35	3.25	3.78
	(6.30)	(4.78)	(5.49)	(3.39)	(4.61)	(4.03)	(4.47)

Table 2 continued

	High Checker			Low Checkers			Total
Measures (continued)	Peripheral	Central	Total	Peripheral	Central	Total	N = 139
VOCI Just Right	15.07	15.29	15.18	5.13	4.98	5.05	7.09
	(9.89)	(8.35)	(8.98)	(5.41)	(4.08)	(4.77)	(7.11)
VOCI Indecisiveness	6.29	9.57	7.93	3.41	3.43	3.42	4.33
	(4.34)	(6.24)	(5.53)	(3.40)	(3.18)	(3.28)	(4.22)
BAI [b]	13.71	16.14	14.93	7.64	7.25	7.45	8.96
	(10.31)	(11.06)	(10.56)	(7.44)	(7.29)	(7.33)	(8.59)
BDI-II [c]	14.64	17.00	15.82	10.11	7.60	8.86	10.27
	(8.86)	(12.28)	(10.58)	(10.20)	(5.63)	(8.31)	(9.21)

[a] VOCI refers to the Vancouver Obsessional Compulsive Inventory (Thordarson, Radomsky, Rachman, Shafran, Sawchuk, & Hakstian, in press).

[b] BAI refers to the Beck Anxiety Inventory (Beck, Epstein, Brown, & Steer, 1988).

[c] BDI-II refers to the Beck Depression Inventory Second Edition (Beck, Steer, & Brown, 1996).

* *SD* are presented in brackets below the mean scores.

Table 3

Mean Scores (SD) on questionnaires measuring the strength of OCD related beliefs in high and low checkers.

	High Checkers			Low Checkers			Total
Measures	Peripheral	Central	Total	Peripheral	Central	Total	N = 139
	n = 14	n = 14	n = 28	n = 56	n = 55	n = 111	
OBQ [a] Responsibility/	41.29	46.61	43.95	34.43	35.31	34.86	36.69
Threat Estimation	(11.72)	(16.66)	(14.39)	(13.10)	(11.31)	(12.20)	(13.13)
OBQ Perfectionism/	63.14	69.43	66.29	50.18	50.80	50.49	53.67
Uncertainty	(20.38)	(17.76)	(19.03)	(19.08)	(15.63)	(17.38)	(18.77)
OBQ Importance/	26.86	32.14	29.50	23.36	24.42	23.88	25.01
Control of Thoughts	(10.82)	(9.00)	(10.13)	(9.40)	(9.84)	(9.59)	(9.93)
IUS [b]	61.36	70.50	65.93	48.80	50.38	49.59	52.84
	(17.42)	(23.72)	(20.94)	(18.95)	(16.79)	(17.85)	(19.50)
RAS [c]	108.14	91.50	99.82	119.42	119.76	119.59	115.61
	(23.40)	(30.54)	(28.01)	(23.63)	(18.59)	(21.19)	(23.97)

[a] OBQ refers to the Obsessive Beliefs Questionnaire (Obsessive Compulsive Cognitions Working Group, under review).

[b] IUS refers to the Intolerance of Uncertainty Scale (Buhr & Dugas, 2002; Freeston, Rhéaume, Letarte, Dugas, & Ladouceur, 1994).

[c] RAS refers to the Responsibility Attitude Scale (Salkovskis, et al., 2000).

Table 4.

Mean (SD) memory accuracy and metamemory for peripheral items following 30 checking trials.

	Peripheral Condition		Central Condition	
	High Checkers	Low Checkers	High Checkers	Low Checkers
Memory Accuracy (% correct)	56.92	69.63	37.14	37.35
	(24.28)	(22.23)	(24.63)	(20.01)
Memory Confidence	73.65	72.55	45.09	51.15
	(14.30)	(16.88)	(26.11)	(22.59)
Memory Vividness	72.42	68.37	44.44	46.23
	(12.24)	(18.08)	(24.18)	(22.94)
Memory Detail	72.88	67.04	46.87	41.52
	(13.22)	(18.92)	(25.96)	(22.76)

Table 5.

Mean (SD) memory accuracy and metamemory for checking the stove following a single checking trial.

	Peripheral Condition		Central Condition	
	High Checkers	Low Checkers	High Checkers	Low Checkers
Memory Accuracy (% correct)	96.43	68.75	78.57	70.90
	(13.36)	(46.28)	(42.58)	(45.84)
Memory Confidence	88.21	96.33	93.18	93.80
	(11.33)	(8.06)	(8.92)	(11.86)
Memory Vividness	86.07	91.30	89.21	87.95
	(13.72)	(14.13)	(18.26)	(14.55)
Memory Detail	87.32	90.66	86.54	85.17
	(11.16)	(14.79)	(13.57)	(18.70)

Table 6.

Mean (SD) memory accuracy and metamemory for checking the stove following 30 checking trials.

	Peripheral Focus		Central Focus	
	High Checkers	Low Checkers	High Checkers	Low Checkers
Memory Accuracy (% correct)	67.86	40.18	32.14	35.45
	(42.09)	(43.09)	(42.09)	(41.58)
Memory Confidence	35.71	33.96	48.64	40.41
	(38.02)	(31.39)	(31.47)	(30.75)
Memory Vividness	30.64	32.16	48.29	38.02
	(38.23)	(29.89)	(31.79)	(32.22)
Memory Detail	36.50	31.43	47.57	35.11
	(37.37)	(31.86)	(32.16)	(31.54)

Table 7.

Mean (SD) memory accuracy and metamemory for other central items following 30 checking trials.

	Peripheral Condition		Central Condition	
	High Checkers	Low Checkers	High Checkers	Low Checkers
Memory Accuracy (% correct)	88.10	77.58	66.67	76.97
	(21.11)	(21.33)	(29.24)	(21.15)
Memory Confidence	87.26	85.76	74.79	82.52
	(9.82)	(13.15)	(23.18)	(16.65)
Memory Vividness	83.33	79.45	69.95	77.58
	(11.38)	(16.68)	(25.31)	(19.95)
Memory Detail	80.21	78.00	72.43	73.67
	(21.25)	(18.25)	(24.41)	(22.10)

Appendix A: Single Check Questionnaire

Confidence refers to how confident you are that your memory is accurate.

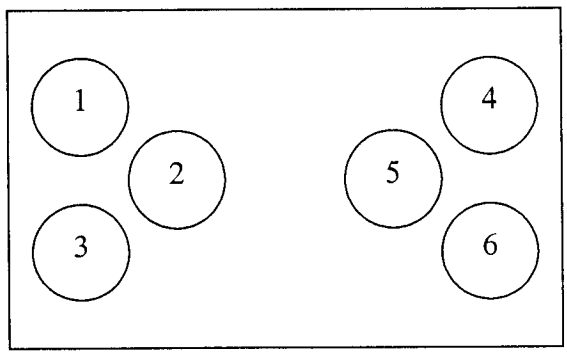
Vividness refers to the clarity or intensity of your memory.

Detail refers to the particular visual features of your memory.

Knowing the knobs are turned off means that you have a *general* sense that they are off. Even if you *do not have a concrete detailed memory*, you just *know* they are turned off. For example, your memory of brushing your teeth this morning is probably "known" as opposed to "remembered."

Remembering the knobs are turned off means you can go through your memory and bring up the *detailed process (with specific features)* of turning them off. For example, your memory of finding the lab in the PY building is probably "remembered" as opposed to just "known."

Stove Knobs:



For the following questions place your answer in the ANSWER box.
Then rate how confident you are in your memory for that particular question using a scale of 0 (Not at all confident) to 100 (Extremely confident). Place your answer in the box marked CONFIDENCE.

Then rate how vivid your memory is for that particular item, using the definition provided above and a scale of 0 (Not at all Vivid) to 100 (Extremely vivid). Place your answer in the box marked VIVIDNESS.

Then rate how detail your memory is for the particular item, using the definition provided above and a scale of 0 (Not at all detailed) to 100 (Extremely detailed). Place your answer in the box marked DETAIL.

Then using the definitions for Remembering and Knowing provided above, indicate if your memory for that item is primarily based on Remembering or Knowing by circling

the R if it is primarily remembered, or circling a K in the REMEMBER/KNOW box if it is primarily known.

QUESTION	ANSWER	CONFIDENCE (0 – 100)	VIVIDNESS (0 – 100)	DETAIL (0 – 100)	REMEMBER /KNOW
1. On the last trial, which knob did you check first?					R K
2. On the last trial, which knob did you check second?					R K

Appendix B: Repeated Checks Questionnaire

Confidence refers to how confident you are that your memory is accurate.

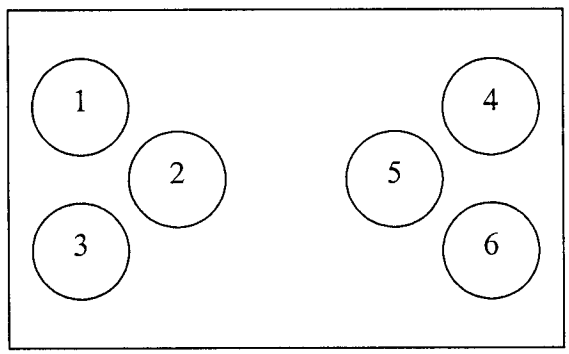
Vividness refers to the clarity or intensity of your memory.

Detail refers to the particular visual features of your memory.

Knowing the knobs are turned off means that you have a *general* sense that they are off. Even if you *do not have a concrete detailed memory*, you just *know* they are turned off. For example, your memory of brushing your teeth this morning is probably "known" as opposed to "remembered."

Remembering the knobs are turned off means you can go through your memory and bring up the *detailed process (with specific features)* of turning them off. For example, your memory of finding the lab in the PY building is probably "remembered" as opposed to just "known."

Stove Knobs:



For the following questions place your answer in the ANSWER box.
Then rate how confident you are in your memory for that particular question using a scale of 0 (Not at all confident) to 100 (Extremely confident). Place your answer in the box marked CONFIDENCE.

Then rate how vivid your memory is for that particular item, using the definition provided above and a scale of 0 (Not at all Vivid) to 100 (Extremely vivid). Place your answer in the box marked VIVIDNESS.

Then rate how detail your memory is for the particular item, using the definition provided above and a scale of 0 (Not at all detailed) to 100 (Extremely detailed). Place your answer in the box marked DETAIL.

Then using the definitions for Remembering and Knowing provided above, indicate if your memory for that item is primarily based on Remembering or Knowing by circling

the R if it is primarily remembered, or circling a K in the REMEMBER/KNOW box if it is primarily known.

QUESTION	ANSWER	CONFIDENCE (0 – 100)	VIVIDNESS (0 – 100)	DETAIL (0 – 100)	REMEMBER/ KNOW
1. What kind of food or drink was by the stove?					R K
2. Which knob did *not* click loudly?					R K
3. How many electrical plugs were on the stove?					R K
4. Did any burners glow red/orange while you were in the kitchen?					R K
5. What colour was the tea towel on the stove?					R K
6. On the last trial, which knob did you check first?					R K
7. On the last trial, which knob did you check second?					R K
8. What pattern was on the teapot?					R K
9. Did the stove beep at anytime?					R K
10. How many cups were there in the sink?					R K

Appendix C: Manipulation Check Questions

Task Difficulty

Please answer the following question by marking a point on the bar which best represents how difficult you felt the task you just completed was.

Writing your full name in your dominant hand.	Writing your full name in your dominant hand while spelling/saying the letters of your full name in order.	Writing your full name in your dominant hand while spelling/saying the letters of your full name in reverse order.

Attention

Please answer the following question by marking a point on the bar which best represents where you allocated your attention during the task you just completed.

I was paying attention to only the actions I was doing, and not at all to the surrounding environment.

My attention was equally divided between the actions I was doing and the surrounding environment.

I was paying attention only to my surrounding environment, and not at all to my actions.