Attentional Focus During Repeated Checking Influences Memory But Not Metamemory

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Abstract

Numerous studies demonstrate that compulsive checking is associated with reduced memory confidence (Muller & Roberts, 2005; Woods, Vivea, Chambless, & Bayen, 2003). Some researchers have shown that the act of repeated checking may result in changes in encoding and subsequently reduced confidence in memory (Radomsky, Rachman, & Hammond, 2001; Van den Hout & Kindt, 2004). 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, 64 participants were instructed to focus not only on their actions but also on their surroundings (Peripheral condition), and 66 participants were instructed to focus only on their actions (Central condition). Contrary to expectations, compared with those in the central condition, participants in the peripheral condition did not report greater memory confidence, but did however have a more accurate memory. Furthermore, this effect was largest for participants scoring high on a measure of compulsive checking. Results are discussed in terms of cognitive models of OCD and compulsive checking.

KEYWORDS: Obsessive-compulsive disorder, checking, memory confidence, metamemory, memory, attention

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A common manifestation of obsessive compulsive disorder (OCD) is compulsive checking (Stein, Rode, Anderson, & Walker, 1997; Taylor, 2002), which is characterized by the urge to repeatedly verify that an action aimed to prevent harm has been completed (Rachman & Hodgson, 1980). It has been argued that compulsive checking occurs as a result of poor memory, however research to date has not consistently demonstrated that this is the case. Though some investigators have demonstrated that clinical and non-clinical checkers have impaired memory for actions (Rubenstein, Peynircioglu, Chambless, & Pigott, 1993; Sher, Frost & Otto, 1983; Sher, Mann, & Frost, 1984; Sher, Frost, Kushner, Crews & Alexander, 1989), others have not detected this impairment (Tallis, Pratt, & Jamani, 1999). Several reviews of memory in OCD suggest that OCD may be related to deficits in memory for actions as well as visual memory, although all of these emphasize the inconsistencies in the literature (Coles & Heimberg, 2002; Greisberg & McKay, 2003; Muller & Roberts, 2005; Tallis, 1997).

Further complicating the current understanding of memory in OCD is the fact that some researchers have not found memory deficits under threat relevant conditions, when the to-be-remembered material is related to the individual’s fear (Ceschi, Van der Linden, Dunker, Perroud, & Brédart, 2003; Foa, Amir, Gershuny, Molnar, & Kozak, 1997; Radomsky & Rachman, 1999; Radomsky, Rachman, & Hammond, 2001). In fact, several studies have actually demonstrated that under personally relevant or anxiety provoking circumstances, individuals with symptoms of OCD actually have a more accurate memory, particularly for threat relevant information (Ceschi et al., 2003; Constans, Foa, Franklin, & Mathews, 1995;

Radomsky & Rachman, 1999; Radomsky et al., 2001; Tolin, Abramowitz, Brigidi, Amir, Street, & Foa, 2001; Wilhelm, McNally, Baer, & Florin, 1996).

Although the literature related to actual memory is relatively inconsistent, one increasingly common finding is that individuals who compulsively check tend to report 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), although a few studies have not found significant differences between checkers and non-checkers (e.g., Tallis et al., 1999). Recent research suggests that the declines in memory confidence following repeated checking, at least in non-clinical samples, are larger than the changes in memory accuracy that have been observed (Coles, Radomsky, & Horng, in press; Radomsky, Gilchrist & Dussault, in press; Van den Hout & Kindt, 2004), and that decreases in memory confidence appear to be most salient under conditions of high responsibility (Radomsky et al., 2001). It may be that compulsive checkers do not have a worse memory than others, but rather are less confident in their memory.

Van den Hout and Kindt (2003a; 2003b; see 2004 for a review) recently demonstrated that decreases in memory confidence can be induced in non-checkers. They examined if low memory confidence was produced by increases in the familiarity of the checking event, by asking undergraduate students to repeatedly turn on, turn off, and check random combinations of either computer simulated light bulbs or gas rings on a virtual 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. Under the “relevant checking” condition, participants reported significantly decreased vividness and detail of, and confidence in memory compared to participants in the “irrelevant checking” condition. These results have been replicated by Radomsky and colleagues (2006) and Coles and colleagues (2006) under conditions of real perceived threat and responsibility in a functioning kitchen. In addition to the large declines in confidence, vividness and detail, these more recent studies also found small declines in memory accuracy. Van den Hout and Kindt (2004) argued that the conditions of high familiarity, such as those produced by the “relevant checking” condition in their study, inhibited processing of the perceptual features of a stimulus which in turn decreased the vividness and detail of later recollections, and subsequently deflated the confidence in that recollection.

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. This in turn leads to decreased memory vividness and detail, and ultimately to decreased memory confidence (Rachman, 2002; Radomsky et al., 2001). More specifically, according to Rachman’s model of compulsive checking (2002), high perceived responsibility, multiplied by high perceived seriousness and probability of harm occurring, will lead to increased arousal which will impair the vividness and detail of the encoded checking event, leading to mistrust in memory. Thus, according to this model, decreases in memory confidence may be observed in compulsive checkers even during an initial check, due to the inflated beliefs of responsibility and harm. Importantly, both models suggest that less detailed encoding of the checking event leads to decreased vividness and detail, which, in turn lead to decreased memory confidence.

It follows from these models that increasing the amount of detail encoded (e.g., increased processing of perceptual features according to Van den Hout and Kindt, or increased processing of threat-irrelevant cues according to Radomsky and colleagues (2001)) may attenuate these declines in memory confidence. Not only would demonstrating that increased encoding of detail attenuates declines in memory confidence add support to these theories of how repeated checking affects memory and meta-memory, this finding could also offer clinicians additional tools in the cognitive-behavioural treatment of compulsive checking.

One way to increase the amount of detail encoded during a repeated checking task is to instruct participants not only to attend to the stimulus being checked, but also to the surrounding (peripheral) details of the checking environment. The purpose of this study is to examine if the increased encoding of peripheral details will lead to attenuated decreases in memory confidence in individuals instructed to repeatedly check. It was predicted that increasing the amount of detail encoded while checking would reduce the decline in memory confidence. Because previous studies have only investigated this phenomenon in student samples, we also divided our sample into two groups: individuals with high levels of compulsive checking and those with normative levels of checking to determine a) if high checkers have lower memory confidence even following an initial check as proposed by Rachman (2002), b) if the effect of repeated checking on memory confidence is stronger in high checkers and c) if the effect of peripheral focus has a larger effect on high checkers compared to low checkers.

Methods

Participants

Participants (n =152) were recruited from undergraduate psychology classes at Concordia University, Montreal Canada. Participants were told that the study would take approximately one hour to complete, and had their name entered in a draw to win one of five cash prizes, ranging from \$50 to \$250, in exchange for participating. Twelve participants were removed from analyses because of incomplete or missing data. One half of the sample was randomly assigned to a peripheral focus condition, while those remaining were assigned to a central focus condition (see below).

At the end of the study, participants were further subdivided into high and low checking groups. Group assignment was based on previously established scores on the Vancouver Obsessive Compulsive Inventory (VOCI) checking subscale for OCD and community samples (Thordarson, et al., 2004; see below). There were fourteen high checkers in each of the peripheral and central conditions, 54 low checkers in the central condition and 52 low checkers in the peripheral condition. Six participants were eliminated from the analysis due to the fact that their scores fell outside the cut-off scores for both checking groups.

The mean age of participants was 24.28 (*SD* = 6.41) years. A 2-way ANOVA with focus condition and checking group as between-participant factors determined that there were no significant age differences between the groups, *F*s (1, 130) < 2.21, n.s., $\eta^2_p = .02$, confirming the random assignment of our participants. The majority of our participants were female, comprising 73.13% of our sample. Random assignment was once more demonstrated by the absence of gender distribution differences across the 4 groups, χ^2 (3, N = 134) = 3.38, n.s..

Measures

Depression

The Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) is a 21-item frequently used self-report measure assessing symptoms of depression. The scale exhibits excellent reliability and validity (Beck et al., 1996). The internal consistency of the BDI-II in the current samples was also excellent, $\alpha = .92$.

Anxiety

The Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988) is a 21-item frequently used self-report measure assessing general symptoms of anxiety. The scale exhibits excellent internal consistency in clinical and student samples and moderate test-retest reliability (Creamer, Foran, & Bell, 1995; Fydrich, Dowdall, & Chambless, 1992). The divergent and convergent validity of the BAI is also excellent (Creamer et al., 1995; Fydrich et al., 1992). The internal consistency of the BAI in the current samples was excellent, $\alpha = .91$.

OC Symptoms

The VOCI (Thordarson et al., 2004) is a 55-item self-report measure assessing a variety of symptoms associated with OCD. The scale has 6 subscales, each measuring a different symptom type. Validation of the questionnaire indicates that the scale has good internal consistency and acceptable test-retest reliability, as well as acceptable convergent and divergent validity in a student sample (Radomsky, Ouimet, Ashbaugh, Lavoie, Parrish, & O'Connor, in press; Thordarson et al., 2004). For the purposes of this study, the means for individuals with OCD and the community sample for theVOCI checking subscale, as established during the initial validation of the study (Thordarson et al., 2004), were used to divide the sample into high and low checkers. The internal consistency of the 6-item checking subscale in the current sample was excellent, $\alpha = .94$, and consistent with previously reported levels of internal consistency

(Radomsky et al., in press; Thordarson et al., 2004). In the initial validation, individuals with OCD scored 12.32 (*SD* = 8.62) on the checking subscale, whereas students scored 3.16 (*SD* = 4.27), and the community sample scored 0.79 (*SD* = 1.51) (Thordarson et al., 2004). In this study, any participant scoring at or above the reported mean of the OCD group minus one standard deviation (e.g., scores greater than or equal to 3.7) was classified as a high checker. To reduce overlap between the high and low checkers, the reported community sample mean was used to define the low checkers. Thus, any participant scoring at or lower than the published mean of the community sample plus one standard deviation (e.g., a score less than or equal to 1.94) was classified as a low checker.

Memory Accuracy

Memory accuracy was assessed following a single checking trial and following a repeated checking trial. For the single checking trial, participants were asked to recall which stove knob they checked first and which knob they checked second (as described below, participants were required to check random combinations of 2 out of 6 knobs). For the repeated checking trials, memory accuracy was divided into a number of subcategories. Participants were asked to recall which knob they checked first and second on the last trial. In addition to this main variable of interest, we also examined the effect of our focus manipulation on items increasingly peripheral to the checking event. Participants were asked to recall items in the room that were central to the checking task, but not the knobs themselves. Questions related to other central items included a) Which knob did *not* click loudly?, b) Did any burners glow red/orange while you were in the kitchen?, and c) Did the stove beep at anytime?. Participants were also asked to recall peripheral items from the room that were not related to the check. Questions related to peripheral items included a) What kind of food or drink was by the stove?, b) How many electrical plugs were on the stove?, c) What color was the tea towel on the stove?, d) What pattern was on the tea pot?, and e) How many cups were there in the sink? Memory accuracy for each category was calculated as the percentage of items correctly recalled.

Memory Confidence

For each item, participants were asked to rate how confident they were that their memory was accurate from 0 (not at all confident) to 100 (extremely confident). Memory confidence was calculated for each category by computing the mean confidence score for items contributing to a specific memory accuracy score.

Attention

As a manipulation check at the end of the study, participants were asked to rate on a 10 inch (25.4 cm) Visual Analog Scale (VAS) how they allocated their attention during the checking task. The scale was anchored on the left with “I was paying attention only to the actions I was doing, and not at all to the surrounding environment,” on the right 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.” As such, low scores indicated that participants attended primarily to their actions, and higher scores indicated that participants attended to their surroundings.

Difficulty

At the end of the study, participants were also asked to rate how difficult they found the task, using a 10 inch (25.4 cm) VAS scale to determine if the ‘cognitive load’ for peripheral and central groups was similar. One end of the 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." Thus, lower scores indicated that participants found the task to be fairly easy and higher scores indicated that participants found the task to be difficult.

Procedure

Participants first completed a questionnaire package which included the BAI, BDI-II, and VOCI. They were then guided to the laboratory's fully equipped kitchenette, where they were trained to "turn on," "turn off," and "check" various combinations of two out of six stove knobs in a ritualized, standardized manner. The stove used in this experiment was an electric stove. Throughout the training and testing periods, all six plastic stove knobs were removed and participants had to use only one plastic knob to operate the stove. This procedure is consistent with the procedure used by Radomsky and colleagues (2006), and Coles, and colleagues (2006), and was used to reduce the influence of visual checking because the cognitive component of checking was of primary interest in this study. The knobs on the stove were numbered one through six, and a diagram clearly indicating the location of each knob was posted on the wall next to the stove. To increase perceived responsibility and uncertainty, participants were told that the stove knobs were unreliable and that the experimenter would not be watching them check the stove. It was emphasized to participants that it was their responsibility to ensure that the burners were off.

Checking instructions were provided to the participants via an intercom. For each trial, participants were first asked to "turn on," "turn off," and "check" two stove elements. After each instruction was given (i.e., "turn on," "turn off," or "check"), participants were asked to walk over to the intercom to inform the experimenter that they had completed the task.

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 answered the memory accuracy and confidence questions about the knobs that they checked following the single checking trial.

After participants had answered the questions, they were brought back into the kitchen and were told that they had not properly turned off one of the burners. Consistent with Van den Hout and Kindt (2004), this was done to increase the perceived probability of harm associated with the task. The importance of ensuring that the burners were off was emphasized by reminding them that "an unchecked stove can cause a fire." Participants were then told that they would be taken through a series of checking trials, and were 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:

> 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 only on 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 that:

> 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 of 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. Each trial was composed of checks of two different knobs, and participants were randomly assigned to check one of two different sequences of knobs 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 30^{th} and final trial was the same for all participants.

Once the 30 trials were completed, participants were taken into another room and given a distracter task of counting backwards in sevens from 4321 for 30 seconds to ensure that the last knobs checked were not held in working memory. After this was completed, participants were asked the memory accuracy and confidence questions about the knobs checked following repeated checking, and about other central details, and peripheral details. Finally, participants answered the manipulation check questions about attention and difficulty.

Statistical Analyses

Two-way ANOVAs with group (high vs. low checkers) and focus condition (peripheral vs. central focus) as between-participant factors were used to examine memory accuracy and confidence for the knobs checked following a single check and following repeated checking, as well as for other central items and peripheral items following a repeated check. Partial eta squared (η^2_p) was reported as a measure of effect size. Significant interactions were followed up with pairwise comparisons that examined differences between the central and peripheral focus groups in high and low checkers respectively using a Bonferroni adjustment. These pairwise comparisons were chosen not only because we were interested in examining if the focus condition had differing effects in high and low checkers, but also because this allowed for more equal sample sizes for our pairwise comparisons. Additionally, ANOVAs were used to examine if there were differences in how difficult participants found the task to be, whether attentional focus varied across groups, and to compare the group scores on the BAI, BDI-II and VOCI (total and checking subscale) scores.

Results

Participants

Means and standard deviations of the self-report measures are presented in Table 1. It is notable that the standard deviation on the VOCI checking subscale was much smaller in low checkers than high checkers. Scores on this subscale ranged from 0 to 1 in the low checkers with most participants scoring 0. In the high checkers, scores ranged from 4 to 24. The majority of high checkers reported mild to moderate levels of checking. There were neither significant differences for focus condition, Fs (1, 130) < .62, n.s., η^2_ps < .005 , nor significant interactions between focus condition and checking group, Fs (1, 130) < 1.27, n.s., η^2_ps = .01. High checkers scored significantly higher on all measures, Fs (1, 130) > 18.04, ps < .01, η^2_ps > .12 .

Manipulation Check

Attention

As expected, there was a significant effect of focus condition on reported attentional focus, F (1, 124) = 42.22, $p < .001$, $\eta^2_p = .27$, with the peripheral group dividing their attention equally between focusing on the task and on their surroundings (M = 4.49, SD = 1.34), and the central group focused more on the task than on their surroundings (M = 2.48, SD = 1.48). There were no significant differences between the checking groups, F (1, 124) = .61, n.s., $\eta^2_p = .005$, nor was there a significant interaction between focus condition and checking group, F (1, 124) = .39, n.s., $\eta^2_p = .003$.

Difficulty

There were no differences found with regards to how difficult participants perceived the task to be, Fs (1, 124) < 2.68, n.s., η^2_ps < .02. On average participants reported finding the task to be fairly simple, as indicated by the overall mean falling below the half-way mark on the VAS scale (M = 3.90, SD = 2.58).

Memory and Metamemory Following a Single Check

There was a trend for high checkers to show greater memory accuracy for the knobs checked following a single check compared to low checkers, F (1, 130) = 3.48, $p < .06$, η^2_p = .03. As anticipated, there were no significant differences between the focus conditions regarding memory accuracy for the knobs checked following a single check, F (1, 130) = .77, n.s., η^2_p = .006, nor was there a significant focus condition by checking group interaction, F (1, 130) = 1.13, n.s., $\eta^2_p = .009$.

There was also a trend for high checkers to report lower memory confidence than low checkers following a single check, F (1, 130) = 3.77, $p = .05$, η^2_p = .03. However, this was qualified by a trend for a focus condition by checking group interaction, F (1, 130) = 3.22, p = .08, η^2_p = .02. Pairwise comparisons, however, demonstrated that there were no statistically significant differences between focus conditions for either the high or the low checkers. Confirming the equivalence of our focus condition groups prior to the attention manipulation, the main effect of focus condition was not significant, F (1, 130) = .23, n.s., η^2_p = .006. Table 2 presents the means and standard deviations for measures of memory confidence and accuracy.

Memory and Metamemory Following Repeated Checking

Memory and metamemory for the knobs

Analyses revealed a significant main effect of focus condition on memory accuracy, F (1, 130) = 5.66, $p < .05$, η^2_p = .04. As shown in Table 2, participants in the peripheral group were more accurate in their memory for the knobs checked than participants in the central group. There was no significant main effect of checking group on memory accuracy, F (1, 130) = 1.74, n.s., η^2_p = .01, nor was the group by condition interaction significant, F (1, 130) = 2.54, n.s., η^2_p = .02.

For memory confidence, contrary to expectations, neither of the main effects, nor the interaction was significant, Fs (1, 130) < 2.22, n.s., η^2_ps < .02. Table 3 presents the means and standard deviations for memory confidence.

Because memory and metamemory for the knobs were the variables of interest, we conducted *post hoc* comparisons between the central and peripheral conditions within the high checkers only to determine if the attention manipulation had any effect on memory accuracy or metamemory in the high checkers. Consistent with the results reported for the entire sample, high checkers in the peripheral condition had a significantly more accurate memory for the knobs checked compared to high checkers in the central condition, t (26) = -2.25, $p < .05$, η^2_p = .16, but were not significantly different from each other on memory confidence for the knobs checked, t (26) = .98, n.s., $\eta^2_p = .04$.

Memory for other central items

As shown in Table 2, the main effect of focus condition on accuracy was significant, with participants in the peripheral condition being more accurate at recalling other central items than participants in the central condition, F (1, 130) = 5.01, $p < .05$, $\eta^2_p = .04$. The main effect of checking group was not significant, F (1, 130) = .02, n.s., $\eta^2_p = .0001$, however the interaction between focus condition and checking group for memory accuracy for other central items was significant, F (1, 130) = 5.43, $p < .05$, $\eta^2_p = .04$. Pairwise comparisons revealed that high checkers in the peripheral condition had a more accurate memory for other central items than high checkers in the central condition, but there was no difference between the focus conditions among low checkers.

As demonstrated in Table 2, a similar pattern was observed for memory confidence for the other central items. Participants in the peripheral condition had significantly greater memory confidence than participants in the central condition for other central items, F (1, 130) = 4.98, $p < .05$, $\eta^2_p = .04$. The main effect of checking group was not significant, F (1, 130) = .87, n.s., $\eta^2_p = .007$, nor was the interaction between checking group and focus condition, F (1, 130) = 2.36, n.s., $\eta^2_p = .02$.

Memory and metamemory for peripheral items

The peripheral group correctly recalled a significantly greater percentage of peripheral items than the central group, F (1, 130) = 29.95, $p < .0001$, $\eta^2_p = .18$. There was no significant main effect of checking group, F (1, 130) = 1.12, n.s., $\eta^2_p = .009$, nor was there a significant focus condition by checking group interaction, F (1, 130) = 1.64, n.s., $\eta^2_p = .01$.

As shown in Table 2, participants in the peripheral condition gave significantly higher ratings of memory confidence than participants in the central condition, F (1, 130) = 33.80, $p <$ .0001, $\eta^2_p = .21$. There was no significant difference between the checking groups, F (1, 130) = .26, n.s., $\eta^2_p = .002$, nor was there a significant condition by group interaction, F (1, 130) = .89, n.s., $\eta^2_p = .007$.

Controlling for depression

Because scores on the BDI-II were greater for high checkers than low checkers, we were concerned that some of the differences between the groups may be attributable to differences in depression, particularly given the fact that depression has been associated with memory biases (see Dalgleish & Watts, 1990 for a review). We therefore reran the analyses controlling for BDI-II scores using ANCOVAs with focus condition and checking status as between-participant factors. Results were the same as described above, except that the trend for the effect of checking group on memory confidence for the knobs checked following a single check was no longer significant, F (1, 128) = 1.82, $p = .18$, $\eta^2_p = .01$.

Discussion

This study found that in a repeated checking task, instructions to attend not only to one's actions but also to one's surroundings (compared to instructions to attend only to one's actions) led to a more accurate memory for the knobs that were last checked, but did not influence confidence in memory. Not surprisingly, peripheral focus also led to more accurate memory and greater memory confidence for items that were increasingly peripheral to the act of checking (e.g., other central items and peripheral items). The benefits of peripheral focus on memory accuracy, particularly for other central items, seemed to be greatest in the high checking group. Before repeated checking began, high checkers had a more *accurate* memory than low checkers for which knobs they checked, but were less *confident* in their memory for checking the stove. The implications of these findings will be considered separately.

Effects of attentional focus on memory confidence

Van den Hout and Kindt (2004) argued that declines in memory confidence following repeated checking occur because of decreased encoding of detail during repeated checking. We therefore tested the hypothesis that increasing the amount of (albeit peripheral) detail encoded during repeated checking may attenuate the distrust in memory. Our findings did not support this hypothesis. Memory confidence for recalling the knobs checked was not influenced by instructions to attend to one's actions and surroundings, but these instructions did result in greater memory confidence for items in the room (e.g., other central items and peripheral items).

One explanation for why memory confidence did not improve may be because our manipulation of attention was ineffective. However, the attention manipulation check suggests that participants in the peripheral focus condition did attend to their surroundings and their actions, whereas participants in the central focus condition attended only to their actions. Furthermore, peripheral focus did result in better memory and memory confidence for increasingly peripheral items (e.g., other central items and peripheral items), suggesting that our manipulation was effective.

An alternative explanation is that the instructions to attend to "objects in the room" may have led participants to have a better memory and memory confidence for items in the room, but not necessarily for the act of checking itself. Perhaps instructions to attend to the *context* of one's actions may have resulted in improved memory confidence for the knobs last checked. Recalling the specific *context* of a single checking event (e.g., remembering that one walked back to the stove to check) may increase the elaboration and distinctiveness of encoding which should assist in memory retrieval (Craik & Lockhart, 1972; Lockhart & Craik, 1990).

Effects of attentional focus on memory accuracy

One surprising and interesting effect of the peripheral focus instruction was to increase participants' memory accuracy for the knobs checked, as well as for other central items and peripheral items. One possible reason why the peripheral focus group exhibited greater memory accuracy for central items is that when attending to central details, the peripheral focus group may have had fewer involuntary rest pauses (IRPs) than the central focus group. An IRP is defined as a pause in performance (or in this case a lapse in attention) which is hypothesized to occur in order to dissipate reactive inhibition during a 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 focus on peripheral details served as a forced rest pause, thereby reducing the likelihood of an IRP during central focus. This hypothesis is consistent with findings that adding a secondary vigilance task results in improvements in a primary task (Bakan, 1959). Thus memory for central detail may have improved in the peripheral focus condition because of a decreased need for IRPs.

The benefits of peripheral focus appear to apply to both high checkers and low checkers, at least with respect to memory accuracy for the knobs checked. In fact, peripheral focus instructions appeared to have a larger effect on high checkers than low checkers. In the peripheral condition, high checkers exhibited a more accurate memory for other central items compared to high checkers in the central condition, and to low checkers in both conditions. Peripheral focus instructions may have led participants to focus on *details* around the room, instead of the overall *context* of the room. 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. Focusing on the specific details may have improved recall for these details (including which knobs they checked), rather than increasing perceptual salience of the checking event. Our instructions may have actually encouraged high checkers to use ineffective encoding strategies they already employ (e.g., focusing on individual details in the room) rather than encouraging them to focus on the *context* of checking as an integrated whole. While the peripheral encoding strategy may have improved memory for the knobs checked, it may not have had any impact on metamemory as it did not increase the distinctiveness of each check.

Differences between high and low checkers before repeated checking

Following a single check (but not repeated checks), high checkers exhibited greater memory accuracy for the knobs checked than low checkers, even after controlling for symptoms of depression. This memory bias is consistent with other studies that demonstrate an explicit memory bias in OCD for threat-relevant information (e.g., checking to make sure the stove is off) under ecologically valid conditions (Radomsky & Rachman, 1999; Radomsky et al., 2001). One possible reason for why such biases are not consistently detected is that repeated checking perhaps degrades the quality of recall, thereby masking memory biases that may initially be present.

Additionally, consistent with Rachman’s (2002) model of compulsive checking, high checkers tended to report lower memory confidence prior to repeated checking compared to low checkers (although this difference was not apparent after controlling for depression). It may be that an initial distrust in memory is what motivates individuals to begin to check repeatedly. The fact that differences between high and low checkers in memory confidence disappeared after repeated checking suggests that checkers and non-checkers are both influenced by decreases in vividness and detail that result from repeated checking. Future research should investigate the factors that contribute to the initial distrust in memory observed in high checkers.

Changes in memory confidence and accuracy following repeated checking

Although we did not systematically examine changes in memory accuracy and confidence from a single check to repeated checks, because the focus manipulation occurred in between the single check and the repeated checking trials, an examination of the differences between means of memory accuracy and confidence for the burners checked suggests that both memory confidence and memory accuracy declined. This is consistent with previous work demonstrating that repeated checking leads to distrust in memory (Coles et al., 2006; Van den Hout & Kindt, 2003a, 2003b, 2004; Radomsky et al., 2006). However, the decline in memory *accuracy* for the knobs checked is inconsistent with findings by Van den Hout and Kindt (2003a, 2003b, 2004), but consistent with results from Radomsky et al. (2006), and Coles et al., (2006), and supports the idea that repeated checking may reduce the salience of encoded threat-relevant information, and subsequent recall of these events.

Findings from this study support Radomsky and colleague's assertion that declines in memory accuracy following repeated checking may be observed only under more ecologically valid conditions. Additional possible explanations for memory accuracy reductions could include: participants performed 30 checks, rather than 20 checks as in previous studies; participants were asked to use an attentional strategy while checking; and, participants were asked to recall not only which knobs they checked but also in which order they were checked.

Summary and Implications

Although there are some limitations that warrant mention, one important strength of this study is that it is consistent with a recent call for studies using ecologically valid research protocols to investigate memory and related phenomena in association with OCD (Radomsky & Rachman, 2004). In an attempt to maintain the integrity of testing, this paradigm required the standardization of the checking task which may have reduced the ecological validity to some extent. Nevertheless, this task is of greater ecological validity than previous experiments on memory and metamemory in OCD that utilized paradigms such as neuropsychological tests (Rubenstein, et al., 1993; Sher, et al., 1983, 1984, 1989; Tallis, et al., 1999).

To date, several studies have successfully used this protocol in a non-clinical population to examine the effects of repeated checking (Coles et al., in press; Radomsky et al., in press; Van den Hout & Kindt, 2003a, 2003b, 2004). There is now a need to establish the utility of this paradigm in a clinical sample. Our results from an analogue sample of high checkers suggest that this paradigm may be useful in a clinical sample. The mean VOCI checking subscale score of the high checking group fell just below that of compulsive checkers in the initial validation of the VOCI (Thordarson et al., 2004), suggesting that our sample of high checkers falls in the non-clinical range. While OCD symptomatology likely exists along a continuum (Rachman & de Silva, 1978; Gibbs, 1996), it may be that people who engage in more pronounced compulsive checking would have been more strongly influenced by our manipulation. We did not include a "no attention" group in our design, so it may be difficult to conclude from this study what effect repeated checking has on memory and metamemory without manipulating attention. However, several previous studies have clearly demonstrated that repeated checking does lead to decrements in memory confidence, and in some cases also to declines in memory accuracy (Coles et al., in press; Radomsky et al., in press; Van den Hout & Kindt, 2003a, 2003b, 2004).

There are several important implications of this study. First, results speak against the hypothesis that compulsive checking is associated with memory deficits. These findings add to the mounting evidence suggesting that people with OCD may be more accurate in recalling personally relevant, anxiety provoking information (Ceschi et al., 2003; Constans, et al., 1995; Radomsky & Rachman, 1999; Radomsky et al., 2001; Tolin, et al., 2001; Wilhelm, et al., 1996). Results of the current study further suggest that the act of repeated checking may reduce our ability to detect these biases.

This is one of the first attempts to examine how attention influences memory and metamemory in repeated checking in an ecologically valid experimental paradigm. Although we were unsuccessful in attenuating decrements in memory confidence for the knobs last checked, our instructions to attend to one's actions and details around the room did increase memory confidence for items around the room, and more interestingly improved memory accuracy overall. Future research should examine if increasing encoding of the *context* of a specific checking event, rather than the encoding of *details* present during checking, will increase the distinctiveness and richness of memory, and subsequently have a greater impact on memory confidence than our peripheral focus instructions.

Finally, this study demonstrated in an analog sample that high checkers are influenced by repeated checking in the same way as a normative sample. That is participants, including high and low checkers, responded to repeated checking with decreased confidence in and accuracy of memory. Furthermore, increasing the scope of attentional focus by attending to one's surroundings as well as to one's actions appears to improve memory accuracy in both groups. This knowledge may help clinicians to develop cognitive-behavioral interventions that demonstrate to compulsive checkers the effects that repeated checking have on memory accuracy and confidence, and the effects that shifting attentional focus can have on memory accuracy. It is hoped that continued advancements in our understanding of the complex interrelationships between OCD, memory, attention and metamemory will help to improve our ability to provide psychoeducation about cognition, and cognition-based behavioral interventions for OCD.

Author Notes:

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Table 1.

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* = 54	*n* = 52	*n* = 106	*N* = 134
VOCI [a] Total	55.36_{+}	58.29_{+}	56.82_{+}	17.56_{o}	17.70_{o}	17.62_{o}	25.81
	(31.44)	(29.50)	(29.95)	(15.80)	(14.19)	(14.96)	(24.79)
VOCI Checking	9.43_{+}	8.57_{+}	9.00_{+}	0.29_{o}	0.42_{o}	0.36_{o}	2.16
	(6.26)	(5.54)	(5.82)	(0.65)	(0.70)	(0.65)	(4.43)
BAI [b]	13.71_{+}	16.14_{+}	14.93_{+}	6.98_{o}	7.17_{o}	7.08_{o}	8.71
	(10.30)	(11.05)	(10.56)	(6.54)	(7.28)	(6.88)	(8.38)
BDI-II [c]	16.64_{+}	17.00_{+}	15.82_{+}	9.15_{o}	7.54_{o}	8.36_{o}	9.92
	(8.86)	(12.28)	(10.58)	(8.99)	(5.71)	(7.57)	(8.79)

[a] VOCI refers to the Vancouver Obsessional Compulsive Inventory (Thordarson, et al., 2004).

[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.

Means with differing subscripts are significantly different at $p < .05$.

Table 2.

Mean (SD) memory accuracy and metamemory following single and repeated checking trials.

		Peripheral Condition		Central Condition	
		High Checkers	Low Checkers	High Checkers	Low Checkers
Single Check	Memory Accuracy for the Knobs	96.43_{+}	69.44_{o}	78.57_{+}	71.15_{o}
		(13.36)	(45.99)	(42.58)	(45.75)
	Memory Confidence for the Knobs	88.21_{+}	96.38_{o}	93.18_{+}	93.50_{o}
		(11.33)	(8.15)	(8.92)	(12.14)
Repeated Check	Memory Accuracy for the Knobs	67.86_{+}	41.67_{o}	32.14_{o}	34.62_{o}
		(42.09)	(43.16)	(42.09)	(41.47)
	Memory Confidence for the Knobs	35.71_{+}	33.37_{+}	48.64_{+}	40.34_{+}
		(38.02)	(30.30)	(31.47)	(30.73)
	Memory Accuracy for Other Central items	88.09_{+}	77.78_{o}	66.67_{o}	78.21_{o}
		(21.11)	(21.48)	(29.24)	(20.75)
	Memory Confidence for Other Central Items	87.26_{+}	85.26_{+}	74.79_{o}	82.96_{o}

	(9.82)	(13.03)	(23.18)	(16.78)
Memory Accuracy for Peripheral Items	57.14_{+}	68.51_{+}	37.14_{o}	36.08_{o}
	(23.35)	(24.14)	(24.63)	(20.79)
Memory Confidence for Peripheral Items	73.91_{+}	72.07_{+}	45.09_{o}	51.28_{o}
	(13.82)	(16.96)	(26.11)	(22.51)

Means with differing subscripts in each row differ at $p < .05$.

Appendix

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