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Don't even *think* about checking: Mental checking causes memory distrust

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Abstract

Compulsive checking occurs in both physical and mental forms and is a common symptom of obsessive-compulsive disorder (OCD). Though there has been much recent attention devoted to research on physical checking, *mental checking* has been largely neglected. Previous research has reliably found that repeated physical checking reduces memory confidence, vividness and detail, while memory accuracy remains relatively unaffected. The current study examined memory accuracy and meta-memory in (n = 62) undergraduate students for both physical and mental checks after repeated physical or mental checking of a stove. We hypothesized that repeated physical checking would lead to reductions in meta-memory for previous physical checks and that repeated mental checking would lead to reductions in meta-memory for previous mental checks. Results were consistent with hypotheses, in that checking in each modality led to significant decreases in all meta-memory variables for that modality but not the other. Results also showed that checking in each modality led to slight but significant declines in memory accuracy for that modality. Findings are discussed in terms of cognitive-behavioural models of and treatments for compulsive checking in OCD.

Keywords: compulsive checking; memory; confidence; OCD; mental compulsions; metamemory

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Checking is one of the most common compulsions in obsessive-compulsive disorder (OCD), as 75% of those diagnosed with the disorder report checking or washing behaviour as their primary compulsion (Ball, Baer, & Otto, 1996; Rachman & Hodgson, 1980). Although checking behaviour itself is quite normative (Muris, Merckelbach, & Clavan, 1997), when the time spent checking becomes excessive, it often leads to significant distress and interference with daily living (APA, 2000). Checking behaviour takes many forms, including physical checking (e.g., the object or situation is physically manipulated in order to determine its safety), visual checking (e.g., going back to *look* at the object and verifying that it is how one left it and/or how one might like it to be), reassurance seeking (e.g., "You saw me turn off the light, right?"), and mental checking (e.g., reviewing and/or evaluating the memory of a previous check in one's mind to assess/determine whether or not it was carried out correctly; comparing the memory of a completed check to an imagined ideal check to assess/determine whether or not it meets a desired standard; etc.). Though all of the above forms of checking are prevalent in OCD, investigations of checking have almost exclusively centred on physical checking.

Although a range of effective psychological treatments exists for compulsive checking in OCD, such as cognitive-behavioural therapy (CBT), including approaches with a behavioural emphasis such as exposure and response prevention (ERP), and those with more of a cognitive emphasis (Radomsky, Shafran, Coughtrey & Rachman, *in press*; Wilhelm & Steketee, 2006), they still leave a substantial proportion of people unwell. A study comparing the efficacy of pharmacotherapy to ERP found that although ERP was more efficacious than pharmacotherapy, and the combination of the two was the best treatment, 30% of patients still did not respond to treatment (Foa et al., 2005). Newer research showed that combining ERP and pharmacotherapy was effective at reducing symptoms, but not to a clinically significant level (Simpson et al., 2008). Investigations comparing CBT with ERP have found similar results. While both treatments were similarly efficacious, at post-treatment 33% of patients did not respond to CBT, and 41% of patients did not respond to ERP (Whittal et al., 2004); at a two-year follow-up, 50% of the patients had relapsed (Whittal et al., 2008).

Another possible reason why current psychological treatments may not be performing optimally could be that the models on which they are based are too broad (Rachman, 2002). A recent cognitive model of checking (Rachman, 2002) has been proposed to better explain, and by extension treat, this prevalent compulsion. Rachman proposes three cognitive multipliers which interact to increase and/or initiate checking behaviour: increased responsibility to prevent harm, increased probability of harm occurring, and increased severity of the potential harm. The checking continues thanks to a self-perpetuating mechanism whereby individuals check to become more certain; but in fact, the more individuals check, the less certain they become, and so the need to check is perpetuated (Rachman, 2002). This theory has now gained much empirical support, with a number of studies showing that the self-perpetuating mechanism does seem to operate as proposed (van den Hout & Kindt, 2003a; 2003b; 2004; Radomsky, Gilchrist, & Dussault, 2006; Coles, Radomsky, & Horng, 2006). As such, it would seem that low memory *confidence*, rather than a memory deficit, is the key feature in this mechanism. (Some researchers had previously proposed that checking behaviour persists because those diagnosed with OCD have poorer memories, and therefore check because of failures or problems in memory (e.g., Tallis, 1997), but there is now increasing evidence that people with OCD can display superior memory for objects and situations related to their obsessions and compulsions, particularly under ecologically valid conditions (e.g., Radomsky & Rachman, 1999; Radomsky, Rachman, & Hammond, 2001; Coles & Heimberg, 2002).)

van den Hout and Kindt (2003a) asked a group of undergraduate students to repeatedly check a virtual stove on a computer, while another group engaged in repeated irrelevant checking of a virtual light bulb. Both before and after the series of repeated checks, there was a single virtual stove checking trial. Results showed that those participants who engaged in repeated relevant checking had significantly decreased memory confidence, vividness and detail for the last check (as compared to the pre-test meta-memory scores), whereas those participants who engaged in repeated irrelevant checking showed no significant decreases in any of these variables. Actual memory accuracy remained intact in both groups. These findings suggest that even nonclinical participants can be made to doubt their memory, simply by asking them to engage in repeated checking behaviour. It is therefore reasonable to conclude that people with OCD do not have memory impairments, although they may perceive them as such because as checking increases, trust in memory decreases.

Repeated checking of *real* objects also leads to significant decreases in memory confidence (along with the other above-mentioned meta-memory variables) in undergraduate students (Radomsky et al., 2006). Using an experimental design similar to that of van den Hout and Kindt (2003), participants repeatedly turned on, off, and checked either a real working stove (relevant checking), or a real kitchen faucet (irrelevant checking). Before and after the repeated checking, participants completed one individual check of the stove. Results were consistent with previous research using a virtual stove (e.g., van den Hout & Kindt, 2003a, b), as participants who engaged in repeated relevant checking had decreased memory confidence when compared to those who engaged in repeated irrelevant checking (Radomsky et al., 2006).

Thus it would seem that *meta*-memory (memory confidence, vividness, and detail) decreases as a result of repeated checking, and may do so a result of memory shifting away from a distinct ‘remembering’, towards a more general ‘knowing’ that the event took place (Tulving, 1985; van den Hout & Kindt, 2003b).

Unfortunately, research to date has focused solely on physical checking, which is only one modality in which checking behaviour can manifest. To the best of our knowledge, there have been no previous investigations of mental checking, a form of checking which according to anecdotal reports is both frequent and distressing. Elucidating the potential detrimental effects of this mental compulsion could help further refine theory and treatment of checking behaviour. Therefore the present study aims to determine the meta-cognitive consequences of repeated mental checking. Does mental checking cause memory distrust? Does it have the same effect(s) on meta-memory as does physical checking? It was hypothesized that repeated physical checking would cause memory distrust (low confidence, but also low vividness and detail) for physical checks. Similarly, it was hypothesized that repeated mental checking would cause memory distrust (low confidence, but also low vividness and detail) for mental checks. It was unclear what effects (if any) would occur across modalities on checking in the opposite modality, so this was also examined to see if repeated physical checking would have detrimental effects on meta-memory for mental checks, and vice versa.

Methods

Participants

Participants were 53 female (85.5%) and 9 male (14.5%) undergraduate students (mean age=24.65, SD=5.97; range=18 to 49 years). Results from the BAI, BDI-II, VOCI, and the VOCI checking subscale measures (see below for descriptions of these) revealed means for both groups that were all well below clinical norms, confirming that we had recruited a sample which was non-clinical in nature (Beck & Steer, 1990; Beck, Steer, & Brown, 1996; Thordarson et al., 2004).

Measures

Participants completed a questionnaire package (see measures below) to assess for the potential influence of between group differences, in case random assignment did not lead to homogenous groups.

The Beck Anxiety Inventory (BAI; Beck & Steer, 1990) is a 21-item self-report questionnaire that assesses symptoms of anxiety. It has excellent internal consistency (Cronbach's $\alpha = 0.92$) and test retest reliability ($r = .75$) as well as good discriminant and convergent validity in a clinical sample (Beck et al., 1988). In a non-clinical sample it has excellent internal consistency with a Cronbach's α of 0.90 and good convergent validity (Osman, Kopper, et al., 1997). In a student sample, the BAI exhibited high internal consistency (Cronbach's $\alpha = 0.90$) and displayed good discriminant validity, but it had a lower test-retest correlation ($r = 0.62$), and its construct validity when compared to the STAI was only moderate (r's = 0.54 - 0.68; Creamer, Foran, & Bell, 1997).

The Beck Depression Inventory II (BDI-II; Beck, Steer, & Garbin, 1996) is 21-item self-report measure that assesses symptoms of depression and suicidality. It has excellent internal consistency, (Cronbach's $\alpha = 0.91$), and high convergent validity, as it correlates strongly with the original BDI with an r of 0.93 (Dozois, Dobson, & Ahnberg, 1998). In a student sample, the BDI-II exhibited high reliability ($\alpha = 0.90$) and high convergent and construct validity (Osman, Downs, et al., 1997).

The Vancouver Obessional Compulsive Inventory (VOCI; Thordarson et al., 2004) is a 55-item self-report questionnaire that measures agreement with symptoms of OCD across a broad range of obsessions, behaviours, and personality characteristics known to be associated with the disorder using a 0 (not at all) to 4 (very much) point Likert scale. The scale has six factors: contamination, checking, obsessions, hoarding, just right, and indecisiveness. The total scale and subscales all have good internal consistency, with alpha levels ranging from 0.79 to 0.98 (Thordarson et al., 2004). The measure also has good convergent and discriminant validity (Thordarson, et al., 2004; Radomsky et al., 2006). In a student sample it had excellent test-retest reliability (r = 0.91; Radomsky et al., 2006) and good internal consistency (r = 0.96), and it correlated highly with another measure of OCD, the Maudsley Obsessional Compulsive Inventory (Hodgson & Rachman, 1977; r = 0.64) and only moderately with measures of other psychopathology, suggesting good convergent/discriminant validity (Thordardson et al., 2004).

Meta-Memory and Memory. Participants provided ratings regarding a number of meta-memory domains (memory confidence, “How would you rate your confidence in your overall answers to the previous question [which three knobs did you check on the last trial?]”; memory vividness, “How vivid (for example, the clarity and the intensity) was your memory of the check?”; and detail, “How detailed (for example, the particular visual features) was your memory of the check?”) for the pre- and post-repeated checking trials using a Subjective Units of Distress (SUDS)-like 100-point rating scale, where 0 meant ‘not at all’ and 100 meant ‘extremely’.

Memory accuracy was recorded as *percent correct*, and was assessed via participants’ answers to the question, “Which three knobs did you check on the last trial?”.

Procedure

Participants were tested individually in a fully functioning laboratory kitchen.

Training Phase: In order to give participants 'mental material' for mental checks (see below), they were first taught to *physically* check the laboratory stove in a standardized ritualized manner. This involved participants being asked to turn on, off, and check all six knobs on the electric stove (during actual physical and mental trials they were only asked to manipulate three of the six knobs at a time; for a full description of this protocol, please see Radomsky et al., 2006).

Then participants were taught to *mentally* check the laboratory stove, also in a ritualized manner. They were told the following:

> "A *mental check* involves all of the same elements as a physical check, but instead of doing it, a mental action involves *imagining* yourself doing it. The check occurs only in your mind (no pointing and no gesturing). More precisely, I would like you to imagine your hand manipulating the knobs, just like you would see yourself doing so in a real physical check. Therefore, for each instruction that will be given to you, you will need to develop a clear and vivid image for each of the elements involved in your check. Subsequently, I will ask you to use your memory from the training and VIVIDLY IMAGINE yourself turning on, off, and then checking the stove."

During all mental checking practices and trials, participants sat in a chair in the laboratory kitchen facing away from the stove and towards the experimenter, in the same environment that was used for the physical checks. Participants were asked to close their eyes during all mental checks.

Pre-trials checks: Participants completed one pre-trials physical check and one pre-trials mental check of the stove. These two checks were counterbalanced such that half of the participants completed a pre-trial physical check first followed by a pre-trial mental check, and half of the participants completed a pre-trial mental check first followed by a pre-trial physical check. After each pre-trials check, participants were asked to indicate which knobs were checked last and to rate their confidence, vividness, and detail of their memory for the most recent check (on a scale of 0-100, see above).

Repeated checking trials: At this point participants were randomly assigned to the either the repeated physical checking condition (RPC) or the repeated mental checking condition (RMC). All participants completed 10 checking trials in a row, but for half of the participants these trials were physical checks; whereas the remaining half of the participants completed repeated trials of mental checks.

Post-trials checks: Following the repeated checking trials, all participants completed one post-trials physical check and one post-trials mental check. Those in the RMC condition completed one post-trials mental check first, and then one post-trials physical check, while those in the RPC completed one post-trials physical check first, followed by a post-trials mental check. Following each post-trials check, participants were asked to indicate which knobs were checked last and to rate their confidence, vividness, and detail of their memory for the most recent (post-trials) check (on a scale of 0-100, see above).

Finally, all participants completed a questionnaire package consisting of the measures listed above.

Results

The questionnaire data revealed no significant between-group differences (all p's $>.05$). Therefore there was no need to consider the questionnaire-based variables as covariates in subsequent analyses. Groups also did not differ significantly on the age or sex of participants.

Meta-memory: Meta-memory scores pre- and post-checking in RPC and RMC conditions are reported in Table 1. A 2 x 2 repeated measures MANOVA on meta-memory variables (memory confidence, vividness, and detail) scores for physical checks revealed a significant interaction between group and time, $F(1, 58) = 12.47$, $p < .001$, partial $\eta^2 = .39$, such that those who repeatedly physically checked had lower meta-memory for the last physical check than those who had repeatedly mentally checked. The reverse was true for a similar MANOVA conducted on meta-memory for mental checks, showing a significant interaction between group and time, $F(1,58) = 12.15$, $p < .001$, partial $\eta^2 = .39$, such that those who repeatedly mentally checked had lower metamemory for the last mental check than those who had repeatedly physically checked. Follow-up ANOVAs (controlling for unequal variance where necessary) revealed that mean levels of each of memory confidence, vividness, and detail were not significantly different between the two groups (i.e., RPC & RMC) *pre*-repeated checking (all *p*'s > 0.5), but were each significantly different between the groups *post*-repeated checking (all *p*'s < 0.05). These differences between the groups post-repeated checking are explained below.

Memory confidence for *physical checks* was significantly lower following RPC compared to memory confidence for physical checks post-RMC, $t(60) = -6.29$, $p < .001$, partial $\eta^2 = .40$ (see Figure 1a), while memory confidence for *mental checks* was significantly lower following RMC compared to memory confidence for mental checks post-RPC, $t(60) = 5.66$, $p < .001$, partial $\eta^2 = .35$ (see Figure 1b). The patterns of findings observed for memory vividness and detail were highly similar to those for memory confidence. Memory vividness for *physical checks* was lower post-RPC than it was post-RMC, $t(60) = -3.75$, $p < .001$, partial $\eta^2 = .19$, while memory vividness for *mental checks* post-RMC was significantly lower than memory vividness for mental checks following RPC, $t(60) = 2.66$, $p < .05$, partial $\eta^2 = .11$. Memory detail for *physical checks* was significantly lower post-RPC than was memory detail for physical checks post-RMC, $t(60) = -2.95$, $p < .01$, partial $\eta^2 = .13$, while memory detail for *mental checks* was significantly lower post-RMC than was memory detail for mental checks post-RPC, $t(60) = 2.29$, $p < .05$, partial $\eta^2 = .08$.

Memory Accuracy: Memory accuracy means pre- and post-repeated checking are displayed in Table 1. A 2 x 2 repeated measures ANOVA with memory accuracy for physical checks as the dependent variable, and group (i.e., RPC or RMC) as the independent variable, calculated over time (pre and post repeated checking) revealed a significant interaction such that repeated physical checking impaired memory accuracy for physical checks slightly yet significantly, but repeated mental checking did not have any detrimental effects on memory accuracy for physical checks, $F(1, 60) = 4.45$, $p = .039$, partial $\eta^2 = .07$ (see Figure 2a). The reverse was true for a 2 x 2 repeated measures ANOVA concerning memory accuracy for mental checks, revealing a significant interaction such that repeated mental checking slightly but significantly impaired memory accuracy for mental checks, but repeated physical checking did not negatively affect memory accuracy for mental checks, $F(1, 60) = 12.02$, $p = .001$, partial $\eta^2 = .17$ (see Figure 2b).

Discussion

Consistent with previous research and with our hypotheses, repeated *physical* checking did cause memory distrust (low memory confidence, but also low vividness and detail in memory) for physical checks. Repeated *mental* checking had similar effects. It caused memory distrust, including low confidence, vividness, and detail for mental checks. Interestingly, these decrements in meta-memory were modality-specific; i.e., repeated physical checking did not affect meta-memory for mental checking, and repeated mental checking did not affect meatmemory for physical checking. This double dissociation is consistent with previous work on physical checking (van den Hout & Kindt, 2003a; 2003b; 2004, Radomsky et al., 2006) which also found that repeated physical checking reduced memory confidence, vividness, and detail for physical checks. Our results also support Rachman's theory (2002) of reduced memory confidence contributing to the self-perpetuating mechanism of repeated checking, as repeated checking itself caused reduced memory confidence. More importantly, these findings expand on previous work by demonstrating that repeated mental checking has the same deleterious effects on meta-memory that repeated physical checking has.

An emerging area of inconsistency however concerns memory accuracy following repeated checking. In the current experiment, repeated physical checking caused slight but significant decreases in memory accuracy for physical but not for mental checks. Repeated mental checking caused slight but significant decreases in memory accuracy for mental but not for physical checks. These results do not replicate initial findings that memory accuracy was not affected by repeated checking (van de Hout & Kindt, 2003a; 2003b; 2004); however they are consistent with later work completed in ecologically valid settings (Ashbaugh & Radomsky, 2007; Coles et al., 2006; Radomsky et al., 2006). A typical traditional assessment of memory accuracy however (e.g., "Which three knobs did you check on the last trial?") fails to accommodate the possible effects of severely reduced memory confidence, vividness and detail on memory accuracy. It is entirely possible that those participants who experienced very poor meta-memory had the 'correct' knobs in mind, but indicated others in their place because of extreme doubt. In this case, one would expect that decrements in memory accuracy will be mediated by declines in meta-memory variables. This is of course an empirical question, and the current study was neither designed nor powered to address it. Future investigations into memory accuracy following repeated checking may well benefit from an exploration of the nature of the relationship between memory accuracy and meta-memory.

Of course the current study contains some limitations worth addressing. First, only one type of mental checking was taught to participants (“check in your mind”). Though this is consistent with patient reports of a particular manifestation of mental checking it is likely that other forms of mental checking behaviour (e.g., remembering a previous check, assessing the memory of a previous check, etc.) could have differential effects on memory and meta-memory for the mental check. Another potential problem is that we have no way to verify that the participants really did check mentally in the way that was prescribed. It is impossible to know what they were doing in their minds, or if all participants were mentally checking in exactly the same way. However, though all participants were asked to engage in at least some mental checking (at training, pre- and post-trials at the least), results are consistent with hypotheses based on participant engagement and compliance with the study protocols. Future experiments may benefit from a protocol which perhaps employs a more rigid, and possibly observable form of mental checking. Finally, the current study did not have a control condition in which participants repeatedly (physically or mentally) checked a sink, for example, as has often been employed in previous checking research (e.g., Radomsky et al., 2006). Thus, we cannot rule out the possibility that, rather than the mental checking itself causing declines in meta-memory variables, it could very well have been a more general effect of thinking or enhanced cognitive load. Another potential confound could lie in the domain of demand characteristics. However, this is not likely to have influenced our findings, since the second experimental group served as a control for this purpose (if demand characteristics were playing a role, we would expect meta-memory would have decreased for all modalities, across all conditions, instead of being relatively specific).

Why does repeated checking cause declines in meta-memory? It seems intuitive that the more familiar and rote a task becomes, the less effort it requires, and less attention is paid to it. van den Hout and Kindt (2004) have proposed that decreases in memory confidence for physical checking occur as a function of the decreased encoding of perceptual details as checking recurs, since without encoding there can be no elaboration in memory (see Craik & Lockhart, 1972; Lockhart & Craik, 1990). Given the results of the current study, a similar process seems likely to be responsible for the decreases in memory confidence (and other meta-memory variables) following repeated mental checking. The more one reviews the mental check in ones' mind, the fewer details are encoded. Though the 'details' to be encoded during mental checking may be more visual in nature compared to those in physical checking, we do maintain mental representations of touch (Gottfried & Rose, 1980), sound (e.g., Crowder, 1982) and smell (Dade, Zatorre, & Jones-Gotman, 2002) to name a few, and these may well feature in mental checking, just as they can in physical checking. In addition, previous work on checking (van den Hout & Kindt, 2004; Radomsky et al., 2006) found that the more one checks, the more the reliance on memory changes from specifically 'remembering' to more of a feeling of 'knowing'. Perhaps the same mechanism is at work in mental checking.

Though the current experiment showed no cross-over effects (that is, RMC did not produces memory or meta-memory declines for physical checking and RPC did not produce such declines for mental checking), future work in this area may benefit from specific examination of the effects of RMC on subsequent urges to physically check (and, by extension, of RPC on subsequent urges to mentally check), as it is entirely possible that repeated checking of any type could lead to the amplification of subsequent urges to check across modalities. Further, examinations of the interplay between physical checking, mental checking, visual checking and other forms of checking behaviour may well prove to be most valuable in understanding the complexity underlying different approaches to verification, particularly in a threat- and/or responsibility-related context.

Recent work on staring (a common component and/or manifestation of visual checking) has shown that perseverative staring not only affects retrospective memory, but can also affect perception in the moment. Just as perseverative checking causes memory distrust, perseverative staring causes perception distrust (van den Hout et al., 2008). Forty undergraduates stared at a stove or a light for 10 minutes. Pre- and post-staring they were asked about how certain they were about the same object (experimental condition) or the opposite object (control condition). In both groups, perseverative staring caused perception uncertainty. The effect was stronger in the experimental group, where they stared at the same object they were later asked about (van den Hout et al., 2008). A replication of this study using much more clinically realistic staring intervals (5 to 300 seconds) found that perceptual distrust can manifest in as little at 7.5 seconds of staring (van den Hout et al., 2009). Perseverative checking causes distrust in the memory of having checked, just as perseverative staring causes distrust in the image one is seeing (van den Hout et al., 2008; 2009).

Research on reassurance seeking in OCD suggests that it is functionally similar to checking behaviour (Parrish & Radomsky, *in press*). Though early investigations did not show that the repeated provision of reassurance led to decreases in memory confidence or increases in urges to check or seek additional reassurance (Parrish & Radomsky, 2006), future work in this area may seek to examine the cognitive and meta-cognitive consequences of repeated reassurance seeking behaviour.

The clear implication of this work is that even *thoughts* about checking can be harmful, as they reduce memory confidence and therefore perpetuate the debilitating checking cycle. Importantly, clinicians should ask their patients/clients about mental checking, and this behaviour should be specifically targeted in CBT interventions through response prevention and/or behavioural experiments about the consequences of repeated mental checking. This is particularly important as we suspect that the assessment of *mental* checking in the context of an intake interview or early evaluation of someone presenting with OCD concerns is more often absent than present. Continued research into the effects of various types of mental checking on meta-memory and memory could reveal additional important implications for theory, research and treatment of both overt and covert OCD checking behaviour. This may prove to be a useful step in increasing our depth of understanding of how repeated checking behaviour begins and how it can be stopped or prevented.

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Table 1

Mean group scores on memory accuracy (%) and meta-memory (confidence, vividness, and detail; 0-100 ratings) for physical and mental checks pre and post repeated checking

	Physical Checks				Mental Checks			
	Pre RC		Post RC		Pre RC		Post RC	
	RMC	RPC	RMC	RPC	RMC	RPC	RMC	RPC
Confidence	84.58	89.52	90.81*	54.87*	81.45	79.90	41.06*	83.81*
Vividness	73.90	82.65	79.61*	55.39*	76.29	77.55	62.58*	78.26*
Detail	68.26	77.65	75.84*	54.84*	70.32	71.58	58.39*	73.35*
Accuracy	96.00	98.90	98.90*	91.29*	95.61	92.32	82.61*	98.90*

Note. Asterisks indicate significant differences (all *p*'s <.05) between the Repeated Mental Checking (RPM) group & the Repeated Physical Checking (RPC) group.

Figure Captions

Figure 1: Average memory confidence ratings (%) for physical and mental checks by group, pre and post repeated checking. $*p < .001$.

Figure 2: Average memory accuracy (%) for physical and mental checks by group, pre and post repeated checking. $*p < .05$; $**p < .001$.

Figure 1

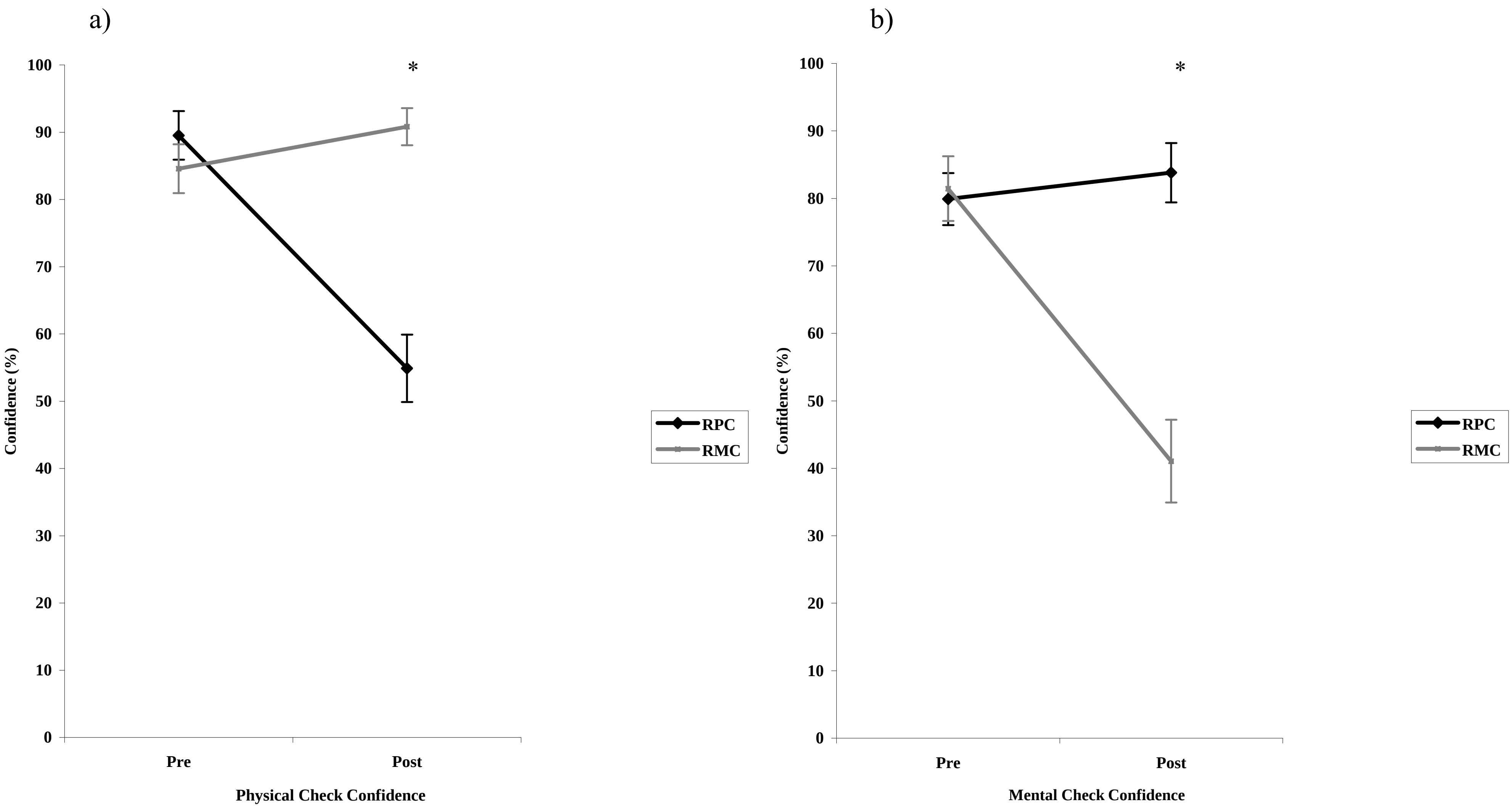
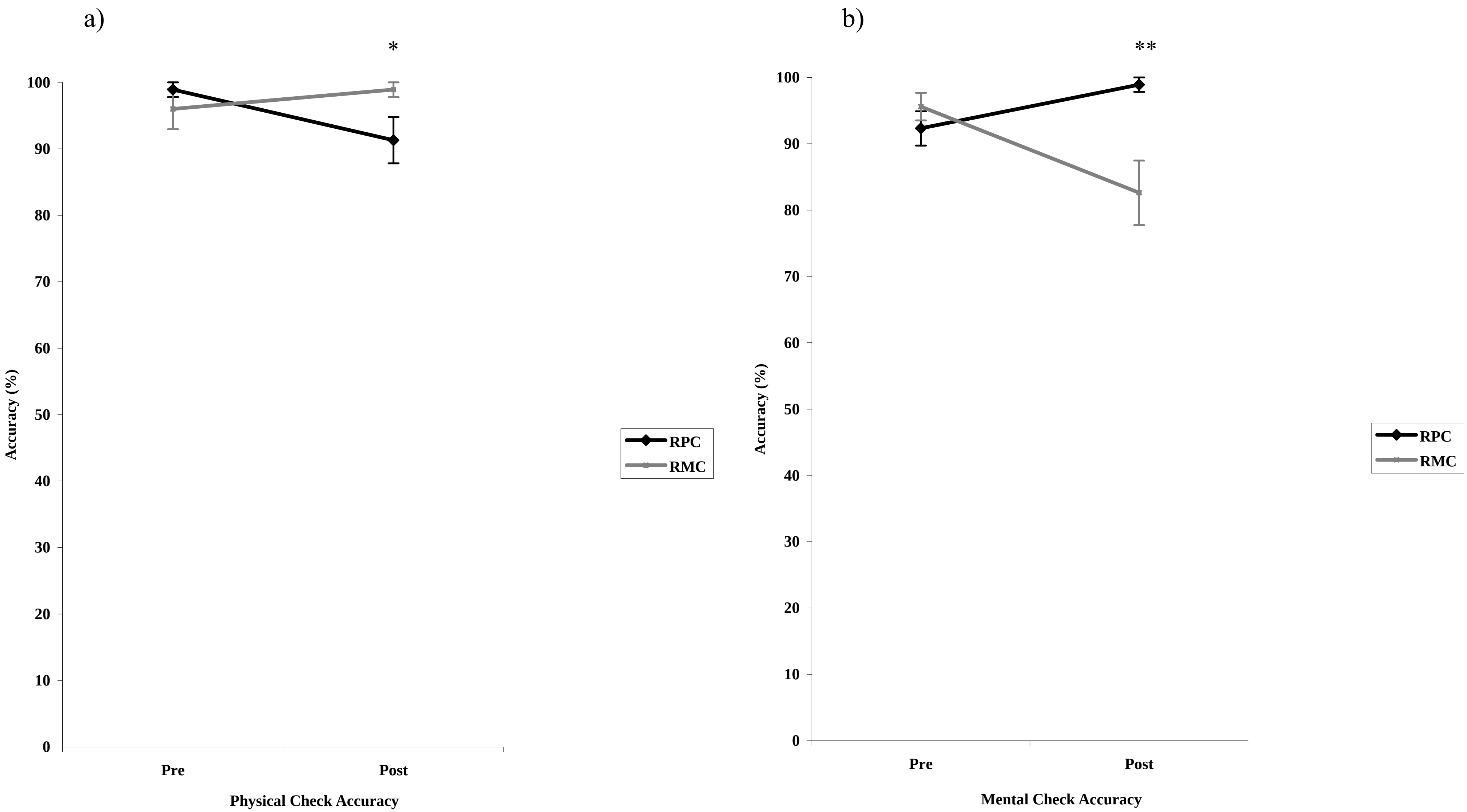

a)
100
90
80
70
60
50
40
30
20
10
0
Confidence (%)
*
Pre
Post
Physical Check Confidence
RPC
RMC
b)
100
90
80
70
60
50
40
30
20
10
0
Confidence (%)
*
Pre
Post
Mental Check Confidence
RPC
RMC

Figure 2


a)
*
100
90
80
70
60
50
40
30
20
10
0
Accuracy (%)
Pre
Post
Physical Check Accuracy
RPC
RMC
b)
**
100
90
80
70
60
50
40
30
20
10
0
Accuracy (%)
Pre
Post
Mental Check Accuracy
RPC
RMC