Sub-Clinical Obsessive-Compulsive Checkers' Prospective Memory is Impaired

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Abstract

We explored whether prospective memory task performance is impaired in sub-clinical obsessive-compulsive checkers. Participants were 126 undergraduate students who were divided into three groups: High, medium, low checkers. Participants completed two objective tests of their episodic prospective memory, one event- and one time-cued, as well as two questionnaires that measured their subjective prospective memory. The results indicated that medium and high checkers performed worse than low checkers on the objective event-cued prospective memory task but that the three groups performed similarly on the objective time-cued prospective memory task. Moreover, high checkers reported experiencing every type of prospective memory failure measured by the questionnaires more frequently than either the medium or the low checkers. We suggest that individuals with obsessive-compulsive checking tendencies have an impaired prospective memory that causes them to have more experiences with prospective memory failures and that their increased experience with these failures causes their intrusive obsessions.
1. Introduction

Obsessive-Compulsive Disorder is an anxiety disorder that is characterized by obsessions and compulsions. Obsessions are intrusive and persistent ruminations or impulses that cause anxiety (Rachman & Shafran, 1998), which is temporarily relieved by the execution of compulsions, repetitive behaviors or mental acts such as washing, counting or checking (Rachman & Shafran, 1998). There are several different types of compulsions, the two most common being washing and checking (Jenike, Baer, & Minichiello, 1990). Our present focus is on the latter. Individuals with checking compulsions become obsessed with the idea that they failed to do something or failed to do something correctly and they feel compelled to check repeatedly to ensure that the task was indeed completed and/or that it was completed properly (Muller & Roberts, 2005; Woods, Vevea, Chambless, & Ute, 2002). For instance, an individual with checking compulsions may have the reoccurring intrusive thought that s/he forgot to lock the front door of her/his home, worry about the consequences of such a failure (e.g. robbery) and then feel compelled to return home to check the door.

Very little is understood about the mechanisms that mediate obsessive-compulsive checking. However, according to one prominent theory the root cause of the checking compulsions is an impairment of memory. This impairment may be real, marked by an objective inability to remember important activities, such as locking the front door, or it may be subjective and expressed primarily as a lack of confidence in the ability to remember (Sher, Frost, & Otto, 1983). Because checkers are either unable to recall performing an activity or because they do not trust their memory for performing the activity, they feel compelled to check.

In a recent comprehensive review, Muller and Roberts (2005) argued that the memory deficit theory of obsessive-compulsive checking receives at best only qualified support from the results of empirical investigations. However, this conclusion conflicts with the outcome of a prior comprehensive meta-analysis of research with both clinical and sub-clinical checkers by Woods and colleagues (2002). Based on the results of their analysis, Woods and colleagues (2002) concluded that checkers have an objectively verifiable impairment in short-term memory as well as in episodic memory. Moreover, they argued that checkers also have a subjective memory impairment, that they lack confidence in their ability to remember (see also Hermans, Martens, De Cort, Pieters, & Eelen, 2003; Macdonald, Antony, Macleod, & Richter, 1997; Tuna, Tekan, & Topcuoglu, 2005).

To our knowledge, this memory deficit theory of obsessive-compulsive checking has never been framed or tested in the domain of prospective memory, defined as the ability to formulate intentions, plans and promises, to retain them, to recollect and carry them out at the appropriate time or in the appropriate context (Einstein & McDaniel, 1996; Graf, 2005; Graf & Uttl, 2001; Meacham & Dumitru, 1976). This ability to formulate and/or remember intentions seems intimately connected with the kinds of everyday tasks that frequently trigger checking compulsions, such as, remembering to turn off the stove or iron after use or to lock the front door upon leaving home. For this reason, the main goal of the present study was to explore the possibility that obsessive-compulsive checkers have a cognitive deficit related to prospective memory.

We suggest three possible ways in which checking compulsions might be related to prospective memory. First, individuals with
checking compulsions may have difficulty de-
activating their intentions after executing
them. Previous research has found that in
normal healthy adults, once a prospective
memory task has been completed, the
memory representations of words related to
that task are inhibited (Marsh, Hicks, & Binks,
1998). In contrast, words related to a task that
someone else (e.g., the experimenter) had to
perform and words that simply needed to be
remembered for a later recall test show no
such inhibition (Marsh, Hicks, & Binks, 1998).
It has been argued that the already-executed-
intention inhibition effect, or the mechanism(s)
that mediates it, is responsible for preventing
us from perseverating on already completed
intentions (Ellis, 1996; Marsh, Hicks, Binks,
1998). By this view, if the inhibition
mechanism fails, a task may remain part of
our 'to-do-list', and thereby contribute to
compulsive checking behaviors.

A second possibility is that individuals
with checking compulsions fail to remember
intentions that they have already executed,
and consequently, they worry about still
needing to execute them. By this view, the
root cause of compulsive checking is a
retrospective memory deficit for prospective
memory tasks, a hypothesis that fits the
traditional memory deficit theory of
compulsive checking behavior (Sher, Frost, &
Otto, 1983), except that it underscores
amnesia for intentions rather than for previous
events and experiences.

The third and final possibility is that
individuals with checking compulsions have
generally poor prospective memory skills,
have a long history of prospective memory
failures, are aware of those failures and
consequently they worry about future failures.
Thus, when the possible consequences of a
failure are serious (e.g., the failure to unplug
the iron after use might cause a fire), the fear
of a future prospective memory failure may
trigger obsessive-compulsive checking
behaviors. Moreover, checking behaviors may
be triggered not only by the fear of objectively
verifiable poor prospective memory task
performance but also by a person’s subjective
lack of confidence in his/her prospective
memory ability. For a person who knows or
believes that his/her prospective memory is
not reliable, checking is a reasonable strategy
for dealing with the impairment. In other
words, we suggest that checking compulsions
are a compensatory response to an objective
and/or subjective impairment in prospective
memory.

The main goal of the present study
was to examine whether or not prospective
memory task performance is impaired in
individuals who are compulsive checkers.
Although we have identified three potentially
different prospective memory deficits related
to obsessive-compulsive checking, our study
focused most directly on the last, the general
possibility that individuals who are compulsive
checkers suffer from an objective and/or a
subjective impairment in prospective memory
task performance.

1.1 Overview of Present Study

Each participant in the present study
completed a set of questionnaires, two
laboratory-based episodic prospective
memory tasks, and a battery of standardized
neuropsychological assessment tests. We
used participants’ questionnaire responses as
a subjective index of (i.e. a measure of
confidence in) their prospective memory
abilities and we used participants’
performance on the two laboratory tasks as
an objective index of their prospective
memory abilities.

The questionnaire set included the
Padua Inventory (Sanavio, 1988), an
instrument that focuses on obsessive-
compulsive behavior, and contains a detailed
subscale for measuring checking behavior. We used participants’ scores on the checking subscale to classify them into one of three groups: High checkers, medium checkers, and low checkers.

The questionnaire set also included two inventories related to prospective memory: The Prospective Memory Questionnaire (PMQ; Hannon, Adams, Harrington, Fries-Dias, & Gibson, 1995) and the Prospective and Retrospective Memory Questionnaire (PRMQ; Smith, Della Sala, Logie, & Maylor, 2000). Each of these questionnaires requires participants to rate the frequency of experiencing various kinds of memory failures. Specifically, the PMQ probes failures connected with episodic prospective memory tasks, with habitual prospective memory tasks, and with internally cued prospective memory tasks. Episodic prospective memory tasks are those where a to-be-performed plan is not in conscious awareness during the retention interval and needs to be executed only once (e.g., making an important phone call after dinner) (Graf, 2005; Kavilashvili & Ellis, 1996; Meacham & Dumitru, 1976). Habitual prospective memory tasks require repeated execution of the same plan (e.g., removing the keys from the car before closing and locking the doors) (Graf & Uttl, 2001; Hannon, Adams, Harrington, Fries-Dias, & Gibson, 1995; Kavilashvili & Ellis, 1996; Meacham & Dumitru, 1976). Internally cued prospective memory tasks are those where no salient external cue is provided for prompting the retrieval of the previously formed plan (e.g., cashing a paycheck before running out of money) (Hannon, Adams, Harrington, Fries-Dias, & Gibson, 1995). The PRMQ probes the frequency of both prospective and retrospective memory failures. We assumed participants’ ratings on the PMQ and the PRMQ would reflect both their perceptions of everyday experiences with prospective memory failures as well as confidence in their memory skills. Consistent with the further assumption that compulsive checking is a response to a subjective impairment in prospective memory related abilities we expected the high checkers’ questionnaire scores to evidence lower confidence.

The assessment battery also included two laboratory-based episodic prospective memory tasks, one event-cued and the other time cued (Einstein & McDaniel, 1990; Graf & Grodin, 2005). For the event-cued task, participants had to request the return of a personal belonging upon the occurrence of a specified spoken cue. For the time-cued task, participants were asked to remind the experimenter to place a phone call in exactly 30 minutes. In connection with these tasks, we also collected self-assessment data, first, by asking participants to rate how confident they felt about succeeding on the event-cued task, and second, by asking them to predict how close they would come (in seconds) to providing the phone-call reminder. For the time-cued task, participants had access to a clock, and we recorded clock-checking responses for an additional index about task-related planning and worrying.

Finally, the assessment battery included several standardized tests for measuring attention, cognitive flexibility and verbal fluency. The primary purpose of these tests was to occupy participants during the retention intervals that were required for the objective episodic prospective memory tasks.

2. Method

2.1 Participants and Design

Sub-clinical checking compulsions are fairly common among otherwise healthy and normal-functioning undergraduate students (Sher, Frost, Otto, 1983), and
compared to patients with clinical checking compulsions students are far more readily accessible and typically free of the comorbid affictions (anxiety, depression) often present in patients. For these reasons, we used undergraduate students for the present study. We proceeded on the assumption that if a study with students shows evidence in support of our modified memory hypothesis, this evidence most likely would be even stronger in individuals with fully developed clinical checking compulsions.

We recruited 126 undergraduate students from the University of British Columbia Department of Psychology subject pool. In order to ensure our sample included individuals with a wide range of checking behaviors, we used two types of advertisements, one that called specifically for participants with checking compulsions and another that made no mention of compulsions. Participants ranged from 18 to 47 years of age with a mean of 20.95 years (SD = 3.47). Participant's postsecondary education ranged from 1 to 6 years with a mean of 2.51 years (SD = 1.09). Forty of the participants were male and 86 were female.

In order to address our main research objectives, the overall design of our study had to be quasi-experimental. We used participants' scores on the checking subscale of the Padua Inventory to assign them to one of three groups: Low checkers, medium checkers or high checkers. Specifically, participants with mean checking scores between 0 and 4 were assigned to the low checkers group, participants with mean checking scores between 5 and 11 were assigned to the medium checkers group, and participants with mean checking scores 12 and higher were assigned to the high checkers group. These cut-off points were chosen because they yielded approximately the same number of participants per group: 40 low checkers, 41 medium checkers and 45 high checkers. As one would expect based on the demographically homogeneous pool from which we drew our sample, the results of separate one-way ANOVAs showed that the three groups did not differ in age, \( F(2, 125) = 2.94, MSE = 34.37, p > .05 \), or in years of postsecondary education, \( F(2, 125) = 1.52, MSE = 1.80, p > .05 \). The three groups also did not differ in gender, \( \chi^2(2) = 3.24, p > .05 \).

We conducted this research with the approval of the University of British Columbia Behavioral Ethical Review Board. Completing all components of the study required approximately one hour and participants received course credit in return for their participation.

2.2 Instruments

In the course of the experiment each participant was administered several questionnaires, prospective memory tasks and neurocognitive filler tests. Each of these study components is briefly described below.

2.2.1 Padua Inventory (PI). The PI is a standardized self-report inventory developed by Sanavio (1988). The inventory contains 60 statements describing common obsessive-compulsive behaviors (e.g., I return home to check doors, windows, drawers etc., to make sure they are properly shut). For each item participants use a 5-point scale to indicate the degree of disturbance each behavior creates, with scale points marked: None at all, a little, quite a lot, a lot and very much. The inventory contains 4 subscales each of which measures different obsessive-compulsive concerns: Impaired control of mental activities, contamination, checking, urges and worries about losing control over motor behaviors. The questionnaire is a reliable measure of obsessive-compulsive behavior, as evidenced by high test-retest reliability (.80) (Sanavio, 1988), and internal
consistency (.94) (Sanavio, 1988). We computed participant’s checking scores according to Sanavio (1988). Possible scores on the checking subscale range from 0 to 32, with higher scores indicating a higher level of checking behavior.

2.2.2 Prospective and Retrospective Memory Questionnaire (PRMQ). The PRMQ is a standardized self-report inventory developed by Smith, Della Sala, Logie and Maylor (2000). The scale contains 16 questions concerning various memory failures (e.g., Do you forget appointments if you are not prompted by someone else or by a reminder such as a calendar or diary?). For each item, participants indicate the frequency of experiencing the failure using a 5-point scale, with scale points marked: Never, a little, quite a lot, a lot, very often. The scale contains two subscales, one focusing on prospective memory and the other on retrospective memory. Both subscales yield high reliability coefficients (prospective memory = .84, retrospective memory = .80) (Crawford, Smith, Maylor, Della Sala, & Logie, 2003). We computed scores for each of the PRMQ subscales according to Crawford and colleagues (2003). Possible scores on each subscale range from 16 to 40, with higher scores indicating a greater frequency of memory failures.

2.2.3 Prospective Memory Questionnaire (PMQ). The PMQ is a standardized self-report inventory developed by Hannon, Adams, Harrington, Fries-Dias and Gibson (1995). The scale contains 52 statements concerning various prospective memory failures (e.g., I forgot to lock up my house, bike, or car) and prospective memory aiding techniques (e.g., “I write myself reminder notes”). For each item participants rate the frequency of experiencing the failure or using the technique; they use a 9-point scale, with the scale points representing how many times in a given time period (e.g., a week, month or year) participants experience each prospective memory failure or use each memory aiding technique. The questionnaire contains four subscales, three of which concern failures connected with different prospective memory tasks, specifically, episodic tasks, habitual tasks and internally cued tasks, and the fourth measures the frequency of using various prospective memory aiding strategies. Each subscale is reliable, with reliability coefficients ranging from .78 to .90, and the test-retest reliabilities ranging from .64 to .88 (Hannon et al, 1995).

2.2.4 Personal Belonging Task. We used a slightly modified version of the standardized belonging task (Wilson, Cockburn, & Baddeley, 1985) for assessing event-cued episodic prospective memory performance. Participants were told we were interested in their ability to remember to do things at a later time, and that we needed one of their personal belongings for this purpose. If the participant was wearing a watch then this was taken, thereby ensuring also that no participant was wearing a watch when completing the time-cued prospective memory task. If the participant was not wearing a watch then a cell phone or something of similar value was requested. We placed the personal belonging in a drawer and instructed participants to ask for its return upon being told later in the testing session: “we are now finished with all of the tests”. Participants were further informed that they would receive this prompt immediately before the debriefing. After ensuring that participants understood the instructions, we asked them to rate their confidence in their ability to remember to request back the personal belonging at the appropriate moment. We used a 10-point scale for making these confidence ratings, where 1 indicated extremely unconfident and 10 indicated extremely confident. Those
participants who requested the return of their belonging at the appropriate time were awarded a score of 1, indicating success; otherwise they received a score of 0.

2.2.5 Phone Call Reminder Task. Inspired by Searleman (1996) and Kvavilashvili (1987) we used a Phone Call Reminder Task for assessing time-cued episodic prospective memory task performance. Participants were told that in exactly 30 minutes the experimenter needed to leave the room to place an important phone call. They were instructed to tell the experimenter when exactly 30 minutes had passed, because we wished to find out "how good [they] are at giving this kind of reminder". The instructions emphasized getting as close as possible to the 30 minute mark. Participants were given a stopwatch for keeping track of time and were told to look at it whenever they wished, but to keep it facedown whenever they were not checking it. Participants were also asked to predict how many seconds or minutes late (i.e. past 30 minutes) they would be on this task. The experimenter had a synchronized stopwatch, permitting her to record the precise time of each discrete stopwatch reference. The time of the final stopwatch check/reminder was also recorded. The delay (i.e. past 30 minutes) in providing the reminder served as our primary measure of time-cued prospective memory task performance accuracy.

2.2.6 Neurocognitive Filler Tests. During the retention interval, we occupied participants by having them complete three blocks of a lexical decision test, Graf, Uttl and Tuokko’s (1995) version of the Color-Word Stroop test (Stroop, 1935), a modified version of the standardized letter cancellation test (Diller, Ben Yishay, Gerstman, 1974), parts A and B of Reitan’s (1992) Trail Making Test, and a modified version of the standardized FAS test of verbal fluency (Benton & Hamsher, 1989). These tasks were administered according to published instructions.

2.3 Procedure

Table 1 shows the order in which the tasks and instruments were administered to each participant and the approximate time required for completing each. The episodic prospective memory tasks are highlighted.

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Participants were tested one at a time in a quiet room. Upon obtaining their written informed consent, we collected basic demographic information. We then assigned the event-cued Personal Belonging Prospective Memory task, and participants' rated their confidence in being able to perform this task as instructed. Participants then completed the set of questionnaires listed in Table 1 according to their own pace.

For the second phase of the experiment participants were assigned the time-cued Phone Call Reminder Prospective Memory task and participants' made predictions about their performance on this task. Participants then completed the battery of neurocognitive filler tests listed in Table 1. The filler tests, most of them commonly used neuropsychological tests, were administered in four 6-minute blocks and one 10-minute block. At the end of each block, participants were told to stop what they were doing and proceed to the next block of tests. We used this procedure to prevent the boredom that might have occurred if participants had been required to work on the same task for the entire 30 minute retention interval, and to ensure that all participants progressed through the neuropsychological tests at about the same rate. For the first 6-minute block, participants completed Block 1 of the lexical decision test. For the next 6-minute block
participants were asked to complete the color-word Stroop test (Graf, Uttl, & Tuokko, 1995) and a modified version of the letter cancellation test (Diller, Ben Yishay, Gerstman, 1974). This was followed by Block 2 of the lexical decision test. During the next 6-minute block participants were given parts A and B of the trail making test (Reitan, 1992) and a modified version of the FAS test (Benton & Hamsher, 1989). During the final 10-minute block participants completed Block 3 of the lexical decision test. The end of the 30 minute retention interval fell 6 minutes into the final block, and thus, participants were expected to carry out the Phone Call Reminder Prospective Memory task (i.e., remind the experimenter to place the phone call) while occupied with making lexical decisions.

After participants completed all of the filler tasks, the experimenter delivered the cue for the personal belonging prospective memory task with the phrase: “we are now finished with all of the tests”. To create a reasonable time-window for responding to this cue, the experimenter took about 10 seconds to tidy up and put the testing materials away and then informed participants that they were going to be debriefed. Then, participants received a full debriefing and their research participation credit.

3. Results
3.1 Data Preparation
All data were double checked for recording and transcription errors. Data accuracy was greater than 99%. There were five missing values on the questionnaires (i.e. < .001%), and each of these was replaced with the mean response from the respective checking group (i.e. high, medium, low checkers). In addition, one missing Phone Call Reminder prediction score (i.e. < .01) had to be replaced with the mean of the respective group.

We examined all of the questionnaire data and the prospective memory data (i.e., confidence ratings, predictions, prospective memory success scores, and clock-checking data) for univariate outliers, defined as scores falling more than three standard deviations away from their respective means. We discovered five outliers in the data from the low checkers, six in the data from the medium checkers and four in the data from the high checkers. These outlying values were replaced with the nearest non-outlying value, specifically, a score either -3 or +3 standard deviations away from the corresponding group mean1. We also conducted a multivariate outlier analysis on all of the questionnaire and prospective memory data. No participants were identified as multivariate outliers by means of the Mahalanobis distance statistic, with the criterion set at $\chi^2 (16) = 39.25$, and $p < .001$.

3.2 Objective Measure of Prospective Memory Performance
One aim of the present study was to investigate whether high checkers have an objective impairment related to either event- or time-cued prospective memory tasks. For the event-cued task, participants had to request the return of a personal belonging when they were told: “we are now finished with all of the tests”. Our results showed that 55.6% of the high checkers, 58.5% of medium checkers and 80% of low checkers requested the return of their personal belonging. A chi-square analysis of participants’ performance on the Personal Belonging task showed a significant difference among the groups, $\chi^2 (2) = 6.39$, $p < .05$. Follow-up analyses revealed

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1 When we reran the analyses without the outlying scores replaced the results reported in this article remained the same.
that the low checkers performed significantly better than the medium or high checkers, with $\chi^2 (1) = 4.37, p < .05$ and $\chi^2 (1) = 5.73, p < .05$, respectively. The medium checkers’ performance was not different from that of the high checkers, $\chi^2 (1) = .08, p > .05$.

For the time-cued prospective memory task participants had to remind the experimenter to make a phone call in exactly 30 minutes. High checkers provided this reminder on average 58.4 sec late, medium checkers provided it 69.1 sec late and low checkers provided it 49.8 sec late. A one-way ANOVA of these reminder lateness scores showed no significant differences among the participant groups, $F (2, 125) = .48, MSE = 3781.87, p > .05$.

On the time-cued prospective memory task, we also recorded participants’ clock-checking behavior. This behavior is summarized in Figure 1, which shows the mean frequency of clock-checking by each participant group for each 5-minute period of the retention interval. A 3 x 6 MANOVA with Group (low, medium, high checkers) as a between subjects factor and the successive 5-minute retention-interval-periods as a within subject factor supports the main message of the figure, namely, that the groups did not differ in their clock-checking strategies, $F (2,123) = .99, MSE = 3.06, p > .05$. The analysis showed a significant main effect due to the 5-minute retention-intervals-periods, $F (5, 615) = 59.03, MSE = 1.10, p < .05$, but no other significant main or interaction effects.

3.3 Subjective Measures of Prospective Memory Performance

Do high checkers suffer from subjective impairments in prospective memory? To answer this question, we compared the three checking groups’ confidence ratings on the Personal Belonging prospective memory task, their predicted lateness scores on the Phone Call Reminding task, and their ratings on the PMQ and the PRMQ.

For the event-cued Personal Belonging task, we asked participants to indicate how confident they were about requesting the return of their personal belonging, and participants provided a rating out of 10, with 1 indicating extremely unconfident and 10 indicating extremely confident. The groups’ confidence ratings were similar, with means of 7.31, 7.80 and 7.38, respectively, for the high, medium and low checkers. A one-way ANOVA of participants’ confidence ratings, with Group (low, medium, high checkers) as a between subjects factor, was not significant, $F (2, 125) = 1.32, MSE = 3.02, p > .05$.

On the time-cued prospective memory task we asked participants to predict how late they would be in providing the Phone Call Reminder. The mean prediction latencies were 174.4 sec, 187.7 sec and 195.6 sec, respectively, for the high, medium and low checkers. A one-way ANOVA of the prediction latencies, with Group (low, medium, high checkers) as a between subjects factor, was not significant, $F (2, 125) = .22, MSE = 4890.22, p > .05$.

The main findings from the PMQ are depicted in Figure 2. We conducted a MANOVA on the ratings concerning the frequency of different kinds of prospective memory failure experiences (i.e. the left three sets of bars in Figure 2), with Group (low, medium, high checkers) as a between subjects factor and Prospective Memory Task Type (episodic, habitual, internally cued) as a within subject factor. The results showed significant main effects due to Group, $F (2, 123) = 11.43, MSE = 1.96, p < .05$, and due to
Prospective Memory Task Type, $F(2, 246) = 176.96, MSE = .51, p < .05$. The interaction between these factors did not reach significance, $F(4, 246) = 1.12, MSE = .51, p > .05$. Follow-up one-way ANOVAs on the data from each prospective memory task type (i.e. on each set of bars in Figure 2) showed significant main effects due to Group on the episodic prospective memory items, $F(2, 125) = 11.87, MSE = 3.82, p < .05$, and on the internally cued prospective memory items, $F(2, 125) = 7.51, MSE = 10.46, p < .05$. In all cases, independent samples t-tests confirmed that high checkers gave significantly higher prospective memory failure frequency ratings than the medium checkers, with $t(84) = -3.36, p < .05, t(84) = -3.52, p < .05, t(84) = -2.99, p < .05$, respectively, for the episodic, habitual and internally cued items.

Comparisons between the high and low checkers produced values of $t(83) = -2.82, p < .05, t(83) = -3.80, p < .05, t(83) = -3.47, p < .05$, respectively, for the episodic, habitual and internally cued items.

The rightmost set of bars in Figure 2 shows participants’ self-rated use of prospective memory aiding strategies. A one-way ANOVA on the corresponding data showed a significant main effect due to Group, $F(2, 125) = 4.44, MSE = 14.53, p < .05$, with high-checkers reporting using more prospective memory aiding strategies than the low checkers, $t(83) = -2.97, p < .05$. High and medium checkers did not differ significantly in their reported use of strategies, $t(84) = -1.73, p > .05$, and the medium checkers did not differ from the low checkers, $t(79) = -1.17, p > .05$.

In a final MANOVA, we examined participants’ ratings on the PRMQ which explored the frequency of experiencing both prospective and retrospective memory failures. The analysis had Group (low, medium, high checkers) as a between subjects factor and Memory Type (prospective memory, retrospective memory) as a within subject factor. The results, displayed in Figure 3, revealed a significant effect of Group, $F(2, 123) = 7.52, MSE = .78, p < .05$, and Memory Type, $F(1, 123) = 76.02, MSE = .107, p < .05$, as well as a significant interaction between these two factors, $F(2, 123) = 3.15, MSE = .107, p < .05$. Follow-up ANOVAs revealed that the three groups gave significantly different ratings concerning their experience of prospective memory failures, $F(2, 125) = 7.56, MSE = 4.40, p < .05$, as well as their experiences of retrospective memory failures, $F(2, 125) = 5.93, MSE = 1.83, p < .05$.

4. Discussion

According to one prominent theory, the root cause of obsessive-compulsive checking is an impairment of memory. This impairment may be real, marked by an objective inability to remember important activities, such as turning the iron off after use, or it may be subjective and expressed primarily as a lack of confidence in the ability to remember (Sher, Frost, & Otto, 1983). For the present study, we framed and tested this theory in the context of prospective memory, primarily because it appears that checking tendencies seem closely linked with activities that require execution at a later moment, or rather, with the failure -- or a lack of confidence in the ability -- to carry out such activities. Put more concretely, if individuals frequently forget to carry out planned activities or if they believe that they frequently forget to carry out such activities then checking may develop as a compensatory strategy to
ensure that important activities are not forgotten.

Our participants were undergraduate student volunteers whom we classified as high, medium or low checkers on the basis of their scores on the Padua Inventory. We required participants to complete two laboratory based prospective memory tasks, one time-cued (the Phone Call Reminder task) and the other event-cued (the Personal Belonging task), to make confidence ratings and performance predictions about these task and to complete two questionnaires on the self-assessed frequency of various kinds of memory failures and memory aiding strategies.

The results from the study showed a lower level of performance in high versus medium and low checkers on the event-cued episodic prospective memory task, but a complete absence of an effect of group on the time-cued task. The three participant groups were similarly confident in their ability to carry out the event-cued task, and they made comparable predictions about how late they would be on the time-cued task. By contrast, on the two questionnaires the high checkers reported experiencing more of all types of memory failures than either the medium checkers or the low checkers, and they also reported making more use of prospective memory aiding strategies.

On the assumption that the questionnaire responses provide a valid and reliable confidence or self-assessment index, the questionnaire results are consistent with the claim that compared to low and medium checkers high checkers suffer from a subjective memory impairment. This impairment seems broad-based and to cover all aspects of prospective memory that were probed by the PMQ, and the data from the PRMQ (see Figure 3) show that consistent with the traditional memory deficit theory this impairment also extends to retrospective memory.

A surprising outcome in the present study is the absence of differences among the checking groups in the success confidence ratings on the event-cued task and in the prediction accuracy ratings about completing the time-cued task. This finding is surprising because both the success confidence ratings and the prediction accuracy ratings are self-produced, subjective indexes of performance, and consequently, we expected them to show the same pattern of checking group differences as the questionnaire data. The failure to find the same group effects in both data sets may provide an important clue about the factors that determine participants' self-ratings under different assessment conditions. For example, it is possible that when required to respond to the general questions about memory failures on the PMQ and the PRMQ, subjects' ratings are filtered by an availability heuristic (Tversky & Kahneman, 1973), and consistent with the memory deficit theory of compulsive checking, when guided by this heuristic, high-checkers have an easier time accessing memory failures than either medium checkers or low checkers. By contrast, when required to respond to the specific demands of a particular prospective memory tasks (e.g., the Personal Belonging task or the Phone Call Reminder task in the present experiment), self-ratings may be determined primarily by the real demands of the task and not by the availability or accessibility of similar previous experiences. Future research will need to explore this possibility.

In the present study, we also sought out objective prospective memory task performance differences among the checking groups, and we found such differences on an event-cued task (i.e. the Personal Belonging
task) but not on a time-cued task (i.e. the Phone Call Reminder task). The absence of an effect due to Group on the latter is interesting. Previous research reveals that performance differences between event- and time-cued prospective memory tasks are not uncommon (for example, Bastin & Meulemans, 2002; Einstein & McDaniel, 1995; Nigro, Senese, Natullo & Sergi 2002) but they typically show the opposite to our findings, that is, effects on time- but not event-cued tasks. To explain this type of finding, it has been argued that compared to event-cued tasks, time-cued tasks are more difficult or resource demanding because they depend more heavily on subject-initiated processes (Craik, 1996; Einstein & McDaniel, 1990). Consistent with this task-difficulty view, we had expected larger performance differences among our checking groups on the time- than event-cued task, in keeping with the additional assumption that the checking compulsion itself is resource demanding (Eysenck & Calvo, 1992; Humphreys & Revelle, 1984) and thus depletes the resources that can be allocated to the prospective memory task. Thus, rather than reflecting a difference in the sensitivity of the event- and time-cued tasks, our finding of a group effect appears due to a more fundamental process that is implicated in compulsive checking.

One possible explanation for why we found differences among the checking groups on the event- but not time-cued task focuses on the contexts that foster compulsive checking behaviors. It seems possible that compulsive checking becomes evident, prominent and performance-limiting only in situations where there is uncertainty that can not be reduced or removed by strategic (i.e. planned, systematic, skillful) behaviors. Time-cued tasks permit this kind of behavior; they supply a clear, familiar and prominent dimension (i.e. time) for anticipating or predicting the context where a planned activity needs to be carried out (Graf & Grodin, 2005). By contrast, for event-cued tasks, the occurrence of a relevant cue may not be predictable. The greater uncertainty inherent in event-cued situations may fuel the compulsion to check, and thereby may reduce the likelihood of success on the task.

The possibility that checking compulsions only impact performance on event-cued prospective memory tasks is consistent with the examples of checking behaviors that tend to be given in the research literature (e.g., checking to ensure that the stove or iron was turned off after use). We are not aware of any literature references to checking behaviors that occur in connection with time-cued tasks. Indeed, it does not seem possible to check to ensure a time-cued task was completed in the same way that one can check to ensure that an event-cued task was completed. Once the time has passed to perform a task (e.g., pick a friend up at the airport at 2pm) the opportunity to perform that task has expired. However, if one fails to unplug her/his iron, s/he can always return home to unplug it.

4.1 Conclusion

The outcome of the present study serves to augment the traditional memory deficit theory of obsessive-compulsive checking. We believe the impairments in prospective memory and retrospective memory work together to produce obsessive-compulsive checking. We propose that individuals with obsessive-compulsive checking tendencies have an impaired prospective memory that causes them to have more experiences where they forget to perform activities. We suggest that their increased experience with these failures causes or at least exacerbates their intrusive obsessions that something was not done or
was not done properly. When the individual attempts to recall retrospectively whether or not s/he performed the activity, her/his impairments in retrospective memory make this task difficult. Further, even if s/he is able to recall performing the activity her/his increased experiences with retrospective memory failures leads to a lack of trust in their memory for the event. Finally, the checking compulsion is exhibited as an attempt to manage the doubts and ruminations.

While previous research (as meta-analyzed by Woods, Vevea, Chambless, & Ute, 2002) supports the latter portion of this theory, our data support the former part. Our findings that sub-clinical checkers subjectively report having more everyday experiences with prospective memory failures and that they objectively perform worse on an event-cued prospective memory task set the stage for future research on clinical checkers. As most would agree that clinical symptoms are at the extreme of a continuum or normal behavior we expect to find that our results will extend to the clinical population.
Acknowledgments

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References


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¹ Sanavio (1988)
² Smith, Della Sala, Logie, & Maylor (2000)
³ Hannon, Adams, Harrington, Fries-Dias, & Gibson (1995)
⁴ Graf, Utll, & Tuokko (1995)
⁵ Adapted from Diller, Ben Yishay, & Gerstman (1974)
⁶ Reitan (1992)
⁷ Adapted from Benton & Hamsher (1989)
Figure Captions

Figure 1. The Frequency of Clock-Checking Responses on the Phone Call Reminder Task Across the Three Checking Groups.

Figure 2. Self-Rated Frequency of Prospective Memory Failures and Use of Prospective Memory Aiding Strategies Across the Three Checking Groups.

Figure 3. Self-Rated Frequency of Prospective and Retrospective Memory Failures Across the Three Checking Groups.
Figure 2

![Bar chart showing the self-rated frequency of prospective memory failures/use of prospective memory aiding strategies for Low Checkers, Medium Checkers, and High Checkers across different types of memory.

* indicates significance at $p < .05$
Figure 3

![Bar graph showing the self-rated frequency of memory failures for prospective and retrospective memory across different checker groups.](Image)

* indicates significance at $p < .05$