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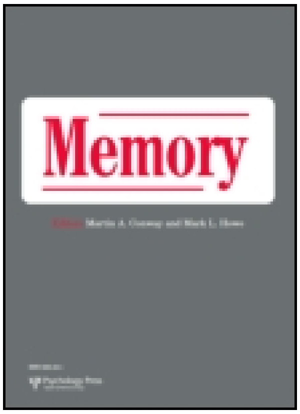

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The specificity of prospective memory costs

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The specificity of prospective memory costs

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A current issue in the field of prospective memory (i.e., memory for intentions) is the extent to which intentions interfere with ongoing activities. A question of interest is whether this interference is specific to stimuli that are relevant to the intention or whether interference is more general in its influence. Participants performed a lexical decision task (LDT) with an embedded prospective memory (PM) task in which they had to remember to press a computer key if a pre-specified target appeared (e.g., GIRL). Results demonstrated a consistent pattern of results. Increased reaction time costs were observed on trials where there was a match between PM targets and non-target ongoing stimuli. That is, when a prospective memory target was a word, then reaction time costs were observed on non-target word LDT trials and there were no costs on non-target nonword trials. Similarly, if a PM target was a nonword (e.g., UEBL) then costs were observed on non-target nonword LDT trials relative to non-target word trials. Evidence from three experiments suggests that task interference is specific to the type of stimulus (word or nonword) that is relevant to the intention. We refer to this finding as a Stimulus Specific Interference Effect (SSIE).

Keywords: Prospective memory; Intentions; Stimulus specific; Task interference.

In daily life an intention to act is often delayed because it cannot be executed immediately. For example, in the interest of politeness we may postpone the act of phoning a colleague until a meeting has finished. The ability to encode such an intention and then successfully execute it at the appropriate future moment is known as *prospective memory* (for a review see Kliegel, McDaniel, & Einstein, 2008). When prospective memory (PM) fails it is often attributed to the person becoming absorbed in some other ongoing thought or activity, with the result that the opportunity to execute the intention (e.g., make the phone call) passes. In most laboratory studies of *event-based* prospective memory, participants receive instructions for an ongoing task (e.g., rating the pleasantness of words). Then in an intention condition, participants are instructed to make an additional response if a pre-specified target event occurs. Event-based prospective memory involves tasks that rely on some environmental cue to elicit a previously established intention. For example, a participant may be given an intention to press the F1 computer key if an animal word is presented at any point during the pleasantness rating task. In this case the target is seeing an animal word which should elicit the intention to press the F1 key. As the participant becomes engrossed in the primary ongoing task of rating pleasantness of words, they must also remember to make a different response in the event that the pre-specified target (animal word) occurs. Thus prospective memory paradigms measure participants' ability to encode an intended

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future action, and to act on that intention at the appropriate time (Ellis & Freeman, 2008).

A current issue in the prospective memory literature concerns the extent to which intention-related processing requires centrally mediated attentional resources. The interest is in understanding how the demands of a prospective memory task can decrease the attention resources available for ongoing task performance. According to the preparatory attention and memory (PAM) model, successful retrieval of a delayed intention can only occur in the context of resource-demanding processes called preparatory attentional processes (Smith 2003; Smith & Bayen, 2004; Smith, Hunt, McVay, & McConnell, 2007). Thus the PAM model argues that successful event-based prospective memory involves allocating resources to monitoring the environment in order to detect an intention-related cue. Much evidence (e.g., Cohen, Jaudas, & Gollwitzer, 2008; Einstein et al., 2005; Hicks, Marsh, & Cook, 2005; Smith, 2003) has supported this model by demonstrating longer latencies on a reaction time task that includes an intention compared to a condition without an intention. This result indicates that attentional resources are required for cue detection. Like the PAM model, the multiprocess theory acknowledges that some prospective memory tasks are resource demanding and require monitoring environmental events for the occurrence of a cue. However, they depart from the PAM model by suggesting that the presence of a cue or target event can spontaneously initiate retrieval of an intention even when no preparatory processes were engaged (Einstein et al., 2005; Scullin, Einstein, & McDaniel, 2009). Importantly, proponents of the multiprocess view have demonstrated high levels of prospective memory performance under conditions of spontaneous cue detection showing that effortful monitoring is not required for successful prospective memory (Einstein et al, 2005). We refer to increased latencies on an ongoing task due to the presence of an intention as *ongoing task costs* or *task interference* and use these two terms interchangeably.

There is a need to better understand the nature of monitoring processes in prospective memory tasks. The goal of much research on task interference has been to determine whether monitoring occurred or not. However, it is important to attempt to specify the conditions that give rise to ongoing task costs. It seems adaptive that the cognitive system would be configured in such a way that intention-related costs may be realised under certain circumstances and not others. For example, Einstein et al. (2005) revealed that whether a prospective memory task produced costs to the ongoing task depends on a variety of factors. According to the multiprocess view, costs are more likely when the PM task is emphasised, when focal processing of the target is not encouraged by the ongoing task, and when there are multiple target events.

Perhaps most relevant for the current study, Marsh, Cook, and Hicks (2006) examined whether ongoing task costs might be material specific. That is, they explored whether task costs are more pronounced when the class of stimulus in the ongoing task matches the class of stimulus relevant to the intention. It would be maladaptive for individuals to experience task interference as a constant cost to all trials even when the material being processed is obviously not relevant to the intention. In Experiments 1A, 1B, and 2, participants performed a naming task in which they had to read words aloud or name pictures. The PM instructions involved remembering to press the "/" key if any words (in the word condition) or pictures (in the picture condition) denoting a piece of furniture appeared. The interest was in examining whether task interference would be specific to either type of item (word or picture) or whether interference would be distributed across both pictures and words. Results showed that task interference could be reduced when participants could reliably predict the material about to be processed in the ongoing task. That is, task interference was reduced on word trials with an intention about pictures and on picture trials with an intention about words. However, this result was only observed if participants could reliably predict what type of trial would appear on the next trial through the use of presenting words and pictures in blocks (Experiment 1B) or by presenting a warning trial before each word or picture (Experiment 2). In Experiment 3 Marsh et al. (2006) replicated their findings using a lexical decision task in which an asterisk presented in red or green reliably predicted the colour of the letter string on the upcoming trial. The intention in this last experiment was to press a certain key if animal words occurred in red in one condition or in green on another condition. Again, results showed that an intention can selectively interfere with materials that are related to that intention but only if the participant knows what type of stimulus will appear next.

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This material specific effect was not observed when pictures and words were presented randomly (Experiment 1A). Marsh et al. explained their results by describing two components. The first component involves metacognitive beliefs that the task will be difficult (resulting in more interference) or beliefs that it will be easy (resulting in less interference). This policy is established at the outset of the task. However, there is a second more flexible component that operates when one is able to predict what sort of material will appear in an upcoming trial. When that material is clearly unrelated to an existing and active intention, it can be processed more rapidly and when it is related to an intention, then more time is needed to process the stimulus leaving fewer resources for the ongoing task.

Guynn (2003) makes an important distinction between two types of monitoring known as retrieval mode and item checking. When a person must execute a future intention it can be said that the cognitive system is in retrieval mode meaning that it is sensitive to the future possibility of an intention occurring. However, the person is relatively free to devote attention to the ongoing task. Retrieval mode can be thought of as similar to the first component of Marsh et al.'s (2006) model described above in which participants adopt attention allocation policies at the outset of a task. The second component of the Guynn (2003) model is item checking. This component of strategic monitoring involves post-stimulus checking for the target events. In this component attention is devoted to the stimuli where the retrieval cue would be expected to occur and the individual evaluates whether or not a stimulus in that context is a retrieval cue for an intended action. This second component of the Guynn (2003) model is different from the second component described by Marsh et al. (2006). Specifically, Marsh et al. (2006) state: "Guynn believes the interference is due to checking, whereas we believe that it is composed of more local attentional allocation policies that are subject to not only material-specific processing, but also the natural waxing and waning of attention over time" (p. 1637). According to Guynn, task interference comes in part from post-stimulus checking; therefore, this model would predict that stimulus specific task interference can be found even when stimulus types are presented randomly.

THE CURRENT STUDY

In the current study we were interested in examining how task interference can exert a material-specific effect but on a trial by trial basis when participants cannot predict the upcoming trial. This prediction was based in part on preliminary evidence from Cohen et al. (2008). The objective of Cohen et al. (2008) was not to examine stimulus specific interference but rather this study demonstrated how varying the number of prospective memory targets contributed to ongoing task costs. Results revealed a linear trend in which there was no significant increase in LDT latencies with one or two prospective memory targets and significant costs emerged with three or more targets. Interestingly, Cohen et al. (2008) analysed word and nonword lexical decision task trials separately and showed more task interference on ongoing LDT word trials relative to nonword trials when participants had a word PM target. Many studies of prospective memory use lexical decision making as the ongoing task and words as PM targets however most of these studies analyse ongoing task performance solely in terms of performance on word LDT trials (for exceptions see Knight, Ethridge, Marsh, & Clementz, 2010; Scullin, McDaniel, Shelton, & Lee, 2010).

In Experiments 1, 2, and 3 we used a simple lexical decision task and examined performance on ongoing lexical decision task words and nonwords separately. Furthermore, in Experiments 2 and 3 we included conditions in which participants had nonword PM targets. Another important difference from the method of Marsh et al. (2006) was that we used specific words as PM targets as opposed to general categories (e.g., furniture words). Einstein, McDaniel, Richardson, Guynn, and Cunfer (1995) showed that planning for specific target events relative to general categories of events improved prospective memory performance. Therefore we believed that specific PM targets might allow participants to maintain the intention in mind more easily leading to more flexibility on the ongoing task.

In Experiment 1 participants encoded an intention condition with six prospective memory word targets and we predicted that reaction time costs would be observed solely for word trials in the lexical decision task trials relative to a control condition. In Experiment 2 we included a condition in which participants were given nonword

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prospective memory targets (e.g., RLGI), thus participants had to respond to PM targets that were either words (in the PM word target condition) or nonwords (in the PM nonword target condition). This experiment allowed us to further examine whether costs would be observed solely on lexical decision task trials that matched the PM targets which would provide further evidence for the specificity of costs. In Experiment 3 we had participants memorise prospective memory targets that were either word or nonword targets but the targets did not occur. This idea was similar to a manipulation employed by Loft, Kearney, and Remington (2008). Results from Loft et al. revealed that task interference decreased across trials showing that participants were able to reset their attention allocation policies when the target failed to appear. We were interested in examining whether attention allocation strategies would be updated similarly for those who were in the PM word target compared to the PM nonword target condition. It is plausible that those with nonwords as PM targets might be less likely to reset their monitoring strategies as quickly as those with words as PM targets. It may be that in the PM nonword target condition participants have metacognitive beliefs that the task is more difficult which could result in task interference lasting longer relative to the PM word target condition. In all experiments the cost associated with the embedded PM tasks was measured by evaluating the change in RTs from Block 1, where the ongoing task was performed alone, to Block 2, where participants held intentions. An important feature of all three experiments was that reaction times on the ongoing task were compared only on non-target trials.

EXPERIMENT 1

Participants performed an ongoing lexical decision task with an embedded intention. To disentangle possible practice or fatigue effects, participants in the control condition simply performed two blocks of the lexical decision task to provide a baseline comparison. Participants in the intention condition performed a block of the LDT alone and then were given an intention which required them to say ''word'' aloud if any of six pre-specified prospective memory target words (e.g., girl, blue) were encountered at any point during the second half of the lexical decision task. In an effort to keep encoding as similar as possible to the intention condition, participants in the control condition were asked to memorise six target words for a later retrospective memory task. Thus, although participants in both conditions were aware that they would have to remember the six target words, the critical difference was that those in the intention condition had to detect the six targets during the lexical decision task, whereas those in the control condition did not. Our interest was in examining whether reaction time costs would be stimulus specific such task interference would be primarily on word trials in the lexical decision task but little to no costs for nonword trials. Most importantly, we were interested in examining whether task interference would vary on a trial by trial basis.

Method

Participants. A total of 55 volunteers were recruited at New York University from an introductory psychology course where students received optional partial course credit for their participation. Each participant was tested individually in sessions that lasted approximately 35 minutes. Participants were randomly assigned to one of two levels (control condition or intention condition) of a between-participants manipulation of task type. There were 28 participants in the control condition and 27 participants in the intention condition.

Materials and procedure. Participants were tested on an IBM-compatible Pentium computer. The experiment was performed using Presentation® software (Version 0.70, www.neurobs.com). All materials used in the experiment were the same as those used by Cohen et al. (2008). Six critical words (e.g., blue, girls, decide, member, maybe, husband) were chosen from the Kucera and Francis (1967) norms such that they had a medium level of frequency. These six items served as the prospective memory targets. There were 504 trials in total, with equal numbers of valid English words and nonwords. Nonwords were created by moving the first syllable of each word to the end of each word (Hunt & Toth, 1990). In the first block of 252 trials participants performed solely the lexical decision task. The first block of lexical decision trials provided a within-participants measure of baseline performance. In the second block of 252 trials, on average every 22nd trial involved a prospective memory target item. Specifically, the appearance of the PM target varied such that on some trials it occurred 10 trials after the last PM target and on other trials it occurred 40 trials after the last PM target. In this way we were confident that participants could not anticipate the appearance of the PM target. Each of the six prospective memory targets occurred twice each for a total of 12 occurrences.

Phase One. Part 1 of the experiment involved each participant filling out a consent form, and then instructions appeared on the computer screen explaining the experiment. Participants were told that letter strings would appear one at a time on the computer screen and that they were to decide as quickly and as accurately as possible whether the letter string formed a word or a nonword. Participants were asked to position the index fingers of each hand on the ‘‘F’’ and ‘‘J’’ computer keys, and to press the ‘‘F’’ key if the string on the screen was a word and press the ‘‘J’’ key if it was not a word. Assignment of the computer keys ‘‘F’’ and ‘‘J’’ to words and nonwords was counterbalanced across participants. All participants were told that they should emphasise speed and accuracy equivalently in this task. Participants performed a first block of lexical decision trials which consisted of 126 word trials and 126 nonword trials (252 in total). After the first block of trials, participants took a break; they received instructions for the second portion of the lexical decision task and the embedded prospective memory task if they were in the intention condition.

Mid-Experiment Interval. During the interval participants in both the control and intention conditions were asked to take 2 minutes to memorise six target words (e.g., blue, girls, decided, member, maybe, husband). If recall of the six words was not perfect, participants were given 2 minutes and learning cycled through the same study–test procedure until it was perfect.

Participants in the ‘‘control condition’’ were told that they would have to recall the six words at the end of the experiment. Those in the ‘‘intention condition’’ were also told that they would have to recall the six words at the end of the experiment; however, they were also told that they should say ‘‘word’’ aloud if any of these words occurred during the second block of trials of the lexical decision task. That is, participants were instructed to say ‘‘word’’ aloud (after first making their lexical decision) if they saw any of these words during the experiment. The intention instructions clearly specified that the word/nonword response to the ongoing lexical decision task should be made first and that the ‘‘word’’ response should be made whenever they detected a target before pressing the space bar to advance the screen to the next LDT trial. Thus, participants in the intention condition were told to say ‘‘word’’ only after they had made their ‘‘F’’ or ‘‘J’’ response. A prospective memory response was deemed correct if it was made at any point before word/nonword of the next trial was on the screen. For participants in both conditions, we emphasised the lexical decision task and instructed participants that they should be sure to respond as quickly and accurately as possible in their word/nonword decisions. Participants in both conditions completed a brief demographics questionnaire that took approximately 2 minutes to finish. This provided a filled interval so that participants would not rehearse the prospective memory instructions.

Phase Two. When it was time to resume block 2 of the LDT there were no further reminders about the PM instructions. Participants were reminded that they would do another block of the LDT and that they should respond as quickly and accurately as they can. A post-experiment questionnaire was administered to test participants' recall of the six target items.

Results and discussion

Recall of the prospective memory targets at the end of the experiment was fairly high in this experiment (Control: $M = 5.12$ of 6 targets, $SD = 1.33$; Intention: $M = 5.21$ of 6 targets, $SD = 1.09$) with no significant difference between conditions ($p = .56$).

Prospective memory task. The number of prospective memory targets detected was fairly low with participants successfully detecting just over half of the total number of targets ($M = 6.41$ of 12 targets, $SD = 4.37$). This number seemed especially low compared to typical prospective memory studies. It may be that making a vocal prospective memory response (e.g., saying ‘‘word’’ aloud) led to poorer performance. Whether or not retrieval is successful depends on the degree to which participants achieve

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sufficient encoding between the cue and the intended action (Einstein et al., 2005). Therefore it may be that the target + action link was not processed sufficiently in this experiment. In the subsequent studies we used a manual key press as the prospective memory action.

Ongoing task. Consistent with previous research that has examined task interference using lexical decisions (e.g., Hicks et al., 2005; Loft et al., 2008; Marsh et al., 2003), we use the average response time (RT) for word/nonword trials as the dependent measure. Data trimming in all three experiments was done separately for each block and each trial type for each participant. Several trials were excluded: (a) the initial five trials of Block 1 and Block 2; (b) trials that contained PM targets; (c) the three trials that followed a PM trial; (d) trials where RTs were greater than 2.5 *SD*s from a participant's grand mean; and (e) trials containing incorrect lexical decisions. Data trimming resulted in 3% of trials being eliminated.

Performance was evaluated using a three-way analysis of variance (ANOVA) with Word Type (word trials, nonword trials) and Block (Block 1, Block 2) as within-participants factors and Condition (control, intention) as a between-participants factor. Results revealed a main effect of Word Type, $F(1, 53) = 11.55$, $p < .05$, $\eta^2 = .18$, showing slower reaction times for nonword lexical decision task trials ($M = 756$ ms) compared to word lexical decision task trials ($M = 705$ ms). There was a main effect of Block, $F(1, 53) = 131.26$, $p < .001$, $\eta^2 = .71$, revealing that performance was slower in block 1 ($M = 787$ ms) compared to block 2 ($M = 673$ ms). The main effect for condition was not significant ($p = .12$). These significant main effects were qualified by several significant interactions. There was a significant interaction between Condition and Word Type, $F(1, 53) = 11.67$, $p < .05$, $\eta^2 = .18$, and a significant interaction between Condition and Block, $F(1, 53) = 33.06$, $p < .05$, $\eta^2 = .38$. These interactions were qualified by a significant three-way interaction, $F(1, 53) = 5.61$, $p < .05$, $\eta^2 = .10$, showing that there was a practice effect from Block 1 to Block 2 on lexical decision task performance for those in the control condition on both word and nonword trials. However, those in the intention condition only benefited from practice on nonword trials but showed no such benefit on word trials (see Figure 1). Planned comparisons confirmed our predictions regarding

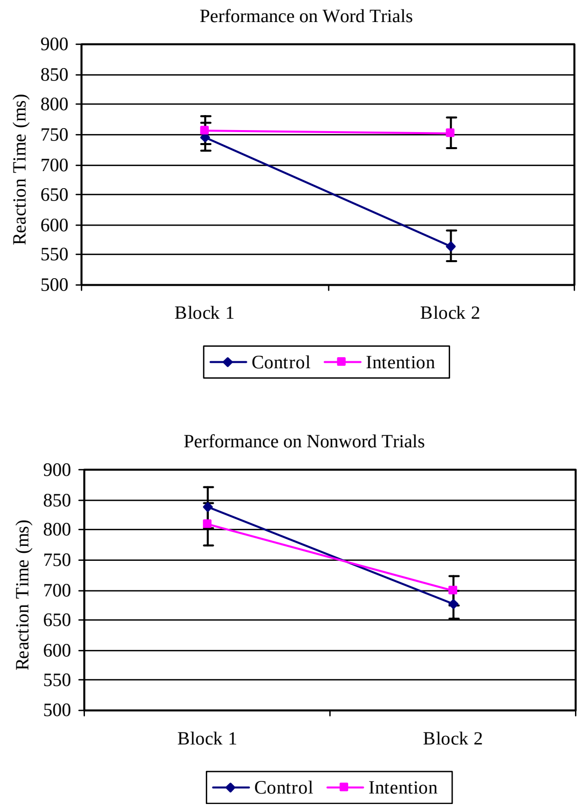

Figure 1. Upper Panel: Reaction time latencies on *word* trials in a lexical decision task in Experiment 1 as a function of condition (control, intention) and block (1, 2). Lower Panel: Reaction time latencies on *nonword* trials in a lexical decision task in Experiment 1 as a function of condition (control, intention) and block (1, 2). Bars represent standard error.

cost to the ongoing task and showed that the control and PM condition did not differ in Block 1 baseline response times for either word or nonword trials (all ps $> .57$). The only significant difference between the control and PM condition was found in Block 2 but only on ongoing word trial performance ($p < .01$, $d = 1.4$). Results showed that costs on the LDT non-target trials were specific to the type of PM cue that was relevant in that condition. That is, when participants had a PM word target then costs were observed solely on LDT word trials (see Table 1).

Results from this experiment yielded evidence that an intention can selectively interfere with materials related to that intention. Our latency data showed that task interference changed as a function of the type of material (words/nonwords) that was being processed and this effect occurred on a trial by trial basis. The fact that we found task interference varied on a trial by trial basis is a novel finding. Marsh et al. (2006) also found reduced costs that were material specific; however,

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TABLE 1
Ongoing task response time (ms)

	Condition			
Experiment	*Control*	*PM W Target*	*PM NW Target*	*Significance*
Experiment 1				
Word Trials				
Block 1	746	757	–	$p > .74$
Block 2	565*	753*	–	$p < .01$, $d = 1.4$
Nonword Trials				
Block 1	837	809	–	$p > .57$
Block 2	676	700	–	$p > .48$
Experiment 2				
Word Trials				
Block 1	719	698	735	all p's $> .31$
Block 2	582^{a}	734^{a}	666	$^{a}p < .01$. $\eta^2 = .28$
Nonword Trials				
Block 1	798	781	826	all p's $> .47$
Block 2	659^{a}	686^{b}	853^{ab}	$^{a}p < .01$. $\eta^2 = .42$; $^{b}p < .01$. $\eta^2 = .34$
Experiment 3				
Word Trials				
Block 1	753	734	690	all p's $> .28$
Block 2	574^{a}	749^{ab}	632^{b}	$^{a}p < .01$. $\eta^2 = .33$; $^{b}p < .01$. $\eta^2 = .17$
Block 3	587^{a}	730^{ab}	602^{b}	$^{a}p < .01$. $\eta^2 = .33$; $^{b}p < .01$. $\eta^2 = .31$
Block 4	586^{a}	712^{ab}	589^{b}	$^{a}p < .01$. $\eta^2 = .25$; $^{b}p < .01$. $\eta^2 = .30$
Block 5	576^{a}	790^{ab}	652^{b}	$^{a}p < .01$. $\eta^2 = .39$; $^{b}p < .01$. $\eta^2 = .20$
Nonword Trials				
Block 1	757	803	779	all p's $> .63$
Block 2	712	753	818	all p's $> .16$
Block 3	637^{a}	715	784^{a}	$^{a}p < .01$. $\eta^2 = .24$
Block 4	624^{a}	738	792^{a}	$^{a}p < .02$. $\eta^2 = .16$
Block 5	619^{a}	715^{b}	818^{ab}	$^{a}p < .01$. $\eta^2 = .34$; $^{b}p = .07$. $\eta^2 = .17$

PM W Target = Prospective Memory Word Target Condition and PM NW Target = Prospective Memory Nonword Target Condition; d = Cohen's d; η^2 = eta squared.

it was only when participants were able to predict the stimulus type on the upcoming trial by receiving a pre-trial warning. In the next experiment we sought to replicate our findings. In addition we included a nonword PM target condition in which participants had to remember to make their prospective memory response when a nonword PM target appeared. This allowed us to explore whether the stimulus specific interference effect could be crossed such that those with a PM word target showed costs only on word trials and those with a PM nonword target only showed costs on nonword trials.

EXPERIMENT 2

We wished to extend findings from the previous experiment by including a third condition in which participants were given prospective memory targets that were nonwords. The question of interest was whether costs might be most pronounced on trials that correspond to the type of target (word, nonword) that a participant had in mind. Many studies of prospective memory have used words as PM targets but have ignored potential costs to non-words nor have these studies included nonwords as PM targets. Following from Experiment 1 we predicted that costs would be greater for LDT word trials for those who had PM word targets and costs would be greater on LDT nonword trials for those who had PM nonword targets. Arguably it is plausible that participants with a nonword prospective memory target might show reaction time costs on *both* word and nonword trials because it might be more effortful to encode and maintain nonword prospective memory targets. In line with this idea, Dewhurst, Holmes, Brandt, and Dean (2006) investigated the speed of the ‘‘remember’’ and ‘‘know’’ components of recognition memory using words and nonwords as stimuli. Results

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from Experiment 3 of this study showed that RTs for remembering words were faster than for nonwords. Therefore it may be that the relative ease of retrieving words versus nonwords could be an important factor in determining whether a SSIE is observed. That is, if nonwords are more difficult to retrieve, then maintaining them as PM targets may influence ongoing task costs differently compared to word PM targets yielding more general task costs. In contrast, if the Guynn model is correct and task interference stems in part from item checking costs then there should not be general costs in the nonword PM target condition because participants should not check on trials where there is no match between stimulus types. In Experiment 2 we explored this research question.

Method

Participants. A total of 61 volunteers were recruited at Yeshiva University from undergraduate psychology courses where students received optional partial course credit or \$5.00 for their participation. Each participant was tested individually in sessions that lasted approximately 35 minutes. Participants were randomly assigned to one of three conditions (control condition, PM word target condition, PM nonword target condition) of a between-participants manipulation. There were 19 participants in the control condition, 22 participants in the PM word target condition, and 20 participants in the PM nonword target condition.

Materials and procedure. All materials used in the experiment were the same as those reported in Experiment 1. Instructions were identical to the previous experiment. The only difference was that we constructed six new prospective memory nonword targets (hantelep, utercomp, nestyho, honep, ckclo, rpape) that served as the prospective memory targets for the PM nonword target condition. In addition participants were required to make a manual PM response (press the F1 key) in response to a PM target.

Results and discussion

A prospective memory response was deemed correct if the participant made their F1 key press at any time before the word/non-word of the next trial appeared on the screen. Recall of the prospective memory targets at the end of the experiment was again high in this experiment (Control condition: $M = 5.17$, of 6 targets, $SD = 1.63$; PM word target condition: $M = 5.29$ of 6 targets, $SD = 1.18$; PM nonword target condition: $M = 5.10$ of 6 targets, $SD = 1.19$) with no significant difference between conditions ($p = .92$). This result indicates that participants did not seem to have any difficulty memorising and retaining the nonword targets.

Prospective memory task. There were no significant differences for prospective memory accuracy (i.e., remembering to press F1) as a function of condition ($p = .99$). The proportion of prospective memory targets correctly detected for the word target condition ($M = 7.95$ of 12 targets, $SD = 2.44$) did not differ significantly from performance in the nonword target condition ($M = 7.95$ of 12 targets, $SD = 2.93$).

Ongoing task. Data trimming resulted in 2.9% of trials being deleted as outliers. Performance was evaluated using a 2 (Word Type: word, nonword) $\times$ 2 (Block: Block 1, Block 2) $\times$ 3 (Condition: control, PM word target, PM nonword target) analysis of variance (ANOVA) with Word Type and Block as within-participants factors and Condition as a between-participants factor. Results revealed a main effect of Word Type, $F(1, 58) = 17.75$, $p < .001$, $\eta^2 = .23$, showing slower reaction times for nonword ($M = 766$ ms) compared to word lexical decision task trials ($M = 686$ ms). There was a main effect of Block, (1, 58) $= 40.98$, $p < .001$, $\eta^2 = .41$, revealing that performance was slower in Block 1 ($M = 756$ ms) compared to Block 2 ($M = 695$ ms). The main effect for Condition was not significant ($p = .13$). These significant main effects were qualified by several significant interactions. There was a significant interaction between Condition and Word Type, $F(2, 58) = 3.29$, $p = .06$, $\eta^2 = .10$, and a significant interaction between Condition and Block, $F(2, 58) = 15.67$, $p < .001$, $\eta^2 = .35$.

As in Experiment 1, these interactions were qualified by a significant three-way interaction, $F(2, 58) = 24.21$, $p < .001$, $\eta^2 = .46$, showing that there was a practice effect from Block 1 to Block 2 on lexical decision task performance for those in the control condition on both word and nonword trials. Those in the PM word target condition (those who memorised the six word PM

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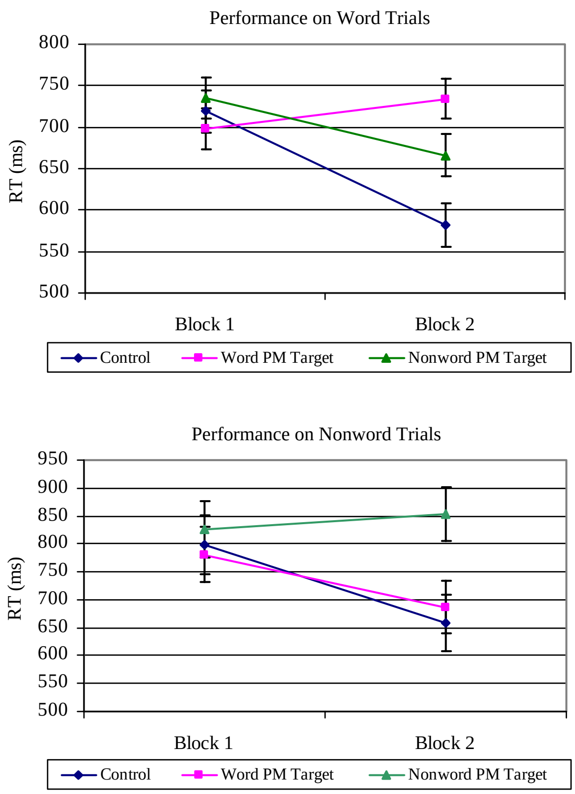

Figure 2. Upper Panel: Reaction time latencies on *word* trials in a lexical decision task in Experiment 2 as a function of condition (control, PM word, PM nonword) and block (1, 2). Lower Panel: Reaction time latencies on *nonword* trials in a lexical decision task in Experiment 2 as a function of condition (control, PM word, PM nonword) and block (1, 2). Bars represent standard error.

targets) showed costs on LDT word trials but no costs on LDT nonword trials. Interestingly, a corresponding pattern was found for those in the PM nonword target condition. Participants who memorised the nonword targets showed costs from Block 1 to Block 2 on LDT nonword trials but no costs on LDT word trials (see Figure 2).

Once again, and more definitively in this experiment, the three-way interaction showed that participants treated the ongoing LDT word and nonword items differently depending on what targets were relevant to intention-related processing. The results for each of these planned comparisons are shown in Table 1 and they confirmed the pattern apparent in the data. Once more there were no significant differences between conditions on Block 1 response times. The results demonstrate that the addition of the PM task in Block 2 has a detrimental effect on ongoing task performance when the PM target matched the ongoing task trials. In the case that a word target was a relevant target, costs were observed only on LDT word trials. Interestingly, we obtained the stimulus specific interference result using nonword PM targets. Participants tended to need more time to commit the six nonwords to memory during the encoding stage (presumably because nonwords are less familiar and thus more difficult to learn). As Dewhurst et al. (2006) state "Nonwords are unlikely to activate stored knowledge and will therefore be encoded less distinctively than words." (p. 156). For this reason one might have expected that the effort involved in maintaining PM nonword targets relative to PM word targets might have led to a more general task interference effect. However, results from Experiment 2 showed more definitively that ongoing task costs are driven by the degree of relevance between the target meant to elicit the intention and the ongoing task stimuli.

A central contribution of Experiments 1 and 2 was that task interference varied on a trial by trial basis when participants could not possibly predict the upcoming trial. Marsh et al. (2006) also demonstrated material specific interference; however, an important difference was that participants in Marsh et al. were warned of the critical feature in a preceding trial. Marsh et al. concluded that task interference is determined by attention allocation policies set when participants first encode the task instructions and more flexible local attention allocation policies that are employed when participants can predict what stimulus type is about to occur. The fact that we demonstrated that task interference varied on a trial by trial basis suggests that some other theoretical interpretation is needed to adequately explain our results. It is not possible to explain our pattern of data as a result of attention allocation policies because it would not be possible for participants to vary such a strategy on a trial by trial basis. Rather, our results suggest that some type of post-stimulus checking occurred similar to ideas expressed by Guyn (2003). When stimuli were encountered that were relevant to an active intention, then the loading of production rules may have resulted in slowing on the ongoing task.

In the next experiment we were interested in exploring whether we could disrupt this pattern of costs by failing to introduce any prospective memory targets. Loft et al. (2008) showed ongoing task costs can decrease over the course of the ongoing task if participants are not presented

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with PM targets. We were especially interested in examining whether task interference would decrease across trials and whether this pattern would be similar for those who were assigned word or nonword prospective memory targets.

EXPERIMENT 3

This experiment was identical to Experiment 2 in all respects except for one important difference. The major change in Experiment 3 was that targets in the PM word and PM nonword conditions did not occur until trial 472 (out of a total of 504 lexical decision trials) and then only one target word (or target nonword) appeared once. This is in contrast to Experiments 1 and 2 in which the six targets appeared twice each for a total of 12 appearances. We were interested in examining how ongoing task costs would or would not change over the course of the task as a result of the presence or absence of targets. As well, we wanted to examine whether participants would continue to exhibit task interference after a long period without target presentation and whether this pattern would differ when we examined ongoing task latencies separately for word and nonword trials. Loft et al. (2008) demonstrated that the allocation of attention to prospective memory tasks can decrease over the course of the ongoing task if these policies are not periodically reinforced by the presentation of targets. Thus Loft et al.'s (2008) results suggested that attention allocation policies set by participants can be modified on the basis of their experience with the ongoing task environment. In Experiment 2 participants told experimenters anecdotally that encoding nonwords took more effort during the intention formation phase. Therefore in Experiment 3 we thought that it might be the case that participants would feel the need to be especially vigilant in monitoring for nonword PM targets when they failed to appear. In a sense, participants might believe that they need to monitor more leading to greater overall interference costs for both word and nonword trials. Near the end of the experiment we finally introduced one of the relevant targets and observed whether performance changed in the last block of trials. Loft et al. (2008) never introduced the cues in their experiment therefore the examination of costs once the target was finally presented is a novel contribution of this experiment.

Scullin et al. (2010) also examined monitoring performance in the absence of presenting PM targets. The purpose of Experiment 4 of their study was to test whether focal word and nonfocal initial-letter PM targets would elicit prospective remembering when monitoring was eliminated by not presenting the target cue for a large proportion of trials. Scullin et al. (2010) also examined performance separately on word and nonword trials.

Hicks et al. (2005) suggested that ongoing costs or task interference reflects an attention allocation policy stored in memory when intentions are encoded. According to Hicks et al. (2005), attention allocation policies are adopted when intentions are encoded such that participants anticipate the degree to which they must devote resources to the prospective memory component of the task. Of course, ongoing task conditions can change from those expected when intentions are encoded so participants would benefit by modifying their attention allocation policy as experience with the ongoing task accumulates. In the following study we examined whether costs declined equally for both PM word and PM nonword target conditions when examining performance on lexical decision task word and nonword trials separately.

Method

Participants. A total of 60 volunteers were recruited at Yeshiva University from undergraduate psychology courses where students received optional partial course credit or $5.00 for their participation. Each participant was tested individually in sessions that lasted approximately 35 minutes. Participants were randomly assigned to one of three conditions (control condition, PM word target condition, PM nonword target condition) of a between-participants manipulation. There were 20 participants in each condition.

Materials and procedure. Participants were tested on an IBM-compatible Pentium computer with a VGA graphics card using the Micro-Experimental Laboratory Professional software package (Schneider, 1988). All stimulus materials used in the experiment were the same as those reported in Experiments 1 and 2. The experiment was administered identically to the previous two experiments in which participants performed two blocks of lexical decision trials with instructions for the prospective memory task given during the break. The major difference was that the prospective memory targets were not introduced until trial 472 and then there was only one occurrence. We used the same six cue words/nonwords as in the previous experiment and all critical words were counterbalanced across participants; however, only one of the critical words appeared in trial 472 for each participant. We were interested in how ongoing task costs would or would not change over the course of the task as a result of the absence of targets. More specifically, we wanted to examine whether patterns of monitoring differed between the PM word and PM nonword target conditions.

Phase One. Instructions were identical to the previous experiment. Participants performed a first block of lexical decision trials which consisted of 126 word trials and 126 nonword trials (252 in total). After the first block of trials participants took a break during which time they received instructions for the second portion of the lexical decision task.

Mid-Experiment Interval. Instructions were identical to the previous experiment such that those participants in the intention conditions memorised six words (or nonwords) and then completed a demographics questionnaire which provided the participants with no opportunity to rehearse the PM instructions. Participants in the *control condition* were given a retrospective memory task in which they were asked to memorise six target words. They were told that they would have to recall the six words at the end of the experiment as a memory check. Participants in the PM word target condition were instructed to press the F1 key on the computer keyboard (after first making their lexical decision) if they saw any one of the six word targets during the experiment and those in the PM nonword target condition were instructed to press the F1 key if they saw any one of the six nonword targets during the experiment. Then Block 2 resumed with no further reminders for the PM task.

Phase Two. As before, we emphasised the lexical decision task and instructed participants to respond as quickly and accurately as possible. The major change in Experiment 3 was that targets in the PM word and PM nonword conditions did not occur until near the end of the experiment. In trial 472 (out of a total of 504 lexical decision trials), one of the critical PM targets appeared once. We were interested primarily in two issues in this experiment. First, we want to examine how monitoring might be influenced by the absence of PM targets and would it differ across PM word and PM nonword target conditions. Second, when we finally introduced a PM target, would presentation of the target affect monitoring performance for the subsequent trials? Participants received two blocks of LDT trials similar to the design of the previous studies. However, when we later analysed the data we divided the trials into five blocks so that we could better examine the pattern of performance across the experiment.

Results and discussion

In contrast to the previous two experiments, recall of the prospective memory targets at the end of the experiment depended on the condition to which participants had been randomly assigned (control condition: $M = 5.33$, of 6 targets, $SD = .95$; PM word target condition: $M = 5.30$ of 6 targets, $SD = 1.03$; PM nonword target condition: $M = 3.95$ of 6 targets, $SD = 1.57$). There was a main effect of Condition, $F(2, 56) = 8.20$, $p < .01$, $\eta^2 = .23$ and planned pairwise comparisons revealed a significant difference ($p < .001$) between the PM nonword target condition compared to the control and PM word target conditions (which were not significantly different from each other, $p = .97$). This result indicates that participants who had to memorise the six nonwords performed more poorly at the end of the experiment when asked to recall them. This result is in contrast to Experiment 2 where recall was very high for both words and nonwords. It may be that memory recall is enhanced when the targets appear during the lexical decision task (as they did in Experiment 2), because participants had a chance to refresh their memory for them. In the current experiment the nonword targets never appeared (except for one near the end of the experiment) which no doubt led to poorer recall for nonwords.

Prospective memory task. There was only one prospective memory target for each participant so we did not submit these data to an analysis. Performance was exactly equivalent in the PM word ($M = .52$, $SD = .51$) and PM nonword

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($M = .52$, $SD = .51$) conditions, meaning that slightly more than half the participants in each condition remembered to press the F1 response when the target appeared. Specifically, 11 out of 21 participants in both conditions successfully executed the prospective memory response when the target appeared in the 472nd trial.

Ongoing task. Several trials were excluded: (a) the initial five trials of Block 1 and Block 2; (b) trials that contained PM targets; (c) the three trials that followed a PM trial; (d) trials where RTs were greater than 2.5 *SD*s from a participant's grand mean; and (e) trials containing incorrect lexical decisions. Data trimming resulted in 3.6% of trials being deleted as outliers.

Although participants experienced the lexical decision task as consisting of two blocks (similar to the previous two studies), we actually analysed the data by dividing the trials into five blocks. We excluded the first five trials of Block 1 in order to take into account the need for participants to warm up and get used to the task. The PM target appeared once on trial 472 so we did not analyse the 3 trials immediately following this PM target trial. We divided and analysed the trials as follows: Block 1: Trials 6–252 (part 1), Block 2: Trials 253–331 (part 2), Block 3: Trials 332–401 (part 2), Block 4: Trials 402–471 (part 2), Block 5: Trials 476–504 (part 2). As mentioned, the critical trial on which we introduced a prospective memory target word or nonword was on trial 472. We were interested in examining how costs might increase in Block 5 after the PM target suddenly appeared after a long period with no target presentation.

Performance was evaluated using a 2 (Word Type: word, nonword) $\times$ 5 (Block: 1, 2, 3, 4, 5) $\times$ 3 (Condition: control, word target, nonword target) analysis of variance (ANOVA) with Word Type and Block as within-participants factors and condition as a between-participants factor. There was a main effect of Word Type, $F(1, 57) = 31.01$, $p < .001$, $\eta^2 = .35$, showing slower reaction times for nonword ($M = 728$ ms) compared to word lexical decision task trials ($M = 658$ ms). There was a main effect of Block, $F(1, 57) = 18.26$, $p < .001$, $\eta^2 = .24$. Planned pairwise comparisons revealed that performance was significantly faster ($p = .001$) in Block 2 ($M = 692$ ms) compared to Block 1 ($M = 749$ ms), Block 3 ($M = 670$ ms) was significantly faster ($p = .001$) than Block 2 ($M = 692$ ms), Block 3 and Block 4 were not significantly different from each other ($p = .54$), and Block 4 ($M = 664$ ms) and Block 5 ($M = 691$ ms) were significantly different from each other ($p = .001$). This pattern of latencies shows that RTs gradually decreased across blocks until they plateaued between Blocks 3 and 4 and then bumped up in Block 5. The main effect for Condition was significant, $F(2, 57) = 4.49$, $p < .05$, $\eta^2 = .14$, showing that latencies in the PM word ($M = 734$ ms) and PM nonword ($M = 708$ ms) conditions were significantly slower (both *p*s $< .05$) than performance in the control condition ($M = 638$ ms). Latencies for the PM word and PM nonword condition were not significantly different from each other ($p = .42$). These significant main effects were qualified by several significant interactions.

There was a significant interaction between Condition and Word Type, $F(2, 57) = 12.85$, $p < .01$, $\eta^2 = .31$, and a significant interaction between Condition and Block, $F(8, 228) = 5.97$, $p < .05$, $\eta^2 = .17$. As in the previous experiments, these interactions were qualified by a significant three-way interaction, $F(8, 228) = 5.91$, $p < .001$, $\eta^2 = .17$ (see Figure 3). As in the previous two experiments there were no significant differences between conditions on Block 1 baseline response times. When we examined performance solely on LDT word task performance, then we observed on Blocks 2, 3, 4, and 5 that response times for those in the PM Word Target condition were significantly slower compared to the Control condition and those in the PM Nonword Target conditions (see Table 1). When we analysed response times on LDT nonword trials then we found a different pattern. Those individuals in the PM Nonword Target condition were significantly slower in Blocks 3, 4, and 5 relative to the Control condition (see Table 1).

Inspection of the means in Figure 3 shows that participants in both PM word and PM nonword conditions showed slowing when the target did not appear but this slowing was greatest on LDT trials that matched the PM target that they had in mind. This result was consistent with the previous two experiments. In the upper panel of Figure 3, which depicts performance on word LDT trials, we can see that participants who had PM word cues as targets showed greater slowing across the four blocks relative to those who had PM nonword cues as targets. Interestingly, in Block 5 after a PM target was introduced, performance in *both* PM word and nonword conditions showed a sudden increase in monitoring. If we inspect the lower panel of Figure 3, which depicts

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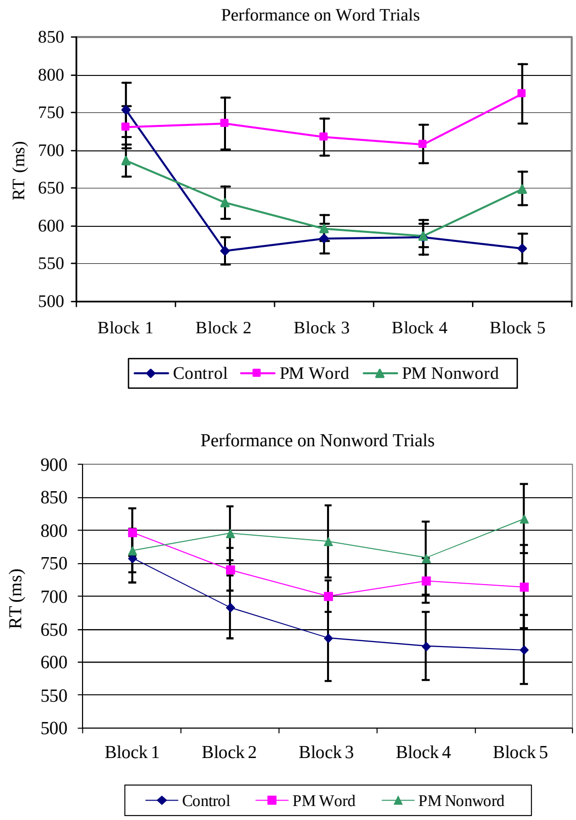

Figure 3. Upper Panel: Reaction time latencies on *word* trials in a lexical decision task in Experiment 3 as a function of condition (control, PM word, PM nonword) and block (1, 2, 3, 4, 5). Lower Panel: Reaction time latencies on *nonword* trials in a lexical decision task in Experiment 3 as a function of condition (control, PM word, PM nonword) and block (1, 2, 3, 4, 5). Bars represent standard error.

performance on nonword LDT trials, we can see a similar pattern for the first four blocks where there was greater slowing for those who had a PM nonword target. Notably, the pattern of performance in Block 5 was different for PM word and PM nonword conditions. We conducted paired samples *t*-tests to analyse the change from Block 4 to Block 5 as a function of condition (control, word PM target, nonword PM target) and type of trial (word, nonword). Those in the control condition showed no significant difference from Block 4 to Block 5 for word ($p = .56$) and nonword ($p = .81$) trials. Those who had PM word targets as targets did show an increase in monitoring in the fifth block for word trials ($p = .02$) but not for nonword trials ($p = .63$). Those who had PM nonword targets as targets did show an increase in monitoring in the fifth block for both word trials ($p = .01$) and a marginal increase in monitoring for nonword trials ($p = .07$). In sum, on word LDT trials: there was an increase in slowing in the fifth block for participants in both the PM word and PM nonword conditions; however, for nonword trials: there was a marginal increase in slowing in the fifth block but only for those in the PM nonword condition. These differential results on Block 5 performance suggest that when participants have PM nonwords as prospective memory targets, they may be less confident of their ability to monitor for targets. Memorising six nonwords (e.g., lueb, lirgs, ceedid, emberm, aybem, shabund) is more difficult than memorising six words. Typically, participants took longer to memorise nonword PM targets compared to words. Therefore participants may be less confident in their ability to maintain six nonwords in mind. Therefore when the PM target finally appeared in Block 5 it led to a sudden slowing for both word and nonword trials as participants begin to monitor more vigilantly.

We also conducted an analysis of Block 4 to Block 5 performance separately based on those who succeeded in correctly responding to the PM target and those who did not. When we analysed performance separately, performance for participants who successfully responded to the PM target exhibited the same pattern of performance as described in the analyses above. However, when we examined performance for those participants who failed to respond to the PM target, there was no significant difference from Block 4 to Block 5. That is, participants did not suddenly begin monitoring in Block 5. This result is intuitive because if participants did not respond to the PM target then presumably they were unaware that the target appeared and thus did not change their monitoring strategy. In addition, we conducted an analysis similar to the one described in Experiment 4 of Scullin et al. (2010). We analysed the five trials preceding the PM target in Experiment 3 as a function of PM accuracy. There was no significant difference ($p = .63$) in mean RTs for the five trials preceding a PM target that was correctly identified (697 ms) compared to trials preceding a PM target that was not correctly identified (717 ms). However, performance in the control condition (614 ms) was significantly faster ($p = .006$) compared to PM successes (697 ms) and performance in the control condition was also significantly faster ($p = .031$) compared to those who did not successfully identify the cue (717 ms). Thus participants who successfully did or did not identify a PM target

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were monitoring at equivalent levels but both groups monitored more compared to the control condition. In sum, participants monitored more when they had a PM task compared to the control condition but the degree of monitoring did not seem to predict successful prospective memory performance. Our results mirror the findings in Scullin et al. (2010) for the nonfocal cue condition. Although our PM tasks in the three experiments would be considered focal tasks, using six PM targets led to monitoring levels that were more akin to a nonfocal task.

GENERAL DISCUSSION

Results from all three experiments demonstrated that reaction time costs were most pronounced on trials where there was material specific overlap between intention-related targets and ongoing stimuli. That is, when a word was a prospective memory target (e.g., GIRL), then reaction time costs were most pronounced on *word* LDT trials. Similarly, if a PM target was a nonword (e.g., UEBL) then costs were most evident on nonword LDT trials. In all three experiments the lexical decision task involved a randomly presented mix of words and nonwords; thus, participants could not predict what type of stimulus item (word vs nonword) might appear next. One might expect that such a presentation of stimuli would lead to more general task interference. The fact that differential patterns of costs were found in a lexical decision task where word and nonword trials are not in blocks but occur on a trial-by-trial basis has important implications for theory building. The observation of task interference is in line with predictions made by both the PAM model and the multiprocess view. However, it is not clear how these two theories would account for the finding that ongoing costs vary across trials according to stimulus type. Our results may be best understood in the context of Guynn's (2003) two-process model of strategic monitoring.

As described previously, Guynn (2003) makes a distinction between retrieval mode and item checking. We conceive of retrieval mode as driven by top-down processes and item-checking as driven by more bottom-up or data-driven processing. When participants receive the task instructions then they must adopt some attention allocation strategy in order to meet the demands of the ongoing LDT and PM task. We suggest that after processing the instructions the participant adopts a retrieval mode meaning that the participant is aware that a PM target may appear in the future. They are in a state of readiness to act. However, the person is relatively free to focus attention to the ongoing task and in our view retrieval mode does not always necessarily involve costs. The second component of this Guynn (2003) model is known as item checking. This component of strategic monitoring involves checking the environment for the target events. In this component attention is devoted to stimuli where the retrieval target would be expected to occur and the individual evaluates whether or not a stimulus in that context is a retrieval target for an intended action. Therefore we would argue that participants employ retrieval mode in both the word and nonword contexts; however item checking and the greater costs associated with this type of monitoring appears only in contexts where the PM target and ongoing task stimuli match. Item checking appears to be implemented as more of an online strategy that is applied when the features of the stimuli in the ongoing task match with those of the PM target stimuli. Participants may have been unable to suppress intention-related processing due to the overlapping features between LDT words and prospective memory word targets. This notion is similar to ideas expressed by Kvavilashvili and Fisher (2007). They stated that "These periodic conscious thoughts about the [prospective memory] task may, in turn, serve an important function of further reactivating the representation of the intention during the retention interval, increasing the chances that it will eventually be remembered at the appropriate moment N . . ." (p. 127).

Our findings can be used to better understand when everyday intentions may exert some interference and when they may not. Marsh et al. (2006) also demonstrated that task interference was material specific to pictures and words depending on the type of PM target that was relevant. However these effects were only observed when stimuli on an upcoming trial could be predicted. It is important to understand why Marsh et al. (2006) did not find material specific interference in Experiment 1A when picture and word trials were presented randomly. Notably, the ongoing tasks in Marsh et al. (2006) had greater retrieval demands than the ongoing tasks used in the current studies. Experiments 1A, 1B, and 2 used ongoing tasks that had greater retrieval demands compared to a straightforward LDT. Experiment 3 also added a dimension of colour to

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the LDT. Therefore all of the ongoing tasks in Marsh et al. (2006) were more complex than the straightforward LDT in the current experiments. The logic is that if the demands of the ongoing task are high, then each stimulus regardless of whether it is relevant or irrelevant to the intention requires more processing making it less likely to avoid a general interference effect. A second important difference between these two sets of studies was the nature of the prospective memory intention. Marsh et al. (2006) used a category PM target (furniture words) whereas we used specific cues (six specific words/nonwords learned to a criterion level). Ellis and Milne (1996) and Einstein et al. (1995) showed that prospective memory performance was significantly more accurate for specific cues relative to category cues. Therefore the need to maintain in mind a category PM target such as furniture words may have been more effortful and led to more resource-consuming task strategies. Participants may have needed to allocate more preparatory attentional resources to the ongoing task in Experiment 1A when they could not predict the upcoming stimulus resulting in slowing on both classes of items. In our studies the PM targets were learned to a criterion level before commencing the task. So, in a sense, the participant could forget about the PM items and store them in long-term memory where they did not interfere with LDT performance until there was sufficient evidence from the ongoing task stimuli to prompt item checking. Based on our data, this item checking mostly occurred when there was a match between word LDT trials and PM word targets and nonword LDT trials and PM nonword targets.

Whether the effects in the current study are operating at a conscious or unconscious level is unclear until further research can be conducted. Anecdotally, participants questioned at the end of the experiment responded that they were not aware of using different strategies for word and nonword trials. That is, most participants claimed that they devoted most of their attention to performing the ongoing LDT and then sometimes the PM task would come to mind or they would remember the PM task in response to seeing one of the PM targets. It has long been understood that attentional control involves both stimulus-driven and goal-directed components. We assume that the SSIE is being driven by a combination of top-down and bottom-up processes. The fact that we found costs for nonwords when targets were nonwords implies that words and nonwords may be processed more similarly than previously thought. In a footnote, Hicks et al. (2005) state: ''All other factors being equal, the reader might assume that nonword latencies would show some evidence of monitoring just like the words in a lexical decision task. One problem in making this prediction is that nonword/negative decisions in a lexical decision task may be a function of extra cognitive processes using extralexical information'' (p. 433). Hicks et al. (2005) cite the work by Grainger and Jacobs (1996) who have suggested that word/nonword discrimination involves participants using extralexical information such as familiarity and meaningfulness to make rapid and accurate judgments concerning the ''word-likeness'' of stimuli. The fact that we found costs for nonwords when targets were nonwords seems to imply that words and nonwords may be processed more similarly than previously thought and what is important is the degree of correspondence between the PM target and the ongoing task stimuli. Importantly, we have other unpublished data that perfectly replicate the SSIE using nonverbal stimuli (shapes and nonshapes). Therefore it may be that what is important here is that the stimuli can be distinguished rapidly by a speeded binary decision response and it is this dichotomous property of the stimuli that is important.

Our data present a more nuanced explanation of the relationship between PM targets and task interference in which monitoring processes can be triggered by the occurrence of a stimulus that matches the category of the prospective memory target item. Marsh et al. (2003) reasoned that target interference can be the result of slowing on one or more of the following cognitive processes underlying prospective memory including (a) recognition of the target, (b) verification that the target is a match to the associated intention, (c) retrieval of the correct response, and (d) coordination of both the prospective and ongoing-task responses. Although Marsh et al. (2003) were referring to target interference as opposed to task interference, one might hypothesise that item checking costs may be due in part to verification and/or retrieval processes. For example, on some proportion of LDT trials where there is overlap between the PM target and LDT ongoing task stimuli verification processing might be needed in order to resolve the dual role of a stimulus (i.e., being a potential prospective memory target and an LDT stimulus). Thoughts of the

PM instructions may come to mind more often on trials where the stimulus could be classified as both an ongoing task LDT word stimulus and a PM target (e.g., in the case that the PM target was a word). On these trials some verification processes might be needed to establish whether the item is in fact at PM item or simply an ongoing task stimulus. This competition for resources between the prospective memory and ongoing tasks may occur due to the need for the use of a common processing mechanism resulting in increased costs.

Results from Experiment 3 showed that participants were not able to update or reset their attention allocation policies when the prospective memory targets did not appear. Interestingly, this effect was most pronounced when the PM target matched the type of ongoing task stimulus. That is, when participants had a PM word target, there was more slowing on LDT word trials, and, similarly, when participants had a PM nonword target, there was more slowing on LDT nonword trials. In Loft et al. (2008) the findings revealed significantly less task interference when expected PM targets were not presented compared to conditions in which they were presented. That is, in contrast to our own results, Loft et al. (2008) showed that participants were able to reset their attention allocation policies. It is important to note that there were several important differences between the Loft et al. (2008) paradigm and our own. First, to avoid ceiling effects participants were asked to complete a 5-minute computer card task before resuming Block 2 of the LDT. In our task participants had to fill out a brief demographic questionnaire which only required about two minutes before resuming the lexical decision task. Therefore it might have been easier to maintain the prospective memory instructions in the current experiment compared to the Loft et al. (2008) task which involved higher cognitive load (eight versus six targets) and a longer and more involved intervening task. Second, in the Loft et al. (2008) study participants performed many more trials compared to the current task. Therefore it is plausible that if we had given participants enough trials, then monitoring would have eventually tapered off.

In Scullin et al. (2010) participants encoded a single target word (e.g., *equator*) or a single initial-letter (e.g., *e*). An interaction was observed showing that interference levelled off for RTs in the initial-letter condition and no significant task interference was observed throughout the blocks in the word condition. That is, participants had only one target to hold in mind and although initially in Quintile 1, participants in the initial letter condition did incur costs they dissipated by Quintile 5. In contrast, in our experiment participants had to maintain six words (or six nonwords in the PM nonword target condition) which was quite challenging. Therefore this might have led to a stronger expectation that one of these six targets MUST appear since it might seem to participants that this was an important component of the overall task instructions. In Scullin et al. (2010) it might have been easier for participants to abandon monitoring for one cue because in a sense participants might have felt like there was less at stake. In the Loft et al. (2008) experiment participants also had a significant cognitive load (eight targets) but they had twice as many trials for monitoring to eventually dissipate.

CONCLUSIONS

The specificity of task interference on a trial-by-trial basis represents a novel and to our knowledge undemonstrated effect and a key step in understanding the processes that mediate strategic monitoring in event-based prospective memory. Typically, monitoring in prospective memory tasks was understood to occur prior to the appearance of a target event. If so, then one would expect that task interference should have been equivalent for both word and nonword trials. Rather, specific features of the ongoing task stimuli appear to trigger checking whether the stimulus represents a prospective memory target. We propose that participants are capable of selectively filtering out stimuli depending on the physical characteristics that were specified in a previously encoded intention. By "filtering" we mean to say that some items get processed further as to whether this item is a prospective memory target. Our hope is that continued investigation into such questions will help us better understand how individuals can maintain intentions and why these intentions sometimes do or do not interfere with ongoing activities. It is adaptive that the human mind can use such a flexible strategy to limit cognitive costs and more research is needed to further understand the complex relationship between PM targets and task interference.

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REFERENCES

Cohen, A-L., Jaudas, A., & Gollwitzer, P. M. (2008). Number of cues influence the cost of remembering to remember. *Memory and Cognition*, *36*, 149–156.

Dewhurst, S. A., Holmes, S. J., Brandt, K. R., & Dean, G. M. (2006). Measuring the speed of the conscious components of recognition memory: Remembering is faster than knowing. *Consciousness and Cognition*, *15*, 147–162.

Einstein, G. O., McDaniel, M. A., Richardson, S. L., Guynn, M. J., & Cunfer, A. R. (1995). Aging and prospective memory: Examining the influence of self-initiated retrieval processes. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*, 996–1007.

Einstein, G. O., McDaniel, M. A., Thomas, R., Mayfield, S., Shank, H., Morrisette, N., et al. (2005). Multiple processes in prospective memory retrieval: Factors determining monitoring versus spontaneous retrieval. *Journal of Experimental Psychology: General*, *134*, 327–342.

Ellis, J. A., & Freeman, J. E. (2008). Ten years on: Realising delayed intentions. In M. Kliegel, M. A. McDaniel, & G. O. Einstein (Eds.), *Prospective memory: Cognitive, neuroscience, developmental, and applied perspectives*. Mahwah, NJ: Lawrence Erlbaum Associates Inc.

Ellis, J., & Milne, A. (1996). Retrieval cue specificity and the realization of delayed intentions. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, *49*(A), 862–887.

Grainger, J., & Jacobs, A. M. (1996). Orthographic processing in visual word recognition: a multiple read-out model. *Psychological Review*, *103*, 518–565.

Guynn, M. J (2003). A two-process model of strategic monitoring in event-based prospective memory: Activation/retrieval mode and checking. *International Journal of Psychology*, *38*, 245–256.

Hicks, J. L., Marsh, R. L, & Cook, G. I. (2005). Task interference in time-based, event-based, and dual intention prospective memory conditions. *Journal of Memory & Language*, *53*, 430–444.

Hunt, R. R., & Toth, J. E. (1990). Perceptual identification, fragment completion, and free recall: Concepts and data. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, *16*, 282–290.

Kliegel, M., McDaniel, M. A., & Einstein, G. O. (2008). *Prospective memory: Cognitive, neuroscience, developmental, and applied perspectives*. Mahwah, NJ: Lawrence Erlbaum Associates Inc.

Knight, J. B., Ethridge, L. E., Marsh, R. L., & Clementz, B. A. (2010). Neural correlates of attentional and mnemonic processing in event-based prospective memory. *Frontiers in Human Neuroscience*, *4*, 1–13.

Kucera, H., & Francis, W.N. (1967). *Computational analysis of present-day American English*. Providence, RI: Brown University Press.

Kvavilashvili, L., & Fisher, L. (2007). Is time-based prospective remembering mediated by self-initiated rehearsals? Role of incidental cues, ongoing activity, age, and motivation. *Journal of Experimental Psychology: General*, *136*, 112–132.

Loft, S., Kearney, R., & Remington, R. (2008). Is task interference in event-based prospective memory dependent on cue presentation? *Memory & Cognition*, *36*, 139–148.

Marsh, R. L., Cook, G. I., & Hicks, J. L. (2006). Task interference from event-based intentions can be material specific. *Memory & Cognition*, *34*, 1636–1643.

Marsh, R. L, Hicks, J. L., Cook, G. I., Hansen, J. S., & Pallos, A. L. (2003). Interference to ongoing activities covaries with the characteristics of an event-based intention. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, *29*, 861–870.

Schneider, W. (1988). Micro Experimental Laboratory: An integrated system for IBM PC compatibles. *Behavior Research Methods, Instruments and Computers*, *20*, 206–217.

Scullin, M. K., Einstein, G. O., & McDaniel, M. A. (2009). Evidence for spontaneous retrieval of suspended but not finished prospective memories. *Memory and Cognition*, *37*, 425–433.

Scullin, M. K., McDaniel, M. A., Shelton, J. T., & Lee, J. H. (2010). Focal/nonfocal cue effects in prospective memory: Monitoring difficulty or different retrieval processes? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *36*, 736–749.

Smith, R. E. (2003). The cost of remembering to remember in event-based prospective memory: Investigating the capacity demands of delayed intention performance. *Journal of Experimental Psychology: Learning Memory and Cognition*, *29*, 347–361.

Smith, R. E., & Bayen, U. J. (2004). A multinomial model of event-based prospective memory. *Journal of Experimental Psychology: Learning Memory and Cognition*, *30*, 756–777.

Smith, R. E., Hunt, R. R., McVay, J. C., & McConnell, M. D. (2007). The cost of event-based prospective memory: Salient target events. *Journal of Experimental Psychology: Learning Memory and Cognition*, *33*, 734–746.