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Control of Cost in Prospective Memory: Evidence for Spontaneous Retrieval Processes

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To examine the processes that support prospective remembering, previous research has often examined whether the presence of a prospective memory task slows overall responding on an ongoing task. Although slowed task performance suggests that monitoring is present, this method does not clearly establish whether monitoring is functionally related to prospective memory performance. According to the multiprocess theory (McDaniel & Einstein, 2000), monitoring should be necessary to prospective memory performance with nonfocal cues but not with focal cues. To test this hypothesis, we varied monitoring by presenting items that were related (or unrelated) to the prospective memory task proximal to target events. Notably, whereas monitoring proximal to target events led to a large increase in nonfocal prospective memory performance, focal prospective remembering was high in the absence of monitoring, and monitoring in this condition provided no additional benefits. These results suggest that when monitoring is absent, spontaneous retrieval processes can support focal prospective remembering.

Prospective memory refers to remembering to perform an intended action in the future or simply remembering to remember. Real-world prospective memory demands, such as remembering to show up for an appointment, remembering to take medication, and remembering to give someone a message, are ubiquitous (Crovitz & Daniel, 1984; Terry, 1988). Although researchers have been investigating retrospective memory (memory for past events such as memory for a list of items) for over a century (Ebbinghaus, 1885/1964), laboratory-based prospective memory research has emerged only during the past two decades (Einstein & McDaniel, 1990).

One critical difference between event-based prospective memory tasks and typically studied retrospective memory tasks (e.g., cued recall) exists at retrieval. On explicit tests of retrospective memory, experimenters prompt participants to recall or recognize a number of target items. By alerting participants to remember, experimenters put participants in a retrieval mode (Tulving, 1983) that engages them in a search of memory for previously studied target items. Yet, in tests of event-based prospective memory, participants are instructed to perform an ongoing activity, and also on some target event (e.g., a cue word), they must interrupt performance of the ongoing task to execute an intended action. Thus, participants are not prompted to initiate a search of memory when the target item appears. Determining the process or processes that underlie prospective remembering (i.e., the conscious realization of an intention) has been at the center of vigorous research in the field (Einstein & McDaniel, 2005; Guynn, 2003; McDaniel & Einstein, 2007a; McDaniel, Guynn, Einstein, & Breneiser, 2004; Smith, 2003; Smith, Hunt, McVay, & McConnell, 2007).

Two general categories of theories have been developed to explain prospective memory retrieval. One perspective proposes that attentional and/or working memory resources need to be devoted to monitoring the environment for the occurrence of the target event (Guynn, 2003; Smith, 2003). According to this perspective, strategic, resource-demanding processes must be engaged before the occurrence of a target event if one is to successfully retrieve an intention. In laboratory prospective memory tasks, the idea is that as trials of the ongoing task are presented, for each trial the monitoring process stimulates a recognition check to evaluate whether the trial is the appropriate one for performing the intended action (Guynn, 2003; Smith & Bayen, 2004). If the recognition check indicates that the trial represents a target event, then the intended action is activated and executed. Prospective memory failures can therefore occur either because the person fails to initiate a recognition check (i.e., fail to monitor) or because the recognition check fails to identify the event as a target. Empirical evaluation of the monitoring perspective has rested primarily on two key assumptions. One is that monitoring processes require capacity-demanding attentional processes. The second is that retrieval of the prospective memory intention is not possible without the monitoring process. Thus, monitoring processes are assumed to be required for prospective remembering to occur.

Because the monitoring perspective posits that prospective memory performance depends on processes that require attentional resources, one line of research has evaluated the extent to which adding a prospective memory task interferes with performance of the ongoing activity. In these studies, the speed of performing the ongoing task alone is compared with the speed of performing the ongoing activity when a prospective memory task is embedded. According to the monitoring perspective, the resource-demanding processes required for prospective memory will reduce the atten-

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tional resources available for performing the ongoing activity. Thus, if monitoring processes are engaged during a prospective memory task, the expectation is that these processes exact a (speed) cost to the ongoing activity. A number of studies have reported just this pattern for some experimental conditions (Burgess, Quayle, & Frith, 2001; Cohen, Jaudas, & Gollwitzer, 2008; Einstein et al., 2005; Marsh, Hicks, Cook, Hansen, & Pallos, 2003; Scullin, McDaniel, Shelton, & Lee, 2009; Smith, 2003; Smith & Bayen, 2004; Smith et al., 2007; but for some exceptions, see Cohen et al., 2008; Einstein et al., 2005; Marsh et al., 2003; Scullin, McDaniel, et al., 2009).

The monitoring perspective yields an even more fine-grained expectation regarding prospective memory-induced cost to the ongoing activity. Because cost is assumed to reflect degree of monitoring, which is assumed to mediate prospective memory, larger amounts of cost should lead to greater prospective memory performance. In several experiments, Smith (2003) confirmed that this pattern also obtained, thereby demonstrating that a range of findings can be marshaled to support the view that monitoring is necessary for prospective remembering.

The above findings provide evidence for prospective memory conditions that exact an overall cost on the ongoing task and that levels of cost are sometimes positively correlated with prospective memory performance (e.g., Smith, 2003). However, because there are some reports of nonsignificant cost (e.g., Cohen et al., 2008; Einstein et al., 2005; Scullin, McDaniel, et al., 2009), and other reports of lower cost being accompanied by higher prospective memory performance (McNerney & West, 2007), monitoring may not always be needed for successful prospective memory retrieval. Given the prevalence of prospective memory demands in everyday life, McDaniel and Einstein (2000, 2007a) suggested that it is adaptive to have a cognitive system that can accomplish prospective memory retrieval through several processes. Their multiprocess theory argues that, in addition to resource-demanding processes such as monitoring, prospective remembering may sometimes be spontaneously elicited by features of the target cue, even when no resources are devoted to the prospective memory intention at the time the target occurs.

Spontaneous retrieval may be supported by a number of processes. For instance, if a cue is associated strongly with an intended action during planning, then processing the cue will reflexively trigger retrieval of the associated intention (i.e., the reflexive–associative hypothesis; McDaniel et al., 2004). Another possibility is that the cognitive system routinely evaluates events for the coherence of their processing, with such evaluations sometimes producing discrepancies between the expected and actual dynamics of the processing (Whittlesea & Williams, 2001a, 2001b). Prospective memory target events may produce such discrepancies, thereby evoking a sense of significance that spontaneously alerts the person to the target event as a prospective memory cue (see Breneiser & McDaniel, 2006; McDaniel & Einstein, 2007b, and McDaniel et al., 2004, for theoretical and empirical elaboration of these possible processes in the service of prospective memory). It is important to note that in contrast to the monitoring perspective, spontaneous retrieval is argued to occur even when no resources are devoted to monitoring for the target prior to and during the target's occurrence (McDaniel et al., 2004).

An assumption of the multiprocess perspective is that reliance on either monitoring or spontaneous retrieval to support prospective remembering will depend on a variety of factors associated with the prospective memory and ongoing task demands as well as characteristics of the individual (see McDaniel & Einstein, 2007a, Chapter 4, for a complete description of the factors assumed to affect the extent to which participants engage a monitoring process). One important distinction is the difference between focal and nonfocal prospective memory cues. Focal and nonfocal cues differ in the extent to which the ongoing task directs attention to the target cue and especially those features that were processed during encoding. For example, during a category decision task that involves deciding whether a presented word is a member of a given category, a focal cue would be the word *tornado,* whereas a nonfocal cue would be the syllable *tor* (see Einstein & McDaniel, 2005, for additional examples of focal and nonfocal cues). The multiprocess perspective predicts that monitoring is important (if not necessary) for retrieving intentions associated with nonfocal cues but that monitoring is less important when the prospective memory cue is focal. Depending on an individual's metamemory for different prospective memory demands (Einstein & McDaniel, 2008), one may forgo monitoring for focal cues and rely on spontaneous retrieval processes to support focal prospective remembering.

Critical for comparing the monitoring and multiprocess perspectives is determining the extent to which monitoring is functionally related to prospective memory performance. This issue is especially pertinent because most research has focused on whether monitoring is present during a prospective memory task as opposed to assessing whether monitoring is necessary and sufficient to explain prospective memory performance. Research directed at establishing the functional nature of monitoring to prospective remembering (or lack thereof; see McNerney & West, 2007) has been minimal, perhaps because extant measures of monitoring lack precision. Because monitoring is inferred from cost averaged across the entire set (i.e., dozens if not hundreds) of ongoing task trials, it is ambiguous whether monitoring is occurring proximal to and during presentation of the target event. For instance, on average, ongoing task cost could be observed if *some* individuals monitor on *some* trials, but because monitoring may wax and wane (cf. Loft, Kearney, & Remington, 2008; Marsh, Hicks, & Cook, 2006; McDaniel, Einstein, & Rendell, 2008; Scullin, McDaniel, et al., 2009; West & Craik, 1999), it is possible that successful prospective memory retrieval occurs during periods when monitoring has waned. A more theoretically illuminating approach would be to measure ongoing task reaction times on trials immediately preceding target events and especially those in which the prospective memory action was executed. If ongoing task cost is eliminated immediately preceding target events and prospective memory performance is low, then we may conclude with reasonable certainty that monitoring is imperative to prospective memory.

We are aware of only two published studies that examined reaction times on trials immediately preceding target events. During an *n*-back ongoing task, West, Krompinger, and Bowry (2005) examined reaction times on the three trials preceding focal and nonfocal prospective memory hits and prospective memory misses. The results demonstrated that ongoing task reaction times were slower on trials preceding focal (Experiment 1) and nonfocal (Experiment 2) prospective memory hits than on trials preceding prospective memory misses. West et al. interpreted this finding as evidence that monitoring processes support prospective remembering.

In another study, Loft and Yeo (2007) manipulated whether the focal prospective memory cue and intended action were highly or minimally associated and then examined lexical decision reaction times on the three trials preceding prospective memory hits and misses. When the prospective memory target cue and action were minimally associated, these authors found a significant difference (Experiments 2–3) between ongoing response times on trials preceding focal prospective memory hits compared with trials preceding focal prospective memory misses. In contrast, the highly associated condition did not yield significant differences between prospective memory hits and prospective memory misses in pretarget reaction times. This pattern suggests that monitoring may not always be necessary for prospective remembering to occur.

A limitation of the above research for evaluating whether monitoring processes are necessary for prospective remembering is that the task conditions generally encouraged monitoring. West et al. (2005) included prospective memory targets on 10% of the trials (see Loft & Yeo, 2007, for evidence that presenting target cues frequently increases engagement of monitoring), and Loft and Yeo required participants to remember four different prospective memory target words (see Cohen et al., 2008, and Einstein et al, 2005, Experiment 3, for evidence that using more than 1–2 targets encourages monitoring). These conditions may increase the perceived difficulty or importance of the prospective memory task and thus lead participants to exert cognitive control to maintain both the ongoing task and prospective memory task goal sets in mind. Under conditions that encourage devoting attention to the prospective memory task, it is difficult to test whether monitoring was required for successful prospective memory retrieval or whether spontaneous retrieval processes could have supported retrieval.

Thus, although there is some evidence that monitoring can increase prospective memory performance under some conditions (Loft & Yeo, 2007; Smith, 2003; West et al., 2005), this effect is predicted by both the monitoring and multiprocess perspectives. A clearer condition for testing the functionality of monitoring and teasing apart the monitoring and multiprocess perspectives is to manipulate whether monitoring processes are utilized on trials immediately preceding a target event. Under conditions of no monitoring, the multiprocess perspective, but not the monitoring perspective, predicts that prospective memory retrieval can occur if the cue is focally processed.

The goal of precisely controlling monitoring immediately before target cues is ambitious, and we accordingly implemented several experimental conditions to promote straightforward interpretation of results. Our primary consideration was to minimize trial-by-trial monitoring so that we could gain fairly close control of when such a strategy was engaged. To do so, we used instructions that greatly emphasized the importance of the ongoing task as well as divided attention during the ongoing task. To examine the effects of monitoring, as well as to gauge the degree to which participants sustained monitoring processes, we attempted to prompt monitoring at designated points in the ongoing task by presenting stimuli that were associated with the prospective memory task. We first used words that were semantically related to the target word (semantic lures), and in Experiment 2 we presented a particular background screen color to signal that the target word might soon appear. By gaining some control over monitoring (especially immediately preceding target events), we could determine whether monitoring was necessary for performing focal (Experiments 1 and 2) and nonfocal (Experiment 2) prospective memory tasks and whether spontaneous retrieval would support prospective remembering in the absence of monitoring.

Experiment 1

Prior to Experiment 1, we conducted a pilot experiment to confirm critical aspects of the method that we developed to bring monitoring under experimental control. First, the pilot work suggested that trial-by-trial monitoring could be minimized by dividing attention with a digit detection task, employing a prospective memory task that had minimal retrospective memory load (a single target cue and a simple action), deemphasizing the prospective memory task while emphasizing the ongoing task, and presenting the target word infrequently (on fewer than 2% of ongoing trials). Second, inserting semantic lures into the ongoing task distal from target cues caused slowing to ongoing task performance, thereby suggesting that participants retrieved the prospective memory task (cf. Kvavilashvili & Fisher, 2007), and began to monitor for the prospective memory target for at least five trials.[1] It is important to note that monitoring following presumed retrieval of the prospective memory task (stimulated by the semantic lures) was not sustained until the target events: Cost on trials proximal to target events was nonsignificant and not even in the direction of cost. The results of this pilot experiment suggested that our method generally discouraged participants from engaging monitoring processes during the prospective memory block and, further, that monitoring was highly unlikely to occur proximal to target events. However, statistical power was not very high for some analyses, and we therefore thought it prudent to replicate the null result of no proximal cost prior to target events.

To begin to understand the relation between costly monitoring and prospective memory performance, we used the pilot experiment finding that semantic lures caused some temporary cost to investigate whether cost immediately prior to target cues improves prospective remembering. Specifically, we manipulated whether the semantic lures were presented proximal to or distal from target events. Because semantic lures appear to cause temporary monitoring (reflected by cost), participants in the proximal-cue condition but not the distal-cue condition should be monitoring when the target event is encountered.

If the assumption that monitoring is always required for prospective remembering is correct, then inducing monitoring close to the target event should lead to relatively high prospective remembering, whereas prospective memory performance should be at

[1] Previous research (Marsh et al., 2003) has suggested that categorical cues are unlikely to elicit spontaneous prospective remembering. Therefore, one might wonder why our semantic lures spontaneously elicited monitoring (or awareness of the prospective memory task) in the pilot experiment and Experiment 1 (there was significant post-lure but not pre-lure cost). One possible explanation is that the semantic lures used in the current research had very high forward associations to our target words. Given that strength of association has been demonstrated to be an important moderator of prospective memory performance and spontaneous retrieval (McDaniel et al., 2004), we suspect that our semantic lures successfully triggered retrieval and subsequent monitoring because they were very well associated with the target words.

floor in a condition in which participants are not monitoring proximal to target events. By contrast, the multiprocess perspective predicts that, in the absence of proximal monitoring (i.e., in the distal-cue condition), spontaneous retrieval processes will lead to levels of prospective remembering well above floor when the prospective memory cue is focal to ongoing activity.

Method

Participants and design. The 64 participants were Washington University students who received $10 or course credit as compensation. Participants were tested individually. The design was a 2 × 2 mixed factorial in which proximity of semantic lures to targets was varied between participants (proximal or distal), and block (prospective memory or control) was varied within participants.

Procedure. Similar to the pilot experiment, participants performed an ongoing task (in this experiment, a lexical decision task) along with a digit detection task for two blocks of the experiment. A prospective memory task was embedded within one of these blocks.

Initially, participants were told that they would perform several different tasks and that their main goal throughout the experiment was to respond as quickly and accurately as possible to the lexical decision task (referred to as the "speed" task). When the prospective memory block was performed first, participants were told that there was a "secondary interest" in their ability to remember to perform an action in the future and that if they saw the target word *water* (or, in a counterbalanced condition, the target word *animal*) they should press the "Q" key. They were reminded (by both the experimenter and the instructions on the computer) that their primary task throughout the experiment was to respond quickly and accurately to the lexical decision task. Following encoding, participants were asked to explain the instructions to the experimenter.

Participants were again instructed that their primary task throughout the experiment was to perform the lexical decision task (referred to as the speed task). They were told to determine as quickly and accurately as possible whether a string of letters formed a word or a nonword by pressing the keys labeled "Y" (yes) or "N" (no), representing 1 and 2 on the number pad, respectively. They were instructed to use their dominant hand on the keyboard, and the experimenter ensured that participants kept their nondominant hand in their lap (so as not to rest it on the "Q" key). Following these instructions, participants performed a block of six lexical decision practice trials in which they received feedback regarding the speed and accuracy of their responses. After practicing the lexical decision task, participants received instructions for the digit detection task. They were instructed that a digit would be spoken from the computer speakers every 2 s and that they should click a counter (held in their nondominant hand in their lap) every time two odd digits were spoken consecutively. Once participants understood the digit detection task, they performed a block of 20 lexical decision practice trials during which they also practiced the digit detection task. During this phase, participants were not reminded that they would be performing the prospective memory task, and the experimenter only answered questions about the digit detection task. Participants filled out a few forms (e.g., demographics questionnaire) after the second practice block.

Next, participants performed a block of the lexical decision and digit detection tasks that included 10 buffer trials and 212 lexical decision experimental trials. The experimental trials consisted of 102 words, 102 nonwords, 4 semantic lures (or, in the control block, words unrelated to the target word), and 4 prospective memory target or control words. The target words were distributed evenly across blocks, and a semantic lure preceded each target word. Specifically, the target word (prospective memory block) and the control word (control block) appeared on Trials 51, 102, 153, and 204 (these items were matched on number of letters and mean lexical decision reaction time; Balota et al., 2002).

In the proximal-cue condition, semantic lures (Nelson, McEvoy, & Schreiber, 1998) appeared six trials prior to each target event. In the distal-cue condition, semantic lures appeared 21 trials prior to each target event. When *animal* was the target, the related words were *beast*, *farm*, *cage*, and *zoo* (mean forward association of .43). When *water* was the target, the related words were *fountain*, *splash*, *faucet*, and *flood* (mean forward association of .61). During the control block, participants were presented with words (on the same trials) that were matched on number of letters and mean lexical decision reaction time (Balota et al., 2002). The matched items for *beast*, *farm*, *cage*, and *zoo* were *union*, *snow*, *bill*, and *bar*. The matched items for *fountain*, *splash*, *faucet*, and *flood* were *shouting*, *lender*, *manage*, and *watch*. The matched control for *animal* was *sensor,* and the matched control for *water* was *steel*.

Following completion of the first experimental block, participants who received the prospective memory task during the first block were told that they would no longer have to perform the prospective memory task (see Marsh et al., 2006, and Scullin, Einstein, & McDaniel, 2009, for evidence for deactivation of prospective memory intentions following such instructions). Participants who received the control block first were given the prospective memory instructions at this point. All participants were reminded that they should respond as quickly and accurately as possible to the lexical decision task.

Before performing the second experimental block, participants filled out more forms (e.g., vocabulary test). Then participants performed another block of lexical decision and digit detection experimental trials. This block consisted of a second list of 10 buffer trials and 212 lexical decision trials. Target words, control words, and semantic lures appeared in the same location as during the first block (the particular order of list presentation was counterbalanced across participants).

Results and Discussion

In all experiments the probability of a Type I error was set at .05 (unless otherwise stated). Smith et al. (2007) suggested that past failures to find significant overall cost might be due to insufficient statistical power. Therefore, for critical nonsignificant cost results, we report power analyses. On the basis of previous research (with similar conditions to the current research; Smith et al., 2007) that reported medium-to-large sized cost effects (i.e., Cohen's d ranged from .45 to .82 for the prospective memory versus control group comparisons in the Smith et al. research), our primary concern was to have power to detect the medium-sized cost effects (medium-sized effect conservatively defined as $r = .25$; Faul, Erdfelder, Lang, & Buchner, 2007) that were observed by Smith et al. Furthermore, for the sake of completeness, we also report power for detecting medium-small-sized effects (defined as $r = .15$) and small-sized effects (defined as $r = .10$; Faul et al., 2007).

Overall reaction time cost. We investigated overall cost by averaging lexical decision reaction times over all correct trials that were not target words or semantic lures (or matched controls for targets or lures).[2] A 2 × 2 mixed analysis of variance (ANOVA) that included the within-subjects variable of block (prospective memory or control) and the between-subjects variable of semantic lure proximity (proximal or distal) yielded no effect of semantic lure proximity or a Semantic Lure Proximity × Block interaction ($Fs < 1$).[3] Despite high power to detect medium-sized (>.99) and medium-small-sized (.86) effects (.52 for a small-sized effect), the main effect of block was not significant, $F(1, 62) = 2.80$, $MSE = 12{,}718.14$, $p = .10$ (see Table 1).[4] However, the more pertinent issue is whether cost reflects functional monitoring (i.e., proximal monitoring); we addressed this issue with the set of analyses reported next.

Effect of semantic lures. In light of the above finding, we were interested in whether the semantic lures caused temporary cost. We averaged the five trials following each semantic lure (or control items during control block) while excluding only incorrect trials. A 2 × 2 mixed ANOVA was conducted that included semantic lure proximity (proximal or distal) as the between-subjects variable and block (prospective memory or control) as the within-subjects variable. The only significant result was the main effect of block, $F(1, 62) = 6.00$, $MSE = 25{,}794.65$ (all other $Fs < 1$) such that participants responded to post-lure lexical decision trials more slowly during the prospective memory block ($M = 976$ ms) than during the control block ($M = 907$ ms). The finding of post-lure cost suggests that the semantic lures caused monitoring (or, at least, awareness of the prospective memory task). To strengthen this conclusion, we evaluated pre-lure cost by averaging reaction times for the five trials preceding each semantic lure (or matched control) event, excluding only incorrect trials. A 2 × 2 mixed ANOVA that included the within-subjects variable of block (prospective memory or control) and the between-subjects variable of semantic lure proximity (proximal or distal) yielded no significant effects (all $Fs < 1$). Therefore, prior to the lure there was no evidence for costly monitoring.

Table 1
Mean Performance on Lexical Decision Filler Items Measured as Reaction Times in Milliseconds Across Blocks, Conditions, and Experiments

Condition	Prospective memory block *M*	Prospective memory block (*SD*)	Control block *M*	Control block (*SD*)	Cost
Experiment 1					
Proximal cue	995	(222)	948	(210)	47
Distal cue	988	(203)	968	(177)	20
Experiment 2					
Focal cued	960	(196)	948	(233)	12
Focal not-cued	993	(216)	971	(170)	22
Nonfocal cued	1,032	(242)	963	(223)	69
Nonfocal not-cued	1,031	(220)	941	(202)	90

The previous analyses on pre-lure and post-lure cost revealed that the semantic lures caused monitoring (or awareness of the prospective memory task) for at least a short duration (a minimum of five trials). In the proximal-cue condition, the implication is that participants were monitoring immediately preceding trials on which the prospective memory task needed to be performed (i.e., immediately preceding the target event). In the distal-cue condition, according to the pilot data patterns, participants probably did not sustain their post-lure monitoring until the target event. We confirmed these expectations by averaging the mean reaction times of the five trials preceding each target or matched control event (excluding incorrect trials) and submitting these data to a 2 × 2 mixed ANOVA in which block (prospective memory or control) was a within-subjects variable and semantic lure proximity (proximal or distal) was a between-subjects variable. Critically, there was a block by semantic lure proximity interaction, $F(1, 62) = 3.85$, $p = .05$ (next largest $F = 1.36$ for the block main effect). The between-subjects comparison between the proximal-cue and distal-cue conditions for prospective memory block response times was not significant, $F(1, 62) = 1.17$, $MSE = 26{,}454.77$. However, as shown in Figure 1, participants in the proximal-cue condition

[2] It is conventional practice in the prospective memory literature to limit reaction time analyses to correct trials (see, e.g., Einstein et al., 2005; Smith et al., 2007). However, to eliminate the potential concern over item effects masking cost effects, we repeated the analyses in Experiments 1 and 2 using both correct and incorrect trials. Doing so did not affect cost by more than a few milliseconds (as should be expected by the high accuracy on the lexical decision task) or in a systematic matter, and importantly, none of the nonsignificant focal cost results became significant.

[3] To ensure that the cue condition variable, which was nested within the prospective memory block, did not dampen monitoring effects, we compared the cue conditions during prospective memory blocks only. There was no prospective memory block reaction time difference between the proximal-cue and distal-cue conditions when examining all filler trials ($t < 1$), all proximal trials ($t < 1$), and proximal trials preceding "Q" presses, $t(53) = 1.50$, $p = .14$.

[4] We compared mean lexical decision reaction times on correct filler trials during the first block (prospective memory) with those during the second block (control). No practice effect could imply that participants were unable to deactivate their intentions. However, a practice effect would suggest that participants deactivated their prospective memory intention after the prospective memory block. In Experiment 1, we conducted a 2 × 2 mixed ANOVA on mean filler trial reaction times that included block (prospective memory or control) as a within-subjects variable and semantic lure proximity (proximal or distal) as a between-subjects variable. There was a significant block main effect, $F(1, 30) = 94.48$, $MSE = 4{,}209.90$ (next largest $F = 1.56$ for the interaction), demonstrating a substantial practice effect from the prospective memory block ($M = 1{,}068$ ms) to the control block ($M = 910$ ms). Likewise, for mean filler trial reaction times in Experiment 2, we conducted a 2 × 2 × 2 mixed ANOVA that included block (prospective memory or control) as a within-subjects variable as well as prospective memory cue (focal or nonfocal) and informed cue condition (cued or not cued) as between-subjects variables. The only significant effect was the block main effect, $F(1, 92) = 187.83$, $MSE = 4{,}993.47$, which obtained because responding was much faster during the second block (i.e., the control block; $M = 902$ ms) than during the first block (i.e., the prospective memory block; $M = 1{,}041$ ms). The magnitude of the practice effect from the first block to the second block suggests that these participants deactivated the prospective memory intention after being told that it was completed.

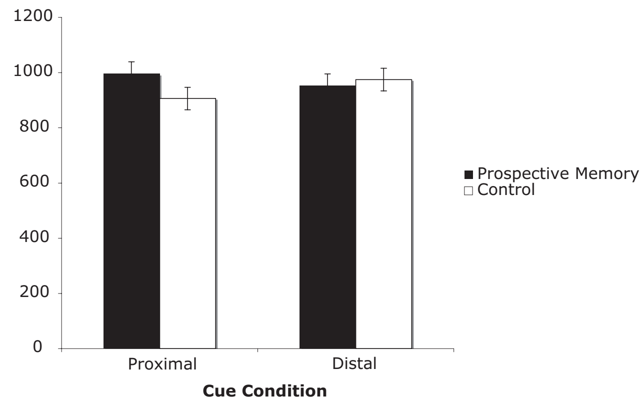

Figure 1. Proximal cost across semantic lure proximity conditions in Experiment 1. Error bars represent 95% confidence intervals.

were responding more slowly during prospective memory block proximal trials than during control block proximal trials, $F(1, 62) = 4.89$, $MSE = 26{,}454.77$, but this pattern did not obtain in the distal-cue condition ($F < 1$; power for medium-, medium-small-, and small-sized effects was .79, .38, and .20, respectively). Thus, as expected, the presence of a semantic lure proximal to, but not distal from, a target event produced monitoring (or awareness of the prospective memory task) immediately before prospective memory target events.

Prospective memory task performance. The critical remaining question was to examine whether the proximal cost in the proximal-cue condition benefited prospective memory performance. Prospective memory performance was defined as the proportion of target events in which participants pressed the "Q" key within two trials. Using this dependent measure we conducted an ANOVA in which semantic lure proximity (proximal or distal) varied between participants. Even though participants in the proximal-cue condition were apparently monitoring more than were participants in the distal-cue condition during the occurrence of the target event, the proximal-cue condition did not significantly outperform the distal-cue condition ($F < 1$; see Figure 2), a condition in which performance was well above zero, $t(31) = 11.74$ (95% confidence interval: .59–.83). This finding of reasonably high levels of prospective remembering in the absence of cost (implying an absence of monitoring; cf. Smith, 2003) proximal to the prospective memory target (the distal-cue condition) is inconsistent with the perspective that monitoring is necessary for prospective remembering. Instead, these nonzero levels of prospective remembering in the distal-cue condition suggest that, in the absence of monitoring, individuals rely on spontaneous retrieval processes to successfully remember to perform an intended action.

To ensure that the finding of no proximal cost in the distal-cue condition was not a product of averaging over all proximal trials (regardless of whether the "Q" key was pressed) we examined mean reaction times on prospective memory block proximal trials that preceded Q presses and compared them with the corresponding proximal trials during the control block. For this dependent measure, we conducted a 2 × 2 mixed ANOVA in which block (prospective memory or control) was a within-subjects variable and semantic lure proximity (proximal or distal) was a between-subjects variable. Consistent with the previous proximal trial analysis, the block by semantic lure proximity interaction was significant, $F(1, 53) = 5.84$, $MSE = 28{,}413.04$ (all other Fs < 1). As illustrated in Table 2, there was significant proximal cost preceding "Q" presses in the proximal-cue condition, $F(1, 53) = 4.17$, $MSE = 28{,}413.04$, but not in the distal-cue condition (the reverse pattern obtained), $F(1, 53) = 1.89$, $MSE = 28{,}413.04$. Even though the control means appear to vary somewhat, the most appropriate comparisons in Table 2 are within subjects because the number of participants in each group is sometimes small and thus subject to sampling error. Power for detecting even medium-sized effects (.64) was relatively low (because $n = 27$) in the distal-cue condition for this analysis but several key points offset this potential concern. First and foremost, the results were not even in the direction of cost (see Table 2); second, the power was sufficient to detect significant cost in the proximal-cue condition, and the patterns converge with the previous proximal trial analysis.

Additional analyses. Even though our primary interest was in localized measures of cost, we also measured ongoing task performance averaged over blocks. First, we measured digit detection

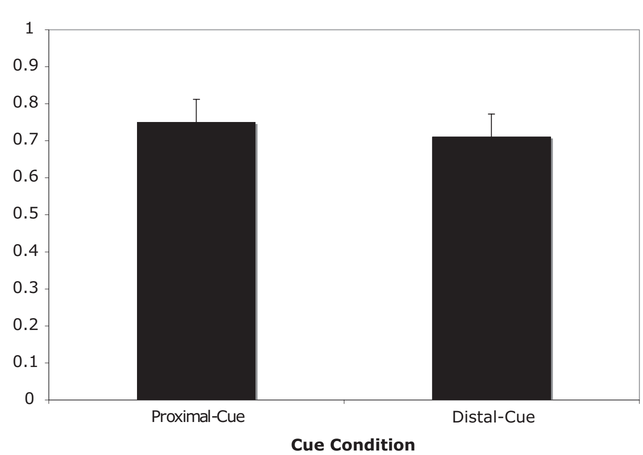

Figure 2. Prospective memory performance across conditions in Experiment 1. Error bars represent 95% confidence intervals.

Table 2
Performance on Proximal Trials Measured as Reaction Times Before Correct Prospective Memory Trials Relative to Corresponding Control Block Trials

		Prospective memory block		Control block		
Condition	*n*	*M*	(*SD*)	*M*	(*SD*)	Cost
Experiment 1						
Proximal cue	28	997	(272)	905	(262)	92
Distal cue	27	907	(156)	970	(211)	−63
Experiment 2						
Focal cued	46	1,062	(301)	1,017	(280)	45
Focal not-cued	46	1,035	(252)	1,073	(316)	−38
Nonfocal cued	35	1,194	(422)	1,039	(286)	155
Nonfocal not-cued	20	1,059	(299)	934	(263)	125

Note. This measure of coincidental proximal monitoring is illustrated across experiments and conditions.

task performance as the number of times a participant clicked the counter during a block. A 2 × 2 mixed ANOVA that included the within-subjects manipulation of block (prospective memory or control) and the between-subjects manipulation of semantic lure proximity (proximal or distal) yielded no significant effects or interactions (all *F*s < 1; see Table 3). Therefore, digit detection task performance was independent of the presence of a prospective memory task or the semantic lure manipulation.

We also investigated accuracy of lexical decision task performance (number correct divided by total possible correct) by conducting a 2 × 2 mixed ANOVA in which block (prospective memory or control) and semantic lure proximity (proximal or distal) were the independent variables. None of the effects was significant (all *F*s < 1; mean performance in each condition = .94). Therefore, performing the prospective memory task did not affect lexical decision task accuracy.

Summary

In the present experiment, we used semantic lures to control whether cost emerged proximal to target events. This finding extends previous research that showed that monitoring can be initiated when encountering the context in which the prospective memory task is to be performed (Marsh et al., 2006) and terminated after the prospective memory response is executed (West, McNerney, & Travers, 2007) by demonstrating even more precise control over cost (i.e., on the order of a few trials). The most important finding of the present experiment was that there was no cost immediately before the target event in the distal-cue condition, and yet high prospective memory performance was observed. Moreover, prospective memory performance in the distal-cue condition was similar to performance in the proximal-cue condition in which significant levels of cost were observed immediately preceding a target event. Such findings implicate a powerful spontaneous retrieval process that supports prospective memory retrieval without incurring significant cost to ongoing tasks. But does proximal monitoring provide no additional benefit to spontaneous retrieval in supporting focal prospective memory? It is possible that had we been able to use an equally sensitive comparison for the prospective memory measure (between-subjects) as for the cost measure (within-subjects), the nominal prospective memory difference between the proximal-cue and distal-cue conditions would have been significant. Therefore, in the following experiment we manipulated whether the prospective memory task used a focal or a nonfocal cue with the intention of demonstrating positive effects of monitoring on nonfocal, but not focal, prospective memory performance (thereby helping to allay concerns over sensitivity of detecting changes in prospective memory levels).

Table 3
Mean Performance on the Digit Detection Task in Number of Counter Responses as a Function of Experiment, Condition, and Block

Condition	Prospective memory block		Control block		Cost
	M	(*SD*)	*M*	(*SD*)	
Experiment 1					
Proximal cue	28.72	(14.76)	29.53	(14.27)	0.81
Distal cue	28.84	(9.26)	29.50	(7.78)	0.66
Experiment 2					
Focal cued	27.31	(8.10)	28.67	(8.83)	1.36
Focal not-cued	29.08	(9.80)	28.67	(9.87)	−0.41
Nonfocal cued	29.79	(8.91)	30.10	(6.87)	0.31
Nonfocal not-cued	27.90	(8.29)	27.67	(8.05)	0.23

Experiment 2

The previous experiment demonstrated that prospective remembering occurs in the absence of cost immediately preceding target events. This experiment used focal cues, which are predicted by the multiprocess perspective to promote spontaneous retrieval (Einstein et al., 2005; McDaniel & Einstein, 2007b; but see Smith et al., 2007, for another view). The multiprocess and the monitoring perspectives assume, however, that monitoring is important for successful retrieval with nonfocal cues. Therefore, if the patterns of cost observed in the previous experiments are reflective of monitoring processes, then when using a similar methodology, we should be able to demonstrate a functional relationship between monitoring and prospective remembering with nonfocal cues. Doing so would compel the conclusions of Experiment 1 that monitoring was effectively controlled (as indexed by cost) and, therefore, that monitoring was not necessary for prospective remembering in that experiment.

In Experiment 2, we manipulated whether the prospective memory task was focal or nonfocal by varying target cue type. During the ongoing lexical decision task that encourages processing of whole words and semantic features, a target word (e.g., *tortoise*) was a focal cue. Because the lexical decision task requires processing of words and not individual syllables, we used the target syllable *tor* as a nonfocal cue (Einstein et al.).[5]

As in Experiment 1, we were interested in the relation between cost and prospective memory performance. Instead of using semantic lures as cues (semantic lures would not be pertinent for nonfocal cues), in this experiment we cued some participants to engage in monitoring by presenting a red (or blue) background screen proximal to target events. In the cued condition, we told participants that the target color screen might precede the target and in another (not-cued) condition, we did not give these instructions. We hypothesized that the color screen would cause participants in the cued condition only to engage monitoring. Further, we

[5] To remain concise in our terminology, we have elected to use *focal* and *nonfocal* to refer to the word and syllable prospective memory targets, respectively. We acknowledge that syllables and words differ not only on cue focality during the lexical decision task but also on identification difficulty (Scullin, McDaniel, et al., 2009); however, the purpose of the present research was to examine the functionality of monitoring on a range of theoretically relevant prospective memory tasks and, by extension, to investigate the presence of spontaneous retrieval processes. By using two very different prospective memory target types in conjunction with achieving some experimental control over monitoring (by providing explicit cues to monitor), we hoped to achieve this goal. Though we cannot completely disentangle the contributions of identification difficulty and cue focality in supporting spontaneous retrieval, the experimental logic of controlling monitoring and assessing cost to establish implications regarding monitoring and the presence of spontaneous retrieval is not undermined.

hypothesized that engaging monitoring processes would be critical to nonfocal prospective memory performance but not focal prospective remembering (Einstein et al., 2005), which may be supported by spontaneous retrieval processes. Finally, because there could be concerns regarding modest power in some cost comparisons in Experiment 1, we increased the sample size in each group by 50% to gain additional power to detect cost, if present.

Method

Participants and design. The 192 participants were Washington University students who received $10 or course credit as compensation. The students were tested individually. The design was a 2 × 2 × 2 mixed factorial in which prospective memory cue (focal or nonfocal) and informed relevance of the color screen to the prospective memory task (cued or not cued) varied between participants, and block (prospective memory or control) varied within participants. The 96 participants in the nonfocal condition were tested before the 96 participants in the focal condition, and all were randomly assigned to informed relevance conditions, thereby creating 48 participants in each between-subjects condition.

Procedure. The overall procedure was identical to that of Experiment 1 except for two important changes to the prospective memory task and cue items. First, the prospective memory task was changed to involve both focal and nonfocal cues. In the nonfocal condition, participants were asked to remember to press the "Q" key if they ever saw the target syllable tor at the beginning, middle, or end of a string of letters during the lexical decision task. In the focal condition, the target cue was the word tortoise (or in a counterbalance, dormitory). Participants were instructed to press the "Q" key when they saw their target or as soon thereafter as they remembered.

Second, the cue was either a red or a blue background screen that occurred during a lexical decision trial. All other items during the lexical decision task appeared in black font on a white background. Cue color was counterbalanced across participants. Furthermore, when red was the cue, a blue background appeared on the same trials during the control block and vice versa.

In the not-cued condition, participants only read their prospective memory instructions against their cue color background. In the cued condition, prospective memory instructions were presented in the cue color, and participants were instructed that the cueing color might precede the occurrence of the target. The experimenter checked that the participants knew both the target item and cueing color (in the cued condition) before proceeding. In both conditions, the cue appeared six trials before each target event (as in the proximal-cue condition in Experiment 1).

Target and control items appeared on the same trial locations as in Experiment 1. The lexical decision list, the order of the prospective memory block, and the cue color were counterbalanced across participants.

Results and Discussion

Overall ongoing task performance. Although our primary interest was in lexical decision performance proximal to target events and subsequent prospective memory performance, we first report analyses on overall cost. Overall performance of the lexical decision task was assessed by examining averaged reaction times on correct filler trials (i.e., trials that were not buffer items, target and control items, or color screen items). A 2 × 2 × 2 mixed ANOVA with the within-subjects variable of block (prospective memory or control) and the between-subjects variables of prospective memory cue (focal or nonfocal) and informed cue condition (cued or not-cued) revealed a main effect of block, $F(1, 188) = 22.47$, $MSE = 9{,}910.77$, that was qualified by a significant block by prospective memory cue interaction, $F(1, 188) = 9.37$, $MSE = 9{,}910.77$ (all other Fs < 1).[6] Responding in the nonfocal condition was significantly slower during the prospective memory block ($M = 1{,}031$ ms) than during the control block ($M = 952$ ms), $F(1, 188) = 30.23$, $MSE = 9{,}910.77$. In contrast, in the focal condition, responding was similar during prospective memory ($M = 977$ ms) and control ($M = 959$ ms) blocks, $F(1, 188) = 1.57$, $MSE = 9{,}910.77$ (power to detect medium-, medium-small-, and small-sized effects was extremely high at >.99, >.99, and .83, respectively). This finding is consistent with Einstein et al.'s (2005, Experiments 1 and 2) results and was predicted only by the multiprocess theory, which assumes that costly monitoring processes will be utilized during nonfocal prospective memory tasks but not usually during focal prospective memory tasks. Also note that there was neither a main effect of informed cue condition nor a block by informed cue condition interaction (both Fs < 1). Participants in the cued conditions demonstrated an overall cost (for nonfocal targets; cost was nonsignificant for focal targets) that was similar to the corresponding not-cued conditions (see Table 1). If overall cost is an adequate measure of functional monitoring processes, then prospective memory should not only be off floor in the nonfocal conditions but also should not differ between cued and not-cued conditions.

Prospective memory performance. Prospective memory performance was tabulated in the same manner as in Experiment 1. A 2 × 2 ANOVA was conducted on prospective memory performance that included prospective memory cue (focal or nonfocal) and condition (cued or not-cued) as between-subjects variables. There were significant main effects of prospective memory cue, $F(1, 188) = 174.74$, $MSE = 0.085$, and informed cue condition, $F(1, 188) = 16.62$, $MSE = .085$, as well as a significant prospective memory cue by informed cue condition interaction, $F(1, 188) = 7.39$, $MSE = 0.085$. As illustrated in Figure 3, prospective memory performance was better in the cued condition than in the not-cued condition in the nonfocal, $F(1, 188) = 44.27$, $MSE = 0.085$, but not the focal, $F(1, 188) = 2.03$, $p = .16$, condition.

In assessing the relevance of calculating overall cost as a marker of functional cost, it is important to note that the increase in nonfocal prospective memory performance in the cued condition relative to the not-cued condition was found in the absence of an overall cost difference between these conditions (Table 1). Therefore, the typical measure of monitoring (i.e., overall cost; cf. Einstein et al., 2005; Smith, 2003; Smith & Bayen, 2004) was not tightly related to prospective memory performance. We next examined whether the prospective memory benefit in the nonfocal-

[6] Reaction times during the prospective memory block did not differ between the cued and not-cued conditions when examining all filler trials, $t(190) = 1.23$, $p = .21$, all proximal trials ($t < 1$), or proximal trials preceding "Q" presses, $t(145) = 1.45$, $p = .15$.

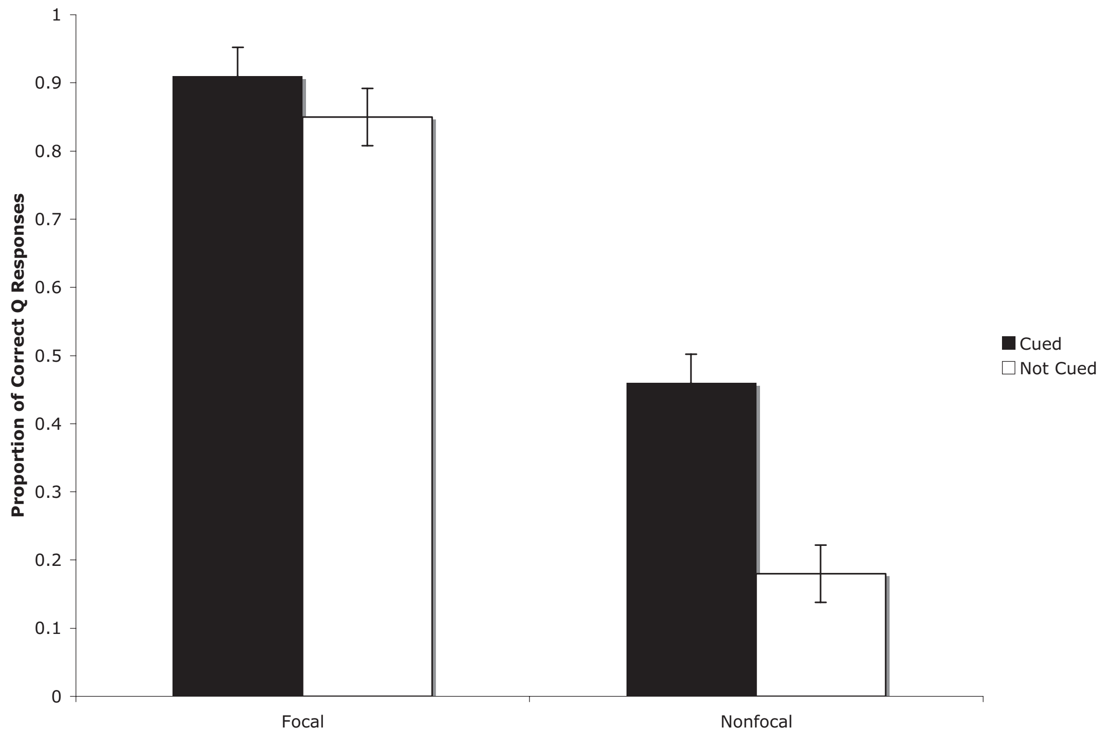

Figure 3. Prospective memory performance across conditions in Experiment 2. Error bars represent 95% confidence intervals.

cued condition was mediated by a temporary activation of monitoring processes.

Proximal ongoing task performance. The finding of significantly better nonfocal prospective memory performance in the cued condition relative to the not-cued condition in the absence of overall cost differences between these conditions suggests that a more precise measure of functional cost (or functional monitoring) is required. Therefore, we examined lexical decision reaction times for the five trials immediately preceding each target event (excluding incorrect trials) and conducted a 2 × 2 × 2 mixed ANOVA that included block (prospective memory or control) as the within-subjects variable as well as prospective memory cue (focal or nonfocal) and informed cue (cued or not-cued) condition as the between subjects variables. There was a main effect of block, $F(1, 188) = 11.87$, $MSE = 34{,}881.96$, that was qualified by a significant block by prospective memory cue interaction, $F(1, 188) = 5.32$, $MSE = 34{,}881.96$. The block by informed cue condition interaction did not reach conventional levels of significance, $F(1, 188) = 3.67$, $MSE = 34{,}881.96$, $p = .06$ (all other Fs < 1.10). Notably, as illustrated in Figure 4, planned comparisons demonstrated that there was significant proximal cost in the nonfocal-cued condition, $F(1, 188) = 18.34$, $MSE = 34{,}881.96$, but in none of the other conditions (Fs = 2.15, 1.16, and <1 in the nonfocal-not-cued condition, focal-cued condition, and focal-not-cued conditions, respectively). Power was high to detect medium-sized (>.99), medium-small-sized (.96), and small-sized (.70) proximal cost effects collapsed across these three nonsignificant conditions, $F(1, 141) = 2.70$, $MSE = 37{,}999.97$, for block main effect. Despite the absence of proximal cost, prospective memory performance was well above zero in the focal-cued condition, $t(47) = 26.18$ (95% confidence interval: .84–.98, and the focal-not-cued condition, $t(47) = 20.91$ (95% confidence interval: .77–.93) and slightly above zero in the nonfocal-not-cued condition, $t(47) = 4.86$ (95% confidence interval: .10–.25).

The results of the previous proximal cost analysis suggested that proximal monitoring was important for nonfocal prospective memory but not for focal prospective memory. To confirm this possibility, we next examined proximal reaction times on only those trials immediately preceding "Q" presses (excluding incorrect responses) and compared them with the corresponding trials in the control block. A 2 × 2 × 2 mixed ANOVA that included block as a within-subjects variable as well as prospective memory cue (focal or nonfocal) and informed cue (cued or not-cued) condition as between-subjects variables revealed a main effect of block, $F(1, 143) = 7.25$, $MSE = 46{,}517.44$, and a block by prospective memory cue interaction, $F(1, 143) = 6.57$, $MSE = 46{,}517.44$ (next largest $F = 2.12$ for the prospective memory cue by informed cue condition interaction). As illustrated in Table 2, in the focal condition, there was no significant difference in lexical decision reaction times on the trials immediately preceding "Q" presses during the prospective memory block ($M = 1{,}048$ ms) relative to the control block ($M = 1{,}045$ ms), $F < 1$ (power to detect medium-, medium-small-, and small-sized effects was >.99, .81, and .47, respectively). However, in the nonfocal condition, there was a strong effect of block, $F(1, 147) = 11.60$, $MSE = 46{,}517.44$, that was not limited to the cued condition (see Table 2). Thus, proximal cost preceded nonfocal prospective memory hits but was absent preceding focal prospective memory hits.

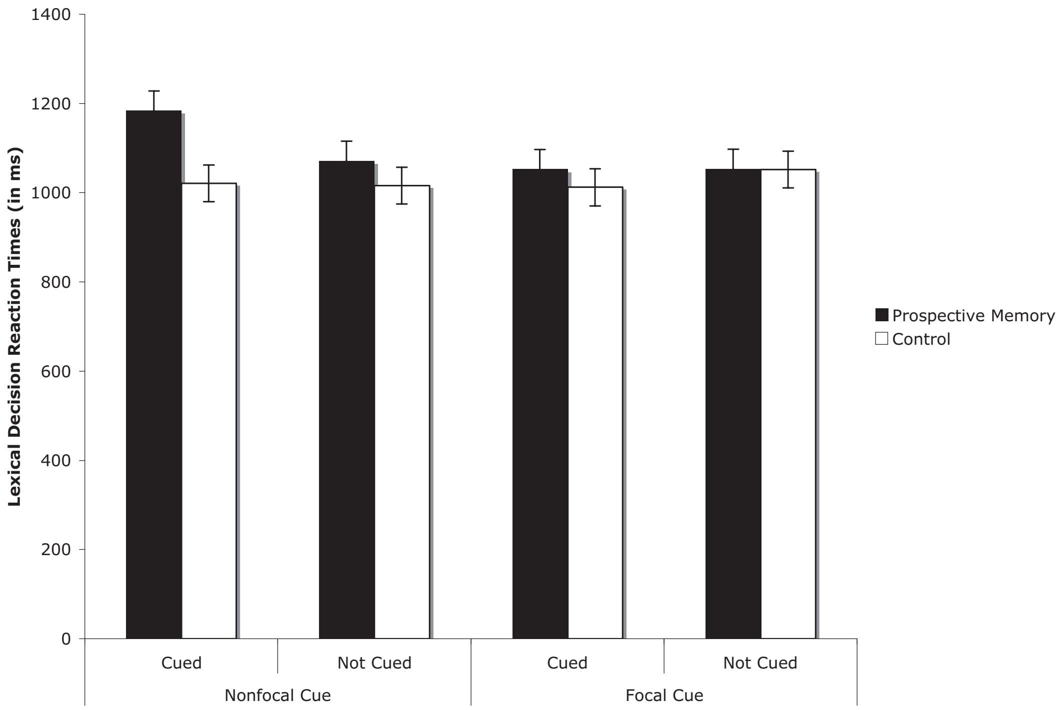

Figure 4. Proximal cost across conditions in Experiment 2. Error bars represent 95% confidence intervals.

Additional analyses. For the dependent measure of digit detection task performance, we conducted a 2 × 2 × 2 mixed ANOVA that included informed cue condition (cued or not cued) and prospective memory cue (focal or nonfocal) as between-subjects variables and block (prospective memory or control) as a within-subjects variable. There were no significant effects: all *F*s < 1 except for the informed cue condition by prospective memory cue interaction, $F(1, 188) = 2.02$, $MSE = 38.74$ (see Table 3).

We also examined lexical decision task accuracy averaged across all filler trials and conducted a 2 × 2 × 2 mixed ANOVA using the within-subjects variable of block (prospective memory or control) and the between-subjects variables of prospective memory cue (focal or nonfocal) and informed cue condition (cued or not-cued). Unexpectedly, the three-way interaction was significant, $F(1, 188) = 6.20$, $MSE = 0.0004$. The interaction seems to have obtained because there was a slight accuracy cost in the nonfocal-cued condition (*M*s = .93 and .94 for prospective memory and control blocks, respectively), but the reverse obtained in the focal-cued condition (*M*s = .91 and .90 for prospective memory and control blocks, respectively). There was no difference between prospective memory and control block accuracy in the not-cued conditions (both *M*s = .91 and .94 for focal and nonfocal conditions, respectively). Because overall performance was high ($M = .92$) and variability was low ($MSE = 0.0004$), the significant three-way interaction may represent a Type I error resulting from artificially reduced variability as performance approaches ceiling.

To ensure that ongoing task accuracy could not account for our proximal trial results, we examined the proportion of correct proximal trials and conducted a 2 × 2 × 2 mixed ANOVA that included block (prospective memory or control) as a within-subjects variable as well as prospective memory cue (focal or nonfocal) and informed cue condition (cued or not-cued) as between-subjects variables. The main effect of block, $F(1, 188) = 3.77$, $MSE = .004$, $p = .05$, was qualified by a block by prospective memory cue interaction, $F(1, 188) = 5.19$, $MSE = .004$ (next largest $F = 2.85$ for the three-way interaction). The interaction obtained because there was no difference between prospective memory and control proximal trial accuracy in the focal conditions (both *M*s = .92 and .93 for the not-cued and cued conditions, respectively; $F < 1$). However, in the nonfocal condition, proximal trial accuracy was worse during the prospective memory block (*M*s = .91 and .94 in cued and not-cued conditions, respectively) than during the control block (*M*s = .95 for both conditions), $F(1, 188) = 8.11$, $MSE = .004$. Thus, the lexical decision proximal trial accuracy results do not alter the main conclusions from the prior analyses.

Summary

The results of the nonfocal cost analyses in Experiment 2 are important for several reasons. First, although overall cost could not predict differences in nonfocal prospective memory performance, proximal cost paralleled nonfocal prospective memory differences (Figures 3 and 4). Second, consistent with the idea that monitoring may be present at some point during the prospective memory task but not immediately preceding target cues, in the nonfocal not-cued condition we found significant overall cost but not proximal cost. Because prospective memory performance was greatly impaired in the nonfocal not-cued condition and because stimulating monitoring proximal to nonfocal target events significantly boosted prospective memory performance (nonfocal-cued condition), we may infer that costly monitoring processes activated in proximity to the appearance of the prospective memory target are critical to detecting that nonfocal target.

The results of the focal proximal cost analyses were also theoretically informative. In the focal condition, neither overall nor proximal cost was observed, though prospective memory performance remained very high (and well above floor levels). This result is inconsistent with the monitoring perspective, which assumes that costly monitoring processes must be engaged immediately before and during target events for a prospective memory intention to be retrieved and executed. Instead, the results are more consistent with the idea based on the multiprocess perspective that, in addition to monitoring processes, spontaneous retrieval processes support prospective remembering for focal cues.

General Discussion

The primary goal of the present project was to determine the extent to which costly monitoring processes are necessary and sufficient to explaining prospective remembering. The general finding of the present research was that both monitoring and spontaneous retrieval processes can support prospective memory. Notably, the results of the present research support the multiprocess perspective's (McDaniel & Einstein, 2000, 2007a) distinction between the processes required for retrieving intentions associated with focal versus nonfocal cues. Consider, first, nonfocal cue situations. According to the multiprocess perspective, detection of nonfocal cues requires processing of features different from those normally processed during the ongoing task, and consequently, costly monitoring processes should be essential for nonfocal prospective remembering (the monitoring perspective assumes the same). The results of Experiment 2 supported this hypothesis. When monitoring of proximal to nonfocal target events (not-cued condition) was minimized, prospective memory performance was quite low. However, when resource-demanding monitoring processes were experimentally stimulated by informing the participant of the relevance of the background screen (cued condition; see Figure 4) or were coincidentally engaged on proximal trials by the participant (not-cued condition; see Table 2), prospective memory performance was significantly improved. This finding directly demonstrates a functional relationship between monitoring processes and nonfocal prospective memory performance and dovetails with previous research (West et al., 2005, Experiment 2) showing that monitoring for nonfocal cues is functionally related to prospective remembering.

Consider next the situation in which the target cue was focal to the ongoing task. Despite ample power to detect medium- to medium-small-sized cost effects (a medium target effect size is presumed from Smith et al.'s, 2007, findings), there was no evidence for cost immediately preceding target events. Indeed, when collapsing across all focal conditions that demonstrated nonsignificant proximal cost (distal-cue condition in Experiment 1, cued and not-cued conditions in Experiment 2, and the pilot experiment), there was good power to detect even a small-sized effect (.78; for medium- and medium-small-sized effects, power was $>.99$ and .98, respectively) but still no statistical evidence that such an effect was present ($F < 1$). Such results compel the conclusion that cost was absent immediately preceding target events and suggest that previous reports of nonsignificant cost (e.g., Einstein et al., 2005) were not due to insufficient statistical power to detect effects (cf. Smith et al., 2007) but instead that experimental methodology (e.g., single focal target cue coupled with instructions that greatly emphasized the importance of the ongoing task) determines whether significant cost is observed.

Under conditions of no proximal cost, the monitoring perspective (at least as specified in the preparatory attentional and memory processes theory; Smith, 2003; Smith et al., 2007) argues that prospective memory retrieval is not possible, whereas the multiprocess perspective (McDaniel & Einstein, 2007a) argues that focal cues may spontaneously retrieve intentions. Our results favored the multiprocess perspective because prospective memory performance was well above floor levels in each focal condition (see Figures 2 and 3) and did not depend upon proximal cost (cf. Figures 1 and 4). The pattern of prospective memory performance in the absence of proximal cost was confirmed by the finding in each experiment that there was no evidence for proximal cost even when only examining the trials preceding focal prospective memory hits (except in the proximal-cue condition in which cost was experimentally induced). These results suggest that, in the absence of monitoring, powerful, cue-driven processes can trigger spontaneous retrieval of prospective memory intentions.

Of further interest was the pattern of postcue cost in Experiments 1 and 2. Though semantic lures led to temporary cost in a focal condition, instructing participants that a red background screen might precede a focal target event did not. This result was somewhat surprising, but we suggest that, because our method greatly discouraged monitoring and because individuals have difficulty maintaining resource-demanding monitoring unless it is perceived to be important (cf., Bargh & Chartrand, 1999), our participants elected to forgo monitoring and to continue devoting all attentional resources toward ongoing task demands. Indeed, the preference for relying on spontaneous retrieval processes (as opposed to more strategic processes such as monitoring) is well documented in more naturalistic studies (Kvavilashvili & Fisher, 2007) and consistent with the idea that less resource-demanding processes should be preferable to more resource-demanding processes when the more demanding process provides no (or minimal) additional benefit (Figures 1 and 2). Importantly, the finding that the red screen did not cause proximal monitoring in the focal-cued condition does not change the main conclusion of Experiment 2 that spontaneous retrieval processes are both reliable and powerful with cues that are focally processed.

In addition to demonstrating the power of spontaneous retrieval processes for retrieving focal prospective memories, this research also demonstrated that drawing conclusions from ongoing task cost averaged over entire blocks can be misleading. Overall cost has been a widespread measure of monitoring (see Loft & Yeo, 2007, and West et al., 2005, for exceptions) that has been used to establish a relation between monitoring and prospective memory performance. According to the monitoring perspective (Smith & Bayen, 2004), however, in order to be functional, monitoring needs to occur immediately preceding (and during) the target event. That overall cost is not necessarily an adequate measure of functional monitoring was best demonstrated by the nonfocal condition in Experiment 2. In this condition, substantial differences in prospective memory performance were obtained between the cued and not-cued groups in the absence of any group difference in overall cost (see Gilbert, Gollwitzer, Cohen, Oettingen, & Burgess, 2009, as well as McNerney & West, 2007, for similar results). This finding reinforces the conclusion that averaging reaction times over hundreds of trials will not be sensitive to the waxing and waning of monitoring that can occur over the course of an experimental session (see also West & Craik, 1999). Thus, given a design in which monitoring is likely to be transient (as is the case, for example, with long experimental blocks), overall cost seems too imprecise to firmly establish whether monitoring is always necessary for prospective memory retrieval (see, e.g., Einstein et al., 2005; Einstein & McDaniel, in press; Smith, 2003; Smith et al., 2007). We believe that researchers need to take caution in interpreting the implications of overall ongoing task cost and, better yet, attempt to more precisely gauge activation of monitoring processes during theoretically auspicious points in the experimental session.

One further methodological question involves whether manipulating prospective memory and control blocks within subjects (instead of between subjects) and counterbalancing order of block presentation masks cost effects. The idea is that participants who receive the prospective memory task instructions first will monitor not only during the prospective memory block but also during the control block, even after being instructed that the prospective memory task is over. If participants were to monitor during both blocks, then reaction times during the control block would be inflated and therefore produce underestimates of cost.

As discussed by Einstein and McDaniel (in press), there is little reason to suspect that individuals would continue to devote resources toward performing a (prospective memory) task when it does not need to be performed. In addition to the logical arguments against continued monitoring during control blocks (see Einstein & McDaniel, in press, for elaboration), several studies have provided evidence that participants are unlikely to monitor during contexts in which the prospective memory task is suspended (Marsh et al., 2006; Smith, 2003). For example, Smith demonstrated that participants who received a prospective memory task, but were told to delay performing the intention, did not appear to monitor during a subsequent lexical decision task (that even included the prospective memory targets). It seems even less likely that participants would continue to monitor when they are told that the prospective memory task has been completed (see Scullin, Einstein, & McDaniel, 2009). Thus, previous research suggests that manipulating prospective memory and control blocks within subjects should produce valid cost estimates because monitoring is only likely to occur during the context in which the prospective memory task is to be performed (Marsh et al., 2006; Smith, 2003).

Two points of evidence from the current study also suggest that a within-subjects test for (monitoring) costs was justified. First, when considering only those individuals who performed the prospective memory block first, analyses demonstrated a large drop in reaction times (practice effect) from the prospective memory block to the control block (see Footnote 4). Though a between-subjects control group would be required to decisively determine how large of a practice effect should obtain, the observed magnitude of the effect does suggest that participants easily deactivated the prospective memory task before beginning the control block (Scullin, Einstein, & McDaniel, 2009).

Second, we conducted a between-subjects prospective memory group versus control group test using only the first ongoing task block. To gain maximum power, we collapsed across the focal conditions in Experiments 1 and 2 as well as the pilot experiment (yielding *n*s = 112 for both the prospective memory and control groups). The between-subjects comparison demonstrated that responding during the first block was similar for participants who received the prospective memory instructions (M = 1,158 ms) and those who had not (M = 1,146 ms), $F < 1$ (power to detect medium-, medium-small-, and small-sized effects was .96, .61, and .32, respectively). This result was consistent with the results from our within-subjects tests but had less power to detect effects. Therefore, in at least the current experiments, the within-subjects test of costs (the index of monitoring) was at least as effective as the between-subjects test for legislating between the multiprocess and monitoring perspectives.[7]

In conclusion, the present experiments were designed to assess whether engaging monitoring is necessary to prospective memory performance. Several important conclusions may be drawn from our results. First, our study establishes that the prevailing measure of monitoring (i.e., overall cost) is not only imprecise but also is not necessarily related to prospective memory. Second, the results suggest that cost can be temporarily controlled by using semantic lures or informing individuals that the prospective memory cue will appear shortly. Third, the results of Experiment 2's nonfocal-cued condition demonstrated that monitoring processes were functionally related to nonfocal prospective memory performance. Fourth, in the distal-cue (Experiment 1) and not-cued (Experiment 2) conditions, participants were not monitoring proximal to target events, and prospective memory was high in the focal conditions but near floor in the nonfocal condition. Fifth, even when considering only successful prospective memory trials, there was evidence of proximal cost only with a nonfocal cue and not with a focal cue (except when proximal cost had been experimentally induced; see Figure 1). These last two results confirm that spontaneous retrieval may support focal prospective remembering but that monitoring processes are critical for nonfocal prospective remembering. This pattern is consistent with the multiprocess perspective (McDaniel & Einstein, 2000) that the cognitive system may accomplish prospective remembering by relying on both costly processes such as monitoring and relatively cost-free spontaneous retrieval processes.[8] Our results demonstrate that single-process theories of prospective memory (e.g., the preparatory attentional and memory processes theory; Smith, 2003; Smith & Bayen, 2004) are limited for understanding the breadth of cognitive processes that appear to be recruited for supporting prospective memory. We believe that an approach that embraces multiple retrieval processes is more fruitful for understanding how individ-

[7] To gain .83 power to detect a small-sized effect (as obtained in Experiment 2 for overall cost) between two independent means, one would need data from 852 participants. Therefore, one would require over four times as many participants as were tested in Experiment 2, which would present a significant practical obstacle.

[8] Spontaneous retrieval does not imply a completely automatized prospective memory response (Einstein & McDaniel, in press; McDaniel & Scullin, in press) but instead specifies that retrieval may be triggered in response to a cue in the absence of monitoring. In addition, some facets of spontaneous retrieval, such as noticing that a target cue is different or special in some way, may be automatic, whereas other aspects such as intention coordination and execution may be effortful. Research on the microprocesses of prospective memory retrieval and execution (Marsh, Hicks, & Watson, 2002) has been minimal, but the bulk of prospective memory research suggests that if prospective memory responding is ever completely automatic, such responding is not common or easily observable in the laboratory setting (McDaniel & Scullin, in press; Smith et al., 2007).

uals successfully remember to perform the diversity of prospective memory intentions in the real world.

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Call for Nominations: *Journal of Neuroscience, Psychology, and Economics*

The Publications and Communications (P&C) Board of the American Psychological Association has opened nominations for the editorship of the ***Journal of Neuroscience, Psychology, and Economics*****,** for the years 2011–2016. The editor search committee is chaired by Peter Ornstein, PhD.

The ***Journal of Neuroscience, Psychology, and Economics (JNPE),*** first published by Educational Publishing Foundation of the APA in 2009, publishes original research dealing with the application of psychological theories and/or neuroscientific methods to business and economics. Therefore, it is the first peer-reviewed scholarly journal that publishes research on neuroeconomics, decision neuroscience, consumer neuroscience, and neurofinance, besides more classical topics from economics and business research.

As an interdisciplinary journal, ***JNPE*** serves academicians in the fields of neuroscience, psychology, business, and economics and is an appropriate outlet for articles designed to be of interest, concern, and value to its audience of scholars and professionals.

Editorial candidates should be available to start receiving manuscripts in July 2010 to prepare for issues published in 2011. Please note that the P&C Board encourages participation by members of underrepresented groups in the publication process and would particularly welcome such nominees. Self-nominations are also encouraged.

Candidates should be nominated by accessing APA's EditorQuest site on the Web. Using your Web browser, go to http://editorquest.apa.org. On the Home menu on the left, find "Guests." Next, click on the link "Submit a Nomination," enter your nominee's information, and click "Submit."

Prepared statements of one page or less in support of a nominee can also be submitted by e-mail to Molly Douglas-Fujimoto, Managing Director, Educational Publishing Foundation, at mdouglas-fujimoto@apa.org.

The deadline for accepting nominations is January 31, 2010, when reviews will begin.