

## COMMENTARY

# Prospective Memory and What Costs Do Not Reveal About Retrieval Processes: A Commentary on Smith, Hunt, McVay, and McConnell (2007)

Gilles O. Einstein  
Furman University

Mark A. McDaniel  
Washington University in St. Louis

On the basis of consistently finding significant overall costs to the ongoing task with a single salient target event, Smith, Hunt, McVay, and McConnell (2007) concluded that preparatory attentional processes are required for prospective remembering and that spontaneous retrieval does not occur. In this article, we argue that overall costs are not completely informative in terms of specifying the underlying processes mediating prospective memory retrieval, and we suggest more promising approaches for testing for the existence of these processes. We also argue that counterbalancing in a within-subjects design is one of several proper methods for assessing costs.

*Keywords:* prospective memory, spontaneous retrieval, monitoring, multiprocess theory, preparatory attentional processes

Much of the research in prospective memory focuses on how retrieval is accomplished. Consider that an important characteristic of prospective memory tasks relative to retrospective memory tasks is that no one is there to put you in a retrieval mode when the target event occurs. For example, in the real world, after forming the intention to give a friend a message, there is usually no one to prompt you to search memory for intentions associated with the friend when you encounter that friend. Similarly, in the laboratory, when given the prospective memory intention to press the “/” key whenever the target word *table* occurs in the context of a pleasantness rating task (imagine that it occurs three or four times in the context of 300 words to be rated for pleasantness), there is no one there to prompt you to search memory when the target actually occurs. By contrast, in typical laboratory tests of retrospective memory, like free recall or cued recall, the experimenter instructs participants to search memory for the to-be-retrieved items. Thus, a key question in the prospective memory arena is how, in the absence of a direct request to search memory, the cognitive system supports retrieval of the intended action at the appropriate moment.

Smith, Hunt, McVay, and McConnell (2007) reviewed two theoretical views that directly attempt to answer this question and presented what they interpreted to be strong support for one of these theories. In the next section, we present an overview of the key distinctions between these theories, and in the following sections, we question the adequacy of their data for clearly testing the theories. We also suggest more fruitful directions for testing these theories and comment on a critical methodological issue.

### Theories of Prospective Memory Retrieval

The preparatory attentional and memory processes (PAM) theory assumes that after forming a prospective memory intention for an event-based prospective memory task (one in which an environmental event signals the opportunity to perform the intended action), people initiate preparatory attentional processes directed at considering environmental events as potential targets for the prospective memory intention. Preparatory attentional processes are assumed to draw on limited-capacity resources and can range from fully conscious strategic monitoring to preparatory attentional processes that are outside of focal awareness (Smith et al., 2007). The preparatory attentional processes are needed to initiate retrospective memory processes (e.g., recognition checks) to evaluate whether the current environmental events include the target (Smith, 2003; Smith & Bayen, 2004; Smith et al., 2007). Critically, the PAM theory assumes that prospective memory retrieval can occur only when these preparatory attentional processes are engaged. Within this view, occurrences of the target event go unnoticed (in terms of the prospective memory intention) when they occur during intervals in which participants are not engaged in preparatory attentional processes. Prospective memory failures also occur when the preparatory processes are engaged but the retrospective recognition check fails to identify a target.

The multiprocess theory emanates from the perspective that good prospective memory is critical for normal human functioning (e.g., remembering to take medication, remembering appointments), and thus it would be adaptive to be able to rely on multiple processes for prospective memory retrieval (see Einstein & McDaniel, 2008; McDaniel & Einstein, 2007). Like the PAM theory, the multiprocess theory assumes that participants can remember prospective memory intentions through monitoring environmental events for the occurrence of the target (for purposes of consistency, from here on we use Smith et al.’s, 2007, term *preparatory attentional processes*). However, in addition, the mul-

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Gilles O. Einstein, Department of Psychology, Furman University; Mark A. McDaniel, Department of Psychology, Washington University in St. Louis.

Correspondence concerning this article should be addressed to Gilles O. Einstein, Department of Psychology, Furman University, Greenville, SC 29613. E-mail: gil.einstein@furman.edu

tiprocess theory assumes that the presence of a target event or cue (we specify in a later section the nature of these cues) can spontaneously initiate retrieval of the prospective memory intentions from memory, even when no preparatory attentional processes are engaged (see Einstein et al., 2005; McDaniel & Einstein, 2007; see also Kvavilashvili & Fisher, 2007, for a similar view of cuing in real-world contexts). By spontaneous retrieval, we mean that “retrieval can occur without executive resources devoted to the prospective memory intention [i.e., without preparatory attentional processes] at the time that the target event first occurs” and that “no resources need to be devoted to evaluating the target event as a prospective memory cue at the moment that it is first processed” (Einstein et al., 2005, p. 328; see also Einstein & McDaniel, 2008; McDaniel & Einstein, 2007). In other words, contrary to the PAM view that “capacity must be devoted to the prospective memory task in the form of monitoring *before* [emphasis added] a target event occurs if the target is to be recognized as a signal or an opportunity to perform the prospective memory action” (Smith, 2003, p. 359), we believe that retrieval of the intention can occur in the absence of preparatory attentional processes.

Borrowing from the retrospective memory literature, we have identified two mechanisms by which spontaneous retrieval can occur (because some of Smith et al.’s, 2007, theoretical conclusions rest on the multiprocess theory’s spontaneous retrieval mechanisms, we briefly review them). The reflexive associative process (McDaniel, Gynn, Einstein, & Breneiser, 2004) assumes that after forming an intention (e.g., press the “/” key when you see the word *table*) and storing that intention in long-term memory, full processing of the target event (*table*) during the ongoing task is likely to cause the associated action (press the “/” key) to pop into mind.

A second mechanism proposed by McDaniel et al. (2004) follows from Whittlesea and Williams’s (2001) view that people chronically evaluate the processing quality of items and that they are sensitive to the discrepancy between the actual and expected quality of processing. McDaniel et al. suggested that discrepancy could be experienced on presentation of the target cue, which in turn could prompt prospective memory retrieval (discrepancy plus search). The idea is that encountering the target cue may cause that item to be processed with more or less fluency than is expected in that context and that this discrepancy in processing (relative to other items in the ongoing task) stimulates a strategic search for the source of that discrepancy (for further details and evidence on these theories, see Breneiser & McDaniel, 2006; McDaniel & Einstein, 2007; McDaniel et al., 2004). The central point here is that the discrepancy process is not dependent on preparatory attentional processes (processes recruited specifically for detecting a prospective memory cue). In their general discussion, Smith et al. (2007) proposed post hoc a process for prospective memory retrieval that is similar to the discrepancy-plus-search process. Specifically, they proposed that the occurrence of a salient target may serve an alerting function that stimulates participants to “recruit resources to the PM task” (Smith et al., 2007, p. 743). Because this process takes place without the engagement of preparatory attentional processes—processes that by operational definition are operative prior to the occurrence of the target event—we classify it (see McDaniel & Einstein, 2007) as a spontaneous retrieval process. In short, the spontaneous retrieval processes we have proposed (Einstein et al., 2005; McDaniel & Einstein, 2000;

McDaniel et al., 2004) are reactively stimulated by the prospective memory cue and do not require preparatory attentional processes engaged prior to the occurrence of the target cue.<sup>1</sup>

The multiprocess theory also assumes that humans are not well suited to sustaining capacity-consuming monitoring processes while performing other tasks (Einstein et al., 2005; cf. Bargh & Chartrand, 1999) and have a general preference for relying on spontaneous processes. The particular process or processes that people rely on for a given prospective memory demand, however, depend on a variety of factors, including the relative importance of the prospective and ongoing tasks, the presence of a good cue, the number of different cues, the delay between the formation of the intention and the occurrence of the target event, and personal inclinations on the part of the participant (see McDaniel & Einstein, 2007, for a thorough discussion of these dependencies).

### Why the Presence of Overall Costs Does Not Test the Theories

In four experiments, Smith et al. (2007) asked participants to press a designated key whenever they saw a highly salient target event (such as the participant’s name) in the context of performing an ongoing task (such as a lexical decision task), and they found very high prospective memory. It is generally agreed that attention to the prospective memory task (such as preparatory attentional processes) can be inferred from the extent to which performing a prospective memory task interferes (i.e., produces costs) with performance on the ongoing task (Marsh, Hicks, Cook, Hansen, & Pallos, 2003). Task interference or costs are measured by having participants perform only the ongoing task in one condition and perform a prospective memory task in addition to the ongoing task in another condition and comparing the response times in those conditions. It is important to note that preparatory attentional processes are inferred from slowing on nontarget items. In Smith et al.’s research, for example, response times were analyzed for those items occurring prior to the target item, with the idea being that slowed responding on those items should be indicative of preparatory attentional processes. Typically, participants are slower at performing the ongoing task while they are also engaged in a prospective memory task (Cohen, Jaudas, & Gollwitzer, 2008; Marsh et al., 2003; Smith, 2003). In all of Smith et al.’s experiments, participants performed the ongoing task more slowly when performing a prospective memory task (by an average of 86 ms) relative to a control group that performed only the ongoing task. Smith et al. concluded that the significant costs in all four experiments support the PAM view that participants needed to engage in preparatory attentional processes for successful retrieval and argue against the multiprocess theory’s assumption that prospective memory retrieval can be accomplished by spontaneous retrieval processes.

These results are interesting in the sense that they speak to the assumption that people are generally sensitive to the nature of the

<sup>1</sup> We now recognize that the term *spontaneous retrieval* in the multiprocess theory is potentially misleading. As is evident from our description, we did not mean to imply that all aspects of the retrieval processes are automatic but rather that the retrieval processes are spontaneously initiated by the occurrence of a target event (rather than by preparatory attentional processes).

prospective cues and the ability of these cues to stimulate prospective memory retrieval (we say more about these cues in a later section). With a single salient target, the sense was that participants would assume that the occurrence of the target was likely to trigger retrieval, and thus they would not devote precious resources to keeping the prospective memory intention activated (i.e., preparatory attentional processes) while performing the ongoing task. In our view, Smith et al.'s (2007) results speak to the perceived task demands in their particular experiments (e.g., in their third and fourth experiments, a prospective memory target occurred on every 10th trial of the 68-trial prospective memory block), perhaps the nature of the prospective memory instructions (the exact instructions can be important in simulating an allocation policy that encourages preparatory attentional processes; Einstein et al., 2005; Marsh, Hicks, & Cook, 2005), and/or metamemory assumptions of the participants (Marsh, Cook, & Hicks, 2006). The significant levels of slowing in Smith et al.'s experiments argue against a strong interpretation of our theoretical position that people are unlikely to monitor with a single salient target item. Preparatory attentional processes seem to be more pervasive in laboratory tasks than we had anticipated, and Smith et al.'s results indicate that we need to carefully consider the presence of these processes in prospective memory experiments.

We disagree, however, with their claim that the presence of these significant costs on the ongoing task is theoretically decisive in terms of legislating between the PAM and multiprocess theories or, more important, in informing the three proposed processes described in the preceding section (all three are endorsed by the multiprocess theory and two by Smith et al.'s, 2007, version of the PAM theory). Finding significant costs on the ongoing task simply reveals that enough participants engaged in preparatory attentional processes on enough trials to produce significant slowing on the ongoing task. It does not indicate that preparatory attentional processes were necessary for all or any of the prospective memory retrievals. To illustrate this point, consider several possible explanations of Smith et al.'s (2007) results.

In the second experiment, for example, participants were asked to press a key when they saw their first name in the context of the lexical decision ongoing task. Participants' lexical decision times (prior to the occurrence of the target item) were, on average, 54 ms slower when performing the prospective memory task (relative to the control condition), and they remembered to perform the prospective memory task on 85% of the trials. Because participants could not anticipate the occurrence of the prospective memory target event, the PAM theory interpretation of these results logically has to be that participants were engaging in preparatory attentional processes on at least 85% of the trials and that the memory failures occurred during lapses in preparatory attentional processes (or as a result of failing to recognize the cue as the prospective memory target when the preparatory attentional processes were engaged). This may be true, but these results can also easily be explained by the multiprocess theory. One alternative explanation is that the task demands encouraged preparatory attentional processes but that they were not necessary for retrieval. The thought to press the key (at the appropriate time) may have been retrieved (i.e., through a reflexive associative process or a discrepancy plus search process) even if participants had not been engaged in preparatory attentional processes at that moment.

Another possibility is that preparatory attentional processes are relatively demanding (note that there is no specification in the PAM theory of the capacity demands of these processes). Accordingly, participants may not have been able to sustain them even 85% of the time (see West & Craik, 1999, for evidence that it is difficult to sustain preparatory attentional processes). Yet, engagement of preparatory attentional processes on less than 85% of the trials could still produce significant cost to the ongoing activity. If this were the case, then some percentage of the prospective memory detections had to be the result of spontaneous retrieval processes. As a concrete example, even if participants engaged preparatory attentional processes on half of the trials, thereby producing increased latencies on half of all of the ongoing task trials, spontaneous retrieval would account for 50% of the prospective memory retrievals (assuming no prospective memory errors in the cue recognition process of PAM). If we additionally consider individual differences and assume that only half the participants engaged preparatory attentional processes (Einstein et al., 2005, Experiment 4) and did so on half of the trials, then spontaneous retrieval would account for 75% of the prospective memory retrievals. The important point here is that simply demonstrating costs is uninformative in terms of evaluating whether preparatory attentional processes were needed for the prospective memory retrievals (see Harrison & Einstein, in press; Scullin, McDaniel, & Einstein, 2010).

A further theoretical conundrum is that Smith et al. (2007) relied on cost to the ongoing task (for items occurring prior to the target item) to simultaneously (a) endorse a salience plus search process (similar to our discrepancy plus search retrieval process) and (b) argue against the existence of a reflexive associative process. In theory, neither of these processes requires preparatory attentional processes prior to the occurrence of the target event (i.e., on nontarget trials).

### More Informative Research Approaches

We propose that a good starting point for testing whether preparatory attentional processes are necessary for prospective memory retrieval is to observe prospective memory performance under conditions of no task interference.<sup>2</sup> Task interference reflects participants' allocation policy (Hicks, Marsh, & Cook, 2005; Marsh et al., 2005), which is influenced by a variety of factors, including participants' perceptions of the task demands, their metamemory, and possibly even their personality characteristics (Einstein & McDaniel, 2008; McDaniel & Einstein, 2007). This perspective underscores the importance of examining individual differences. Indeed, in Einstein et al. (2005, Experiment 4; see also Einstein & McDaniel, 2005, p. 288), as a result of noticing non-

<sup>2</sup> Smith et al. (2007) dismissed our previous research (Einstein et al., 2005, Experiments 1–3; see also Cohen et al., 2008) showing no task interference by stating that our power to detect "even medium-effect sizes" (Einstein et al., 2005, p. 736) was less than .60. However, they underestimated our true power to detect significant costs on the ongoing task. We used G\*Power 3.0.3 (Faul, Erdfelder, Lang, & Buchner, 2007), and factoring in that the critical comparisons were within subjects and the correlations were between the within-subjects levels, our actual power to detect a medium effect size (Smith et al.'s, 2007, average effect size across their four experiments with a highly salient target event was a medium effect size) ranged from .74 to .99 across the three experiments.

significant costs with a single focal target event in several studies, we wondered whether there might be individual differences associated with using a monitoring strategy. To examine this, we used a paradigm that we believed would be especially sensitive to preparatory attentional processes. The ongoing task was to decide if the capitalized word at the end of the sentence could fit into the blank in the sentence, and the prospective memory task was to press the *Enter* key whenever participants saw a nonsalient but focal target word. Because a preparatory attentional processes strategy would involve comparing the target word to the 14 to 18 words in the sentences, we assumed that these conditions would be especially sensitive to this kind of strategy. We tested a large number of participants (104) and found significant costs with a single focal target event.

More important, in this experiment after adjusting for participants' counterbalancing conditions, we analyzed for individual differences and found 58 participants who were slower on the prospective memory block (suggesting that these participants were engaging preparatory attentional processes) and 46 participants who were faster on the prospective memory block (suggesting that these participants were not engaging preparatory attentional processes). According to the PAM theory, these 46 participants should have had very low or zero prospective memory, whereas according to the multiprocess theory, they should have had relatively good prospective memory. Consistent with the multiprocess theory but not with the PAM theory, prospective memory was high in both groups of participants (mean proportion correct was .94 and .95, respectively) and not significantly different. Critically, it is under conditions of no costs that the PAM and multiprocess theories clearly make different predictions.

It should be noted that an individual differences analysis that simply demonstrates better prospective memory for participants who show greater task interference (Smith, 2003) is inconclusive. Although this finding has been taken as evidence for the PAM theory and against the multiprocess theory (Smith, 2003), this conclusion is not warranted. The PAM theory predicts higher prospective memory for those participants who show greater task interference (assuming that the recognition process is successful), but such a pattern is not inconsistent with the multiprocess theory. Consider that spontaneous retrieval when the target items occur is a probabilistic process (cf. Moscovitch, 1994) and that being engaged in preparatory attentional processes is also a probabilistic process (Smith et al., 2007). Participants who can benefit from both processes (i.e., multiple processes) should have higher prospective memory performance than those who rely only on spontaneous retrieval.

Another technique is to use experimental procedures that discourage preparatory attentional processes during the ongoing task. Thus far, we know that task interference is reduced when participants are presented with one target event as opposed to six different target events (Cohen et al., 2008; Einstein et al., 2005, Experiment 3) and when presented with a focal as opposed to a nonfocal target (Einstein et al., 2005, Experiments 1 and 2; Marsh et al., 2003). Also, emphasizing the importance of performing the ongoing task as quickly and accurately as possible and deemphasizing the prospective memory task (Einstein et al., 2005, Experiment 1; Kliegel, Martin, McDaniel, & Einstein, 2004), presenting fewer target events (Loft & Yeo, 2007), and delaying the presentation of the first target event (Loft, Kearney, & Remington, 2008)

lower task interference. To the extent that these conditions eliminate preparatory attentional processes, the PAM theory anticipates floor levels of prospective memory performance with a focal target.

Another approach is to conduct more fine-grained analyses of task interference throughout the ongoing task (see Loft & Yeo, 2007; Scullin, McDaniel, & Einstein, 2010; West, Krompinger, & Bowry, 2005). Overall costs (averaged across all trials) on an ongoing task may reflect early and substantial concern with the prospective memory task; thus, prospective remembering on these trials might reflect retrieval due to both preparatory attentional processes and spontaneous retrieval. By later trials, however, preparatory attentional processes may have waned, and retrievals may be more or even entirely dependent on spontaneous retrieval processes (see Scullin, McDaniel, Shelton, & Lee, in press, Experiment 4). Again, what is generally needed is more control over the preparatory attentional processes to the point that researchers can infer when they are and are not occurring on these trials immediately preceding a target event.

Yet another technique for eliminating preparatory attentional processes is to give participants an intention (e.g., to press a designated key when they see the target item in the context of a task in which they rate the ease of imaging items), to then ask them to suspend that intention during an intervening task (e.g., during a lexical decision task), and yet to present the target event during the intervening task (i.e., during the lexical decision task; Einstein et al., 2005, Experiment 5; Scullin, Einstein, & McDaniel, 2009). Suspending the intention has been shown to eliminate task interference (Marsh, Hicks, & Cook, 2006), and the presentation of the target item has been shown to slow lexical decisions to that target item, thereby suggesting spontaneous retrieval (Einstein et al., 2005; Scullin et al., 2009). Development of this technique holds promise for eliminating preparatory attentional processes and investigating the kinds of cues that trigger spontaneous reactions.

As Smith et al. (2007, p. 735) stated, showing successful prospective remembering in the absence of task interference would disprove the PAM theory. Conversely, showing floor levels of prospective remembering with focal target events (that have been associated with the prospective intention) in the absence of task interference would disprove the central assumption of the multiprocess theory that spontaneous retrieval processes exist. Further, given that successful prospective remembering occurs in the absence of task interference (as suggested by initial evidence; Cohen et al., 2008; Einstein et al., 2005), then it should be possible to evaluate the effectiveness of reflexive associative and discrepancy plus search processes by varying cue conditions and encoding and retrieval conditions. For example, conditions that strengthen the cue-action association and reinstate the original encoding context at retrieval should enhance the reflexive associative process (cf. McDaniel et al., 2004). On the other hand, conditions that enhance the salience of the target event or processing quality of the target (relative to other items in that context) should enhance a discrepancy plus search process (cf. Breneiser & McDaniel, 2006; McDaniel et al., 2004).

### Focal Processing and Encoding Specificity

According to the multiprocess theory, spontaneous retrieval of the intended action is likely when participants have formed a good

encoding of the target cue and a good association between the target cue and the intended action. Also important is that the ongoing task encourages focal processing of the target event. By this we mean that the ongoing task directs attention to the target and especially to those features that were processed at encoding. This thinking follows directly from the encoding specificity principle (Tulving, 1983) that features of the cue that are processed at retrieval need to match those that were processed at encoding for successful retrieval to occur. Indeed, we believe that focal processing (and encoding specificity) is particularly critical in situations where participants are not in a retrieval mode. Unlike in the retrospective memory task of cued recall, where the presentation of a cue can lead to a controlled search and the assembly of additional cues (Raaijmakers & Shiffrin, 1980), in prospective memory and in the absence of preparatory attentional processes, the retrieval process (at least the initial retrieval) has to be accomplished without these additional search processes. Thus, it is especially critical that the ongoing task encourages processing of the cue in a way that closely matches how it was processed at encoding.

In considering the expectations of the conditions under which cost would be prominent in PAM versus the multiprocess theory, Smith et al. (2007) misinterpreted our distinction between focal and nonfocal processing (Einstein & McDaniel, 2005; McDaniel & Einstein, 2000, 2007). Specifically, in Table A1 of their article, some of the studies they reviewed were incorrectly listed as having used a focal task, thereby clouding their interpretation of the cost results. The problem is that they categorized tasks as focal if the prospective memory intention was to perform an action whenever any instance of a general category was presented. For example, they classified Marsh, Cook, and Hicks's (2006) Experiment 1 as a focal task. Yet, in this experiment the ongoing task was naming words (or pictures), and the prospective memory task was to perform an action whenever an instance of the furniture category was presented. According to our distinction, this would not encourage focal processing because naming a word (the ongoing task) does not require the encoding of the categorical concept of furniture (the prospective memory target; see Table 2 of Einstein & McDaniel, 2005, for further examples of focal and nonfocal processing conditions).

### Methodological Issues

What is the proper way to test for task interference? Smith et al. (2007) used a mix of a between- and within-subjects design in which two groups of participants performed two blocks of trials. Participants in the control condition performed only the ongoing task on both blocks, and those in the prospective memory condition performed only the ongoing task on the first block of trials and the prospective memory task in addition to the ongoing task in the second block of trials. Smith et al. inferred task interference from the relative difference in the speed of performing Blocks 1 and 2.

Although this seems to be a reasonable method, we have preferred to use the more efficient and generally more sensitive within-subjects design of having all participants perform two blocks, one a control block and one a prospective memory block. We counterbalance the order of performing the prospective memory block as well as the materials. Smith et al. (2007) suggested that our method may have underestimated task interference because the control block intervened between the prospective mem-

ory instruction and the prospective memory block (this implication was based on a reference to Guynn's, 2005, procedure). The idea here is that participants may monitor during the intervening control block. This implied characterization of our procedure, however, is simply incorrect. Participants who received the control block followed by the prospective memory block received the prospective memory instructions right before the prospective memory block (see Einstein et al., 2005, pp. 330, 332, and 334). Thus, participants were performing the control block without any possible contaminating effects of an impending prospective memory block (unlike in Guynn's, 2005, article cited in Smith et al., 2007).

Furthermore, Smith et al. (2007) discounted our critical individual difference analysis (from Einstein et al., 2005) presented earlier by questioning our use of counterbalancing to control for order effects and by questioning our "curious approach" (p. 745) to adjusting for participants' counterbalancing conditions. Following their example, Smith et al. asked the reader to assume that there is a 100-ms speedup in Block 2 (as a practice benefit of performing Block 1) and that performing a prospective memory task creates task interference of 20 ms. They also assumed a baseline (control) response time on the first block of 1,000 ms. Additionally, they assumed two participants who are in different counterbalancing conditions and who have similar baselines and similar levels of task interference and prospective memory. They then correctly stated that Participant A, who performs the prospective memory task second, will have response times of 1,000 and 920 ms in Blocks 1 and 2, respectively. Participant B, who performs the prospective memory task first, will have response times of 1,020 and 900 ms in Blocks 1 and 2, respectively. They then stated that this method is problematic (see Smith et al., 2007, p. 745) because participants with identical levels of preparatory attentional processes show different levels of task interference (80 ms for Participant A and 120 ms for Participant B).

The first point to note is that counterbalancing is the classic method in experimental psychology for controlling for order effects (i.e., practice or fatigue effects). Indeed, in Smith et al.'s (2007) example, by subtracting the control block from the prospective memory block for each participant and then averaging the difference,  $[120 + (-80)]/2 = 20$ , an average cost of 20 ms would be obtained, which is exactly the theoretical value assumed in generating the example.

It is, of course, true that any particular individual's *raw* difference score will not accurately estimate his or her cost (because of order effects). The second key point is that Smith et al. (2007) did not acknowledge a critical aspect of our cost estimation procedure. For each participant, we adjusted for the speedup or slowdown associated with the order of performing the tasks. In the present example, we would have added 100 ms to the Block 2 response times of Participants A and B. Doing so provides an estimate for adjusting for the counterbalancing condition and accurately estimates task interference to be 20 ms for both Participants A and B (which is the assumption that Smith et al., 2007, started with).

We are aware that counterbalancing is not an appropriate method for controlling order effects when the order effects of practice or fatigue are asymmetrical; yet, there is no a priori reason to assume (and no empirical evidence to support the idea) that the practice effect on the speed of performing a lexical decision task varies according to whether one performs the control or prospective memory block first. Using a within-subjects design is also

inappropriate when one suspects carryover effects (e.g., when an instruction presented in the first block can be used to help performance in the second block); however, the views that we are aware of assume that participants set an allocation policy (Marsh et al., 2005) on the basis of the task demands, and it is unclear to us why participants would devote capacity-consuming resources to preparatory attentional processes when the task demands no longer call for them (i.e., in the control block).

In short, our design appropriately controlled for order effects and also allowed us to examine individual differences. Thus, the counterbalancing design appears to be an appropriate method for examining task interference. Nevertheless, we recognize that there are potential limitations to both between- and within-subjects manipulations of prospective memory instructions (to address the issues raised earlier), and further research is needed to directly compare the influence of the type of design on preparatory attentional processes and prospective memory.

### Spontaneous Retrieval Versus Automatic Retrieval

In recent years, we have preferred the term *spontaneous retrieval* over *automatic retrieval* (Einstein & McDaniel, 2005, 2008; Einstein et al., 2005; McDaniel & Einstein, 2007; McDaniel, Einstein, & Rendell, 2008). By *spontaneous retrieval*, we mean that the occurrence of a focal target event can trigger retrieval of an intention in the absence of preparatory attentional processes. We prefer this term because it is likely that not all components of spontaneous retrieval are automatic. For example, considering our proposed reflexive associative process, the idea is that after forming a good association between a cue and an action, later occurrence of the cue (and full processing of it) will cause the associated action to be delivered to consciousness (e.g., Moscovitch, 1994). It may be, however, that these processes are not fully automatic and may require some general attentional resources when the cue occurs (note that we are not proposing preparatory attentional processes; see Einstein & McDaniel, 2008, for further development of this view). For example, dividing attention may interfere with full processing of the cue and/or individuals may vary their thresholds for allowing cue-driven thoughts into consciousness (cf. Norman, Newman, & Detre, 2006). Specifically, as the ongoing task becomes more demanding and requires more attentional focus, individuals may set a higher threshold for allowing cue-driven thoughts unrelated to the ongoing task to enter consciousness. This thinking is consistent with the idea that involuntary memories (memories that occur without a deliberate search, such as passing a familiar landmark, might cause a memory of a previous episode associated with that landmark to pop into mind) are more likely to reach consciousness when individuals are relaxed and their attention is not highly focused (Ball & Little, 2006; Kvavilashvili & Mandler, 2004). Further empirical work is needed to determine the capacity requirements of these processes.

In terms of the discrepancy plus search process presented earlier, an initial sense of discrepant fluency (that does not require preparatory attentional processes) is followed by a strategic search of memory for the source of the discrepancy (a controlled process; see Breneiser & McDaniel, 2006; McDaniel et al., 2004). Smith et al. (2007) claimed that preparatory attentional processes can be stimulated by salience of the target cue (or in this case discrepancy). If so, then more theoretical and empirical specification is

needed to distinguish the role of preparatory attentional processes (occurring after a salient/discrepant cue) from the controlled search processes presumed to be stimulated by the cue in the multiprocess theory. As presented, it is unclear (a) how these are measured by the operational definition of preparatory attentional processes (measuring costs to the ongoing task on trials occurring *prior* to the target event) and (b) why preparatory attentional processes need to precede retrieval of the intention after an individual has oriented to that cue as a significant event. At this point, it seems that a search for the significance of the cue (McDaniel et al., 2004) is all that is needed. Why would one first need to engage *preparatory* attentional processes related to maintaining the prospective memory intention before retrieval of the significance of the cue could occur?

Do these theoretical nuances blur the distinctions between the theories such that they are untestable? We think not, but they do suggest that more incisive experiments are required. In principle, it should be possible to independently manipulate preparatory attentional processes and resource availability at retrieval. For example, assuming that researchers can create conditions that fully eliminate preparatory attentional processes, they can then divide attention to examine the capacity requirements of the spontaneous retrieval processes.

### Summary

In summary, we appreciate the theoretical controversy between the PAM and multiprocess theories of prospective memory. We agree with Smith et al. (2007) that a critical difference between the theories is that the multiprocess theory but not the PAM theory assumes that “under some circumstances, retrieval of the intention (the prospective component) requires no resources or capacity *prior* [emphasis added] to the occurrence of the target event” (Smith et al., 2007, p. 735). Theoretical disagreements of this sort are helpful for generating research and enhancing researchers’ understanding of prospective memory. Smith and her colleagues (Smith, 2003; Smith & Bayen, 2004; Smith et al., 2007; see also Marsh et al., 2003) have been instrumental in demonstrating that task interference tends to occur in laboratory tests of prospective memory. Our objection is to their accompanying theoretical claim that the presence of significant costs can be used to rule out the existence of spontaneous retrieval processes. We have specified why this claim cannot be unambiguously supported by the data they reported. Most important, we hope that this commentary on Smith et al.’s article helps to put in clearer relief the kinds of data that will and will not distinguish between the theories.

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