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Spontaneous Retrieval in Prospective Memory

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Our chapter, like others in this volume, focuses on episodic memory. Other chapters have approached episodic memory as a process or system to preserve an individual's mental record of his or her past. Here we take a broader view that episodic memory also allows people to mentally place themselves forward in time. Tulving (2004) has termed this process proscopic chronesthesia. Proscopic chronesthesia, likely unique to humans, supports forward-looking activities, the anticipation of what we will be doing in the near and long term, what we are likely to feel in anticipated events, what we hope to accomplish, and the planning activities that accompany this future oriented behavior. Closely aligned with such mental time-travel is prospective memory, which is the focus of the present chapter. Prospective memory is memory for activities that we intend to perform in the future. More specifically, prospective memory refers to remembering to perform an intended action at an appropriate moment in the future.

With even minimal thought, it is clear that everyday living is replete with prospective memory tasks. We need to remember to give colleagues messages, to pack a desired item in our work bag, to remember to pick up some grocery item on the way home from work, and to remember to attend scheduled appointments. For one of us, the last prospective memory challenge is especially salient because recently, at the time that a faculty meeting was scheduled, MAM forgot about the meeting (his colleagues were much amused that a prospective memory researcher would forget the meeting). Prospective memory is also needed for handling health-related needs such as remembering to exercise, monitor various bodily indices like blood pressure or blood-sugar levels, and to take medication. The latter is increasingly frequent as the Center for Disease Control and Prevention reports that 44% of Americans (http://www.cdc.gov/nchs.hus.htm) have taken a prescription medication over the past month and 17% have taken three or more medications.

Despite the prevalence of prospective memory in every day life, the scientific study of memory dating from Ebbinghaus (1885/1964) has not included

investigation of prospective memory. Perhaps this state of affairs rests on the observation that prospective memory tasks appear similar to the ubiquitous retrospective memory task of cued recall (cf. McDaniel & Einstein, 1993). In the typical laboratory paradigm, in cued recall the subject is given a list of paired items that includes a cue item and an item to be remembered (e.g., "train—BLACK"). Then at test, the subject is provided with the cue ("train") and prompted to try to remember the target item. In a parallel fashion, in a prospective memory task, a person pairs a particular anticipated event (e.g., "Roddy") with an intended action (ask him where to buy an Argyle sweater). Later the individual encounters the cue event and must remember the associated intention (the target).

There is a critical difference, however, between the cued recall task and the prospective memory task. In cued recall an agent (the experimenter) requests that the person try to remember—recollection is stimulated by some agent requesting a memory search. In Tulving's (1983) terms, the request to remember places the person in a retrieval mode. Here the person is set to consider incoming information as a potential retrieval cue. In contrast, in prospective memory there is no external agent requesting a memory search, and thus the individual is presumably not always in a retrieval mode when the target event is encountered. (Otherwise, given the prevalence of prospective memory tasks in everyday functioning, arguably people would constantly be in a retrieval mode; if that were the case, then at the theoretical level, there would be little advantage to distinguishing a retrieval mode state.) From our perspective, a critical feature of prospective remembering that sets it apart from the explicit retrospective memory tasks studied extensively for over 100 years is that somehow the intended activity is remembered at the appropriate moment without an external agent stimulating retrieval (cf. Craik, 1986). How can this occur?

HISTORICAL OVERVIEW

An appeal to early prominent psychologists provides one possible answer. Ebbinghaus (1885/1964) identified three types of memories.

(1) Voluntary production: "we call back into consciousness by an exertion of the will . . . the seemingly lost states."
(2) Unconscious influences of prior states that indirectly provide evidence of their lasting effects.
(3) Spontaneous appearance of a mental state "without any act of will" that is recognized as previously experienced.

The first captures processes related to explicit retrospective memory tasks, whereas the second is applicable to what modern memory researchers term implicit memory tasks (Roediger, 1985). We suggest that prospective memory often relies on the third type of memory, spontaneous processes that occur without any act of will. Freud (1909/1952) described the processes involved in remembering an intention in a similar fashion: "The suggested intention slumbers on in

the person concerned until the time for its execution approaches. Then it awakes and impels him to perform the action" (p. 79).

Many, if not most, contemporary memory researchers have taken a different approach and assumed that a more active, resource demanding process is involved in prospective remembering. In a seminal paper, Craik (1986) proposed that prospective memory, more than any other memory task, requires extensive self-initiated retrieval activity. Others have adopted the view that people monitor for the event that signals the appropriate time for performing the intended action, a process that is presumably capacity consuming (e.g., Burgess & Shallice, 1997; Guynn, 2003; Smith, 2003). Smith explicitly proposes that a capacity consuming "preparatory" process is needed to evaluate events as possible targets. She states that "retrieval of an intention will never be automatic, because nonautomatic preparatory processes [monitoring] must be engaged during the performance interval . . . before the occurrence of the target event" (p. 349). In support of this monitoring view, Smith (see also Guynn, 2003; Marsh, Hicks, Cook, Hansen, & Pallos, 2003) finds substantial costs on performing an ongoing task when also performing a prospective memory task. These costs are on the order of a 300 ms slowing for a lexical decision task.

SPONTANEOUS RETRIEVAL VIEW OF PROSPECTIVE MEMORY RETRIEVAL

In contrast, consistent with Ebbinghaus' claim for spontaneous appearances of mental states without any act of will, we (Einstein & McDaniel, 1996; McDaniel & Einstein, 2000) have suggested that people do not have to monitor for the target event in order to have successful retrieval; instead people have a bias to rely on spontaneous retrieval. By this view, prospective remembering occurs when the presence of the target event initiates retrieval. Here remembering does not require that a person be in a retrieval mode, as is claimed for explicit retrospective memory or as is suggested by the monitoring view (e.g., see Guynn, 2003).

Because recent work has argued forcefully and marshaled impressive data for a resource demanding (monitoring) process in prospective memory retrieval, the spontaneous retrieval view does not enjoy unanimous acceptance. As one researcher succinctly objected, "rather than assuming that the prospective [memory] component is automatic, experiments are needed to demonstrate when, if ever, this is the case" (Smith, 2003, p. 359). Our objective in this chapter is to meet that challenge by building an experimentally-based case for the spontaneous retrieval view of prospective memory. To do so, we address five central issues. First, can prospective remembering occur with no cost to ongoing activity? Second, is prospective memory retrieval evidenced when the prospective memory intention is suspended? Third, might spontaneous retrieval be accomplished, at least in part, by a reflexive associative memory process (e.g., Moscovitch, 1994)? Fourth, when reflexive associative processes are preeminent, does divided attention penalize prospective memory retrieval? Fifth, are there other cognitive

processes, processes not specifically recruited for prospective remembering, that might also support spontaneous prospective memory retrieval? Note that we are not claiming that prospective memory retrieval cannot be accomplished by monitoring (see Einstein et al., 2005). Our claim is that monitoring is not always necessary for prospective memory retrieval, and that in some cases (perhaps often in everyday prospective memory) prospective memory retrieval is a predominantly spontaneous, nonstrategic process.

Can Prospective Memory Occur without Cost to Ongoing Activity?

Smith's (2003) paradigm always used six different words as the prospective memory targets. Arguably, many event-based prospective memory tasks are simpler in that only one target event is associated with the intended action. Indeed in everyday settings, a single target event is a common (event-based) prospective memory situation. An intended message is often for one particular person and buying a grocery item on the way home is usually associated with one target store. Though people might monitor for a target when faced with the task of responding whenever any one of six target events appeared, it is not certain that monitoring or other resource demanding preparatory processes (or self-initiated retrieval processes) are engaged when one target event signals the appropriateness of executing the action.

Einstein et al. (2005, Exp. 3) investigated this possibility with a sentence completion ongoing task. Subjects were given a set of sentences, each with a missing word. Following each sentence was a word that might or might not fit into the sentence. Subjects were to respond either "Yes" or "No" to indicate if the word fit the sentence. An example is:

A warrior's armor makes him _____ to blows that he may undergo in battle.
IMPERVIOUS

Subjects were encouraged to be both accurate and fast in responding to the sentence completion task. There were two blocks of sentences with 110 sentences in each block. In one block there was no prospective memory task, whereas in the other block subjects also were instructed to perform a prospective memory task. For the prospective memory block, subjects were instructed to press the "Enter" key whenever they saw a target word.

Importantly, half of the subjects were in a six-target item condition ("evening," "horse," "medicine," "orange," "sauce," and "goggles"), and the other half were in a one-target condition. Figure 14.1 shows the response times to the ongoing activity as a function of the target condition (1 vs. 6 targets) for the control blocks (no prospective memory task) and the prospective memory blocks. Replicating Smith (2003), having a prospective memory task incurred a significant cost (of 322 ms) to the ongoing activity when there were six target events. In contrast, there was no significant cost when there was a single target event (94 ms). Moreover, the absence of a cost was not associated with poor prospective memory performance, as it should have if prospective memory retrieval required preparatory attentional (monitoring) processes (Smith, 2003; Smith & Bayen, 2004). Indeed prospective

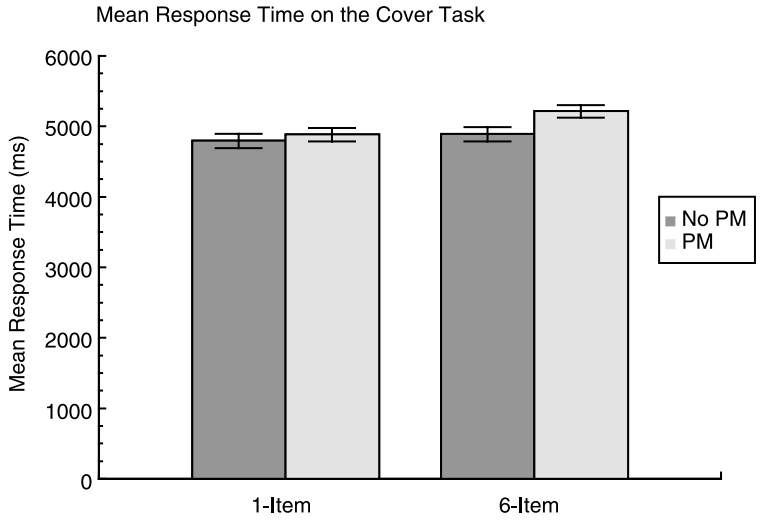

FIGURE 14.1 Response times to the ongoing activity as a function of the number of prospective memory targets (1 vs. 6) for trial blocks with and without a prospective memory task (result from Einstein et al., 2005, Exp. 3).

memory performance was nominally higher in the one target condition (80% responding) than in the six-target condition (72% responding).

The one-target condition showed a non-significant but small cost on the ongoing activity. Perhaps the number of subjects ($N = 32$) provided inadequate power to reveal a significant cost, or produced a nonstable finding that underestimated the true cost. To address this issue, in her master's thesis Jen Breneiser (2004) tested a large number of participants ($N = 128$) in the one-target event condition. Response times to the sentence completion task were nearly identical, with a mean cost of only 9 ms when the prospective memory task was present. The absence of a cost was not a speed–accuracy tradeoff (77% and 75% correct sentence responses in the control and prospective memory blocks, respectively). Finally it is important to note that prospective memory performance was at a high level (83% responding).

Still, a skeptic might argue that participants were able to sneak in monitoring during the sentence completion task (cf. Reitman, 1974) and thus costs were not detectable. To counter this idea, in a recently conducted study in our labs by Matt Larson, we used the lexical decision task as the ongoing activity (as had Smith, 2003; see also Marsh et al., 2003), but we emphasized the importance of the lexical decision task by occasionally giving participants feedback on the speed of their responses. Nevertheless, Larson's results showed a minimal and again nonsignificant cost (14 ms) of performing a prospective memory task and again very high prospective memory performance (80%). These findings of high prospective memory coupled with no cost to the ongoing activity strongly suggest that spontaneous retrieval processes can produce successful prospective remembering.

Still, the evidence for spontaneous retrieval is somewhat indirect. In the next section we describe a new paradigm designed to provide more direct evidence for spontaneous retrieval processes.

Is Prospective Memory Retrieval Evidenced When a Prospective Memory Intention has been Suspended?

Another strategy for determining whether the cognitive system spontaneously responds to stimuli in the environment is based on the reasoning that a spontaneous retrieval process should occur when the conditions for its retrieval are met—even when there is no intention to retrieve at the time these conditions are present. We (Einstein et al., 2005, Exp. 5) recently developed an experimental technique for examining retrieval under these conditions. Subjects were first told about an ongoing image-rating task in which words were presented one at a time, and the task of subjects was to rate the ease of forming an image for each word. Subjects were also given the prospective memory task of pressing a designated key whenever a particular target item occurred in the context of the image-rating task. The novel twist in this experiment was that we interweaved sets of lexical decision trials between sets of image rating trials. Critically, for the lexical decision task, (a) we told subjects to suspend all other task demands and that their sole concern was to decide as quickly as possible whether the letter strings formed a word, and (b) we included the prospective memory target as well as a matched control item among the 18 lexical decision items. This sequence of tasks was repeated for 10 blocks, and subjects received a new prospective memory target at the start of each block.

Given the instructions to ignore the prospective memory task during the lexical decision task, there should have been no monitoring during these trials. According to the monitoring view, prospective memory retrieval cannot occur without controlled monitoring of the environment for the target event. Thus, lexical decision response times to target events should have been similar to those for control items. According to the spontaneous retrieval view, however, the conditions for retrieval (i.e., the presence of the target and an orienting activity that required full processing of it) were present and should produce retrieval. The results supported this latter view as lexical decisions were significantly slower (by 55 ms) for prospective memory target targets relative to control items. This slowing reveals that participants were retrieving something (perhaps noticing the target event and/or retrieving the intended action) when the target occurred.

A possible criticism of this experiment is that participants were constantly switching back and forth between the ongoing task and the lexical decision task, and this may have created confusion regarding the demands associated with each task. To address this concern, we, along with Matt McDermott and Leah Rusinko, recently completed a simplified version of the above experiment. In this new experiment, participants were told about an ongoing image-rating task and then given the prospective memory intention of pressing a key whenever any one of two target events occurred in the ongoing task. We then interrupted them with a "speed" task (in this case a living/nonliving judgement task rather than a lexical

decision task) consisting of 260 trials. Participants were told to ignore the prospective memory intention during this "speed" task, and each target event occurred four times across these trials. This is a simpler procedure because subjects switched only once from the ongoing task instructions to the "speed" task and then back again to the ongoing task. Consistent with the results from the first experiment, participants were significantly slower (by 30 ms) in making judgments to the prospective memory target events relative to matched control items.

Taken together, these results provide the first direct evidence that prospective memory intentions can be retrieved without monitoring for a target event and more generally that spontaneous retrieval can occur without being in a retrieval mode. Also, this new method of "loading" a target event with meaning (in this case, a prospective memory intention) and then examining the speed of responding to that target during an intervening task seems to hold promise for investigating the kind of memory Ebbinghaus (1885/1964) described as occurring "without any act of will."

Is Spontaneous Retrieval Mediated by a Reflexive Associative Memory Process?

A reflexive-associative model of spontaneous retrieval has been proposed by Moscovitch (1994), and here we explore the extent to which the broad ideas of the model can be applied to understanding spontaneous retrieval in prospective memory. According to his view, the hippocampus supports an "automatic" associative memory system in which the inputs are stimuli that have been fully processed (e.g., semantically). To the extent that the representation of this stimulus interacts with prior associations in memory, this system delivers to consciousness the associated information. The key feature for present purposes is that the association is delivered to consciousness rapidly, obligatorily and with few cognitive resources. That is, retrieval by this system occurs without an external agent requesting a memory search; instead retrieval is reflexive. These are the precise conditions that at the outset of this chapter we suggested characterized prospective remembering in many situations.

As applied to prospective memory, we (see Einstein & McDaniel, 1996; Guynn, McDaniel, & Einstein, 2001; McDaniel, Robinson-Riegler, & Einstein, 1998) suggest that during prospective memory planning people form an association between the anticipated target cue and the intended action. Later, when the target cue is encountered, this reflexive associative system delivers the intended action to consciousness (or prospective memory fails). As an everyday example, MAM's daughter asked that he remember to bring home a floppy disk from work. He formed the intention to do so, but forgot to bring a disk home that evening, and forgot for the next several days as well. (With other demands and concerns occupying resources, a monitoring strategy was not implemented.) Later in the week, at work he was removing a disk from a storage box (i.e., fully attentive to the disk) and suddenly remembered that he needed to take a disk home for his daughter (leading to successful execution of the promised intention). Phenomenologically, this experience had the characteristics of a reflexive, nonself initiated retrieval of an

intended action when an associated cue was encountered in the environment. Next we describe more scientifically based support for this idea.

Our experimental method (McDaniel, 2004, Exp. 2) used the ongoing activity of rating words various dimensions. To keep subjects actively engaged in this task, on any given trial the requested rating could involve one of four dimensions (familiarity, concereteness, meaningfulness, or pleasantness), with ratings entered on the keyboard. At the outset of the experiment, subjects were additionally instructed that if they ever encountered one of two target items, they should try to remember to write down on a provided sheet of paper a particular response word. A critical manipulation was the degree to which the target item and the response item could be readily associated. In the high-association condition, subjects were given two of the cue–action pairings from the following set of pairs.

spaghetti–sauce; steeple–church; thread–needle; eraser–pencil

For each pair, the intended action word was the most frequent associate to its target event in the University of South Florida free association norms (Nelson, McEvoy, & Schreiber, 1998).

In the low-association condition, the identical cue words were used, but they were paired with an action (a response word) with no strong prior association (again, a particular subject received only two of the following pairs for the prospective memory task):

spaghetti–church; thread–pencil; steeple–sauce; eraser–needle

Real-world analogues for these conditions could be intending to stop at the grocery store on the way home from work for bread (a high cue-intended action association) versus intending to stop at the grocery store for shoe polish (a low cue-intended action association).

After the initial instructions, there was an approximately 12-minute filler activity and then subjects proceeded to the word rating task, with no additional reminder about the prospective memory task. Note that the design provides a competitive test of the strategic monitoring view and the spontaneous associative retrieval view. According to a monitoring view, people initiate a recognition check of environmental events to determine if the target cue is present (e.g., Smith, 2003; Smith & Bayen, 2004). Because the target cues are identical for both conditions, this process should produce equivalent prospective memory across the low- and high cue-action conditions. One caveat to this prediction is that performance for the low cue-action condition could be worse if subjects can not successfully remember the associated action (a retrospective memory failure). To gauge this possibility, at the end of the experiment all subjects were given a recall test for their memory of the cues and associated actions.

In contrast, according to the idea that prospective memory retrieval can be supported by a spontaneous associative retrieval process, the high association cue-intended action condition should produce better prospective remembering than the low association cue-intended action condition (because reflexive associative retrieval will be more probable in the former condition). This prediction was

borne out. Subjects were significantly more likely to remember to perform the prospective memory response when the cue was highly associated with the intention (.88) than when the cue–intention pair was minimally associated (.74). Importantly, at the end of the experiment when prompted to report the details of the prospective memory task, all but two participants correctly recalled the prospective memory cue words and their assigned action words. Removing these two participants from the analyses did not change the prospective memory patterns. Thus, the advantage conferred by the high cue–intention association was apparently not due to better retrospective memory for the prospective memory targets and associated actions.

Nevertheless, when the two participants who could not correctly recall the components were not included in the analyses the significance level for the cue–intention association effect fell just below the conventional alpha level of .05. This result perhaps slightly undercuts the interpretation that the locus of the association effect was in the prospective-memory retrieval process. To further compel that interpretation, in collaboration with Melissa Guynn we conducted another experiment at a different university (New Mexico State) using a similar procedure. Because this next experiment was not published, we provide more of the critical details here.

In the Guynn experiment, we replaced all of the subjects (seven) who failed to recall the prospective memory cues and intended actions at the end of the experiment. Thus, all 64 subjects in the experiment had perfect retrospective memory for the prospective memory task for both the high ($N = 32$) and low-association ($N = 32$) conditions. There were 208 total word-rating trials, of which eight were prospective memory trials (each target word was presented for four trials each). The high-association condition ($M = 0.85$) produced substantially better prospective memory performance than the low-association condition ($M = 0.56$), $F(1, 60) = 9.33$, $MSE = 0.29$. We also found that prospective memory performance was significantly better for the last four prospective memory trials than the first four trials, $F(1, 60) = 17.93$, $MSE = 0.02$, indicating practice effect or carryover processes (cf. Maylor, 1998). Accordingly, the first several trials may be the most sensitive to the retrieval processes that are operative in everyday prospective memory tasks that are not habitually executed. Thus, to be conservative, we also examined performance on just the first two prospective memory trials. The significant advantage for high- ($M = 0.76$) versus low-association ($M = 0.48$) remained, $F(1, 60) = 7.48$, $MSE = 0.17$.

Because all subjects showed perfect retrospective memory for the target event and its associated action (during postexperimental testing), the results imply that the advantage of the high-association condition rested on the prospective memory retrieval component of prospective remembering. Further, because the prospective memory cues were identical in the high- and low-association conditions, the difference in performance could be not be due to processes involved in cue detection (e.g., monitoring) or prospective-memory target recognition (cf. Smith, 2003). The results are most consistent with the idea that the target cue was more likely to stimulate reflexive and obligatory retrieval of the intended action when the intended action was more associated with the target cue (high-associative

condition). In the next section, we consider a corollary prediction from this interpretation.

Does Divided Attention Penalize Prospective Memory When the Cue and Intention are Highly Associated?

Another implication of the spontaneous associative retrieval theory of prospective remembering is that when prospective memory retrieval is mediated by that process, minimal cognitive resources should be required. To test this idea, we (McDaniel, Guynn, Einstein, & Breneiser, 2004, Exps 2 and 3) required subjects to perform the prospective memory task under different attentional loads. In the normal load condition, subjects simply performed the word-rating task. In the demanding load condition, subjects in addition had to monitor an audio stream of digits for two consecutive odd digits. Of most interest is the effect of this high attentional load in the high cue–intended action association condition, because this condition is the one for which the spontaneous associative retrieval process should be most prominent. That is, in a prospective memory situation, multiple cognitive processes might be exploited to support retrieval (see Einstein et al., 2005, Exp. 4), and accordingly to investigate a particular retrieval process it is important to examine conditions in which the process of interest likely will be predominant (cf. Einstein & McDaniel, 2005).

In a first experiment, prospective memory was slightly but nonsignificantly higher under normal attentional load ($M = 0.90$) than under the more demanding attentional load ($M = 0.86$). A second experiment confirmed that there was no reliable difference in prospective memory as a function of the attentional resources demanded for the ongoing activities (Ms = 0.86 for both attentional load conditions). These results are entirely in line with the idea that prospective memory retrieval in this condition was reflexive and relatively automatic.

But, perhaps the digit monitoring task did not draw sufficient resources to compromise performance of a resource demanding prospective memory retrieval process. This interpretation can be ruled out by results from a low cue–intention association condition in which other retrieval processes might be recruited (see McDaniel et al., 2004, for details). For this condition, there was a notable and significant prospective memory decline in the demanding attentional condition ($M = 0.66$) relative to the normal attention condition ($M = 0.82$).

Are There Other Cognitive Processes that Might Support Spontaneous Prospective Memory Retrieval?

A long-held view embedded in theories of recognition memory is that recognition can rely on familiarity (e.g., Atkinson & Juola, 1974; Jacoby, Kelley, & Dywan, 1989; Jacoby, Woloshyn, & Kelley, 1989; Mandler, 1980), with familiarity often being assumed as a fundamental, primitive quality of an item. Whittlesea and Williams (2001a, 2001b) have developed the idea that familiarity is an attribution derived from a more basic cognitive process. Whittlesea and Williams' theory is that people chronically evaluate the processing quality of items and that people are

sensitive to the discrepancy between the actual and expected processing quality of a particular event. For instance, on boarding a bus a person may see the face of someone they have previously encountered among many unknown faces, perhaps producing discrepancy in the fluency or quality of processing between the previously encountered face and the other unknown faces. An attribution for the discrepancy is generated (as the person's explanation for the discrepancy), with the particular attribution depending on the context, biases, and disposition of the person. In a context in which subjects are asked to make recognition decisions, discrepancy tends to produce an attribution of familiarity, thereby leading to a positive recognition decision. Although, Whittlesea and Williams have developed this view to explain how people make recognition decisions, they note that the nature of an attribution depends on the context. In the above example of the person on the bus, the discrepancy associated with the face of the previously encountered person (but not recollected as previously encountered) may be attributed to the attractiveness of the face (say for an individual who is single and dating).

We suggest that the putative chronic process of discrepancy attribution serves as another possible route to prospective memory retrieval (McDaniel et al., 2004). Specifically, in many contexts subjects are not performing recognition judgments, and here discrepancy can elicit a sense of significance (cf. Jacoby & Dallas, 1981; Whittlesea & Williams, 2001a), which in turn can stimulate consideration of the source of the significance. For instance, I may form the intention to give Roddy Roediger a message, thereby activating memory representations of Roddy. At work the next day, I encounter a number of colleagues, creating an expectancy of the coherence or quality of processing experienced when I pass a colleague in the hallway. When I encounter Roddy, I may have an increased coherence or quality of processing that is unexpected or exceeds the norm, with the ensuing sense of significance stimulating a search that can result in retrieval of the prospective memory task (or perhaps the more general notion that there is something I need to do).

To explore the idea that chronic discrepancy-detection processes can support prospective memory retrieval, we have manipulated the prior exposure of the *nontarget* items in the ongoing activity. Consider that in a typical prospective memory experiment, the target event is typically presented in the instructions prior to the ongoing activity, whereas the nontarget events are not. Accordingly, the quality or coherence of processing of the prospective memory events may be discrepant from that of the nontargets, thereby possibly leading to an attribution of significance for the target event.

In an initial experiment, McDaniel et al. (2004, Exp. 1) attempted to reduce this discrepancy in the processing experience for the nontarget items in the ongoing task (the word-rating task described in a previous section) relative to the prospective memory target items, by including the nontarget words in a word list learning task administered at the outset of the experiment. Thus in this condition (termed the *low-discrepancy* condition), both nontarget words and prospective memory targets were processed prior to the ongoing activity (the former in the word list learning task and the latter during the prospective memory instructions).

For another group, the word-list learning task included none of the nontargets in the word-rating task (the *high-discrepancy* condition). In this situation the fluent, coherent processing of prospective memory targets (due to previous presentation during the initial instructions) is presumably discrepant with the standard of processing established by the nontarget items, none of which was previously presented.

Note that the targets in both groups are identical, the prospective memory response is identical, the cover activity is identical, and the nontargets in the cover activity are identical. Most, if not all, views of prospective memory would anticipate no differences in prospective memory performance across the two groups. In contrast, the discrepancy-plus-search view makes the novel prediction that prospective memory performance will decline in the low-discrepancy group (pre-exposure of nontargets) relative to the high-discrepancy group (no pre-exposure of nontargets). The results confirmed the prediction, with prospective memory responding significantly lower in the low-discrepancy group ($M = 0.77$) than the high-discrepancy group ($M = 0.94$; see also McDaniel et al., 2004, Exp. 2).

The above result is not completely decisive, however. Perhaps the effect rested on the prospective memory target being relatively more familiar in the high-discrepancy (no pre-exposure of nontargets) than the low-discrepancy condition (cf. McDaniel, 1995) or the nontargets being distracting or interfering in the low-discrepancy (nontarget pre-exposure) condition. To provide converging support for the discrepancy attribution interpretation, Breneiser and McDaniel (in press) implemented a nontarget pre-exposure condition in which processing of the target event would be *less* coherent or fluent than the expectation created by the nontarget words. In this experiment, for the high-discrepancy condition the nontargets were studied four times in preparation for a recognition test prior to the critical ongoing word-rating task. Note that in this condition, relative familiarity (or fluency) for the target item would be low and distraction (interference) created by the pre-exposure of the nontarget items would remain present or possibly increase. Thus, if either of these were the critical factors affecting prospective memory, then this condition should be no better, and might be worse, than the condition in which nontarget items were studied once.

By contrast, the discrepancy-attribution idea clearly embraces the possibility that a target that is less coherently or fluently processed than expected will be discrepant, and in the present context such discrepancy could be attributed to significance. A feeling of significance could in turn lead to further consideration of the prospective memory target, thereby leading to retrieval of the intention. Consistent with this idea, when nontargets were studied four times prior to the ongoing task, prospective memory was significantly better ($M = 0.77$) than when nontargets were once-studied ($M = 0.50$). Taken together, these two experiments are directly in line with the notion that discrepancy-attribution processes provide another relatively spontaneous route by which prospective memory retrieval can occur.

SUMMARY

For over 100 years, the scientific study of memory has almost exclusively followed the tradition championed by Ebbinghaus (1885/1964), in which the subject "has been required to recall [or recognize] at the experimenter's request rather than at a time when he would normally do so" (Wilkins & Baddeley, 1978, pp. 27–28). Theoretical constructs about the processes of memory retrieval—such as received ideas that the cognitive system supports retrieval by invoking a retrieval mode (Tulving, 1983), the retrieval mode allows subjects to explicitly consider environmental events as possible retrieval cues, and the retrieval mode incurs resource demands that in part contribute to the effortful nature of retrieval (Craik, Govoni, Naveh-Benjamin, & Anderson, 1996)—hinge on the assumption that recall is requested by the experimenter (or some active agent). Arguably, however, such prompted recall is not the predominant expression of memory in everyday situations (see Wilkins & Baddeley, 1978), and prompted recall is, by definition, not a characteristic of prospective memory. Thus, a main theme of our chapter is that the study of prospective memory represents an intriguing departure from the standard laboratory "memory preparation" common to the memory literature.

The foregoing considerations raise the central question of how retrieval is stimulated in prospective memory. One general answer in the contemporary literature has been to suppose that the person provides his or her own retrieval prompts, perhaps through self-initiated retrieval processes (Craik, 1986), preparatory attentional processes that prompt recognition checks for the prospective memory target event (Smith, 2003), or resources devoted to maintaining a prospective memory retrieval mode (Guynn, 2003).

Alternatively, we have argued that prospective memory retrieval need not require such resource demanding self-prompting. Instead, resurrecting the historical roots of Ebbinghaus (1885/1964), Freud (1909/1952), and Lewin (1961), and building on more contemporary theory (Moscovitch, 1994; Whittlesea & Williams, 2001a, 2001b), we suggest that prospective memory remembering can be mediated by a spontaneous retrieval process that is not initiated by a request to remember, a retrieval mode, or monitoring processes. To compel the case, we offer evidence showing that prospective remembering does not necessarily incur a cost to ongoing activity (i.e., no monitoring), and that retrieval of the prospective memory intention can occur even when the intention to retrieve has been suspended (i.e., no self-initiated retrieval or retrieval mode). Further, we show that retrieval success is influenced by the association between the target event and the intended action, and retrieval can occur under divided attention conditions (implicating a relatively automatic associative memory process; cf. Moscovitch).

Thus, we have come full circle, returning to Ebbinghaus' (1885/1964) observation that one of three basic types of memory is the spontaneous appearance of a mental state "without any act of will" that is recognized as previously experienced. We suggest that the laboratory study of prospective memory, under appropriate conditions (see McDaniel & Einstein, 2000; Einstein et al., 2005), provides a foundation on which researchers can begin to investigate and understand this type

of spontaneous remembering with the thoroughness with which "prompted retrieval" has been studied over the long history of memory research.

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