Prospective Memory
Multiple Retrieval Processes
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ABSTRACT—An interesting challenge for researchers who study prospective memory is to explain how people recognize environmental events as cues for actions. Whereas some theorists propose that a capacity-consuming monitoring process is the only means by which intentions can be retrieved, we argue that the cognitive system relies on multiple processes, including spontaneous processes that reflexively respond to the presence of target events. We present evidence for the existence of spontaneous retrieval processes and apply the idea of multiple processes to mixed findings on age-related decline in prospective memory.

KEYWORDS—prospective memory; monitoring; spontaneous retrieval; automatic and controlled processes; aging and memory

After a change in his usual routine, an adoring father forgot to turn toward the daycare center and instead drove his usual route to work at the university. Several hours later, his infant son, who had been quietly asleep in the back seat, was dead.

Eight months after a hernia surgery, a patient complained of abdominal pain and nausea. A scan of his abdominal area revealed that a 16-cm clamp had been left from his previous surgery. Despite the best intentions of a surgical team of doctors and nurses, they had forgotten to remove the clamp.

The above errors represent real failures of prospective memory (PM) or remembering to perform intended actions. Although they highlight the potentially disastrous consequences of some PM failures, it is important to realize that our daily lives are filled, and sometimes overflowing, with PM demands. From managing work activities (e.g., remembering to pack needed papers in the morning) to coordinating social relations (e.g., remembering to take children to parties) to handling health-related needs (e.g., remembering to take medication), good PM is important. In light of the ubiquity of PM in everyday life and the importance of PM for normal functioning, it is surprising that there was virtually no interest in this type of memory until recently.

A LABORATORY PARADIGM FOR STUDYING PM
Some of the earliest research on PM was conducted in naturalistic settings by asking participants to return postcards or call the experimenter on specified days (see Harris, 1984). Although this research yielded interesting results, the inability to manipulate and control retrieval contexts made it difficult to evaluate theoretical positions. In designing an experimental version of a PM task, we (Einstein & McDaniel, 1990) assumed that the critical features were to busily engage participants in an ongoing task and also give them an intended action to perform at some point in the context of that task. Table 1 lists the steps for a typical PM experiment. As can be seen in this example, the cue for performing an action is an event (the word “rake”), and our focus in this article will be to consider how people remember in these kinds of event-based PM tasks. Note, however, that PM tasks can also be time based, such as when the appropriate moment for performing an action is a time period (e.g., “Press the designated key in 10 minutes”).

WHAT IS DIFFERENT ABOUT PM?
Although there are probably many dimensions along which prospective- and retrospective-memory tasks differ (e.g., we engage in a good deal of planning for some PM tasks), most of the research has focused on what seems to be important differences at retrieval. Superficially, event-based PM tasks closely resemble standard cued-recall retrospective-memory tasks that we often study in the laboratory. For cued recall, participants must associate target items with cue words and, at some point later, recall the target words when they are presented with the cues. Similarly, in the PM task of remembering to press a key when seeing the target word “rake,” participants must associate the target action (pressing the key) with the cue (“rake”). An important difference, however, is that in laboratory tests of cued
Monitoring

So how, in the absence of being put in a retrieval mode, do people remember to perform an action when they encounter a target event? One possibility is that, when establishing an intention, people initiate a monitoring process and thus put themselves in a retrieval mode. In contrast, in the typical PM situation, there is no external request by the experimenter to initiate a retrieval search when participants see “rake.” Successful prospective remembering requires that participants somehow switch from seeing “rake” as an item to be processed for the ongoing task to seeing it as a cue for performing an action.

EVIDENCE FOR SPONTANEOUS RETRIEVAL

At issue is whether monitoring is the sole process in PM retrieval or whether spontaneous processes can also accomplish PM retrieval. In a recent unpublished study with Matt Larson, we attempted to eliminate monitoring by heavily emphasizing the importance of the ongoing task. According to monitoring theory, this should eliminate PM retrieval. According to the multiprocess theory, because the ongoing task encouraged focal recall, at some point recollection of the target item is stimulated by an external request to remember (i.e., the experimenter puts the participant in a retrieval mode). In contrast, in the typical PM situation, there is no external request by the experimenter to initiate a retrieval search when participants see “rake.” Successful prospective remembering requires that participants somehow switch from seeing “rake” as an item to be processed for the ongoing task to seeing it as a cue for performing an action.

HOW DO WE RETRIEVE PROSPECTIVE MEMORIES?

Spontaneous Retrieval and the Multiprocess View of PM

Although it is clear that active monitoring can accomplish PM retrieval, we (Einstein et al., 2005; McDaniel & Einstein, 2000) believe that it would be advantageous for people to also rely on less capacity-demanding and more spontaneous retrieval processes. Given that the delays between forming intentions and the opportunities to execute them are often substantial, it would be maladaptive to rely exclusively on a capacity-consuming monitoring process that necessarily interferes with full processing of ongoing activities during the retention interval. Our thinking was influenced by subjective reports from participants in our earliest research indicating that the PM intention often “popped” into mind (Einstein & McDaniel, 1990) and by Bargh and Chartrand’s (1999) arguments that people have a limited capacity for conscious control over behavior and that many behaviors and thoughts are automatically triggered by stimuli in our environment. Thus, according to the multiprocess view, the cognitive system exploits several processes, including spontaneous ones, to accomplish PM retrieval.

As an example of a mechanism through which spontaneous retrieval can occur, we (McDaniel & Einstein, 2000; McDaniel, Guynn, Einstein, & Breneiser, 2004) have proposed the reflexive-associative theory. According to this theory, when forming an intention for an event-based task, people create an association between the target cue and the intended action. Later, when the target event occurs, an automatic associative-memory system triggers retrieval of the intended action and delivers it into awareness. This is an associative system that processes information specifically for the purpose of associative encoding and retrieval. Regardless of whether a person is thinking about the PM intention at the time that the target event occurs, if the cue is fully processed and the association between the cue and action is sufficiently strong, then the occurrence of the cue will reflexively trigger the retrieval of the intended action.

According to the multiprocess theory, there is a bias to rely on spontaneous retrieval processes but the particular process that is used in a given situation depends on a variety of factors (see McDaniel & Einstein, 2000) such as individual differences, distinctiveness of the target event, and focal processing of the target. By focal processing we mean that the ongoing task encourages processing of the target and especially those features that were processed at encoding (for illustration, Table 2 lists examples of conditions that are low and high in focal processing).

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TABLE 1

A Typical Laboratory Paradigm for Studying Prospective Memory (PM)

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Present participants with instructions and practice trials for an ongoing task (e.g., pleasantness rating).</td>
</tr>
<tr>
<td>2.</td>
<td>Present participants with the PM instructions (e.g., “Press a designated key whenever you see the word ‘rake’ in the context of the ongoing task”).</td>
</tr>
<tr>
<td>3.</td>
<td>A delay is introduced during which participants perform other activities (e.g., do other memory tasks and/or fill out demographics forms)</td>
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<tr>
<td>4.</td>
<td>Reintroduce the ongoing task (pleasantness rating) without reminding participants of the PM task.</td>
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<tr>
<td>5.</td>
<td>The PM target (“rake”) occurs several times in the ongoing task, and PM performance is measured by the proportion of times participants remember to press the designated key when the target occurs.</td>
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</table>

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processing of the PM target, there should be spontaneous retrieval. The ongoing task was a lexical-decision task, and the PM task was to press a key whenever the target word (e.g., “aurora”) appeared. In one block of the experiment, participants performed only the ongoing task; in the other block, they also performed a PM task. There were a couple of important differences between our PM task and that of Smith (2003; reviewed above). First, we gave participants a single target event as opposed to the six events in her research. Second, we told participants that their main goal was to perform the ongoing task as quickly as possible and that we had only a “secondary interest” in their PM. To reinforce this, we presented feedback on lexical-decision speed after every 20 trials. The results suggest that we were successful in discouraging monitoring as lexical-decision times were nearly equal in the PM block and the non-PM block (a difference of 14 ms that did not approach significance). Yet, consistent with the view that spontaneous retrieval processes can accomplish PM retrieval, PM performance was very high (86%).

Although this pattern—no significant costs and high PM with a single focal target—has been consistently found in several studies, examination of Table 3 reveals nominal costs in all of these studies. These nominal costs could reflect chance variation or a mix of participant strategies with some participants monitoring and others not. To legislate between these possibilities, we tested a large sample of 104 participants and examined for individual differences (Einstein et al., 2005, Experiment 4). For the ongoing task, participants determined whether a capitalized word at the end of a sentence fit into the blank space in a sentence. The PM task was to press a key whenever the word “medicine” occurred anywhere in the sentence. Participants performed only the ongoing task for one block and the ongoing task and the PM task for another block. This time the results indicated a significant cost of 192 ms. We next adjusted participants’ costs based on their counterbalancing condition and identified 56 participants who may have been monitoring (they were slower on the PM block) and 44 participants who showed no evidence of monitoring (they were faster on the PM block). Interestingly, PM performance was high in both groups (95% and 93% in the cost and no-cost groups, respectively). Thus, it appears that some participants were more likely to monitor than others were, but those who showed no evidence of monitoring still had very high PM, presumably through spontaneous retrieval.

### TABLE 3

Mean Cost (in Milliseconds) on the Ongoing Task Due to the Presence of a Prospective-Memory Task and Prospective-Memory Performance (PM, Percentage of Target Events for Which Participants Remembered to Respond)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Cost</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Einstein et al. (2005) (Experiment 1)</td>
<td>48</td>
<td>88%</td>
</tr>
<tr>
<td>Einstein et al. (2005) (Experiment 2)</td>
<td>29</td>
<td>93%</td>
</tr>
<tr>
<td>Marsh, Hicks, Cook, Hansen, and Pallos (2003) (Experiment 1)</td>
<td>23</td>
<td>93%</td>
</tr>
</tbody>
</table>

*In all three studies, the costs were not significantly different from zero.*
In the above experiments, we inferred spontaneous retrieval from findings of no cost to the ongoing task and yet high PM. To provide more direct evidence for spontaneous-retrieval processes, we developed a new twist to the paradigm (Einstein et al., 2005, Experiment 5). We gave participants a PM task to perform in the context of an ongoing task in which participants rated the ease of forming images of words. An important feature is that we interleaved sets of lexical decision trials in the middle of the image-rating task. Participants were told that whenever they encountered a lexical-decision task, they should suspend all other task demands and focus solely on responding as quickly and as accurately as possible. Critically, we presented the target event during these lexical-decision trials. Because there was no intention to perform the PM task during these trials, there should have been no monitoring. Thus, according to the monitoring view, there should have been no evidence of retrieval when the target event occurred. On the other hand, because a characteristic of a spontaneous process is that it should occur without intention, the occurrence of the target event should have led to retrieval, which should have slowed down the lexical decision response times. The results supported the spontaneous-retrieval view as there was slowed responding to PM targets (by 55 ms) relative to control items. This finding indicates that something was retrieved (perhaps associative retrieval of the intended action or a sense of significance) when the target event occurred.

PM AND AGING

The foregoing examination of the processes by which we retrieve prospective memories can be applied to help understand PM performance in older adults. Many researchers assume that PM declines with age (Craik, 1986), an assumption that is supported in a number of experiments with event-based PM tasks (see Henry, MacLeod, Phillips, & Crawford, 2004, for a meta-analytic review). Yet, there is also a significant set of studies that report no age differences in event-based PM (e.g., Einstein & McDaniel, 1990).

A potential explanation of this perplexing pattern from the multiprocess viewpoint is that whether or not there are age differences will depend on whether the PM task uses nonfocal or focal target events. Some studies have used nonfocal target events (see Table 1). With nonfocal targets, resource-demanding monitoring processes are assumed to be required for PM, and for these targets age differences are expected (because processing resources decline with age; Craik, 1986). Other studies have used target events that are focal to the subjects’ ongoing activities (see Table 1). With focal targets, PM can be supported by spontaneous retrieval, and thus age differences are expected to be minimal (because spontaneous-retrieval processes may remain relatively intact with age).

To test this explanation, Rendell, McDaniel, Forbes, and Einstein (in press) manipulated the presence of focal versus nonfocal target events (described in the last two rows of Table 1) for younger and older adults. As expected, the age-related differences in PM were slight when the target event was focal (mean difference favoring younger adults was approximately .10). In contrast, when the target event was not focal to the ongoing activity, age differences were more pronounced, increasing significantly relative to the focal-target condition (mean difference favoring younger adults exceeded .30). It remains possible that other factors, such as the number of target events and the demands of the ongoing activity, also play a role in the modulation of age differences.

CONCLUSIONS AND FUTURE DIRECTIONS

In light of the prevalence of PM in everyday living, we believe that it would be adaptive to have a flexible system that allows multiple mechanisms for PM retrieval. Accordingly, it is important to further study the nature of controlled monitoring and spontaneous-retrieval processes and the conditions that affect them. For example, as we develop methods for measuring spontaneous-retrieval processes, it is important to test the assumption that aging does not disrupt these kinds of processes, as well as explore the encoding and retrieval conditions that maximize successful retrieval. Consideration of the roles of controlled monitoring versus spontaneous-retrieval processes in different kinds of PM tasks is also likely to help us understand the PM situations that are especially prone to failure and perhaps develop a metric for gauging the difficulty of PM tasks. The idea here is that task conditions that encourage spontaneous retrieval may be easier. It is interesting to note that in the vignettes presented at the start of this paper, the cues that could have supported spontaneous retrieval were no longer present or were hidden from view, and thus remembering was more dependent on controlled processes.

Recommended Reading

Smith, R.F. (2003). (See References)

REFERENCES


