2

Monitoring in Prospective Memory

. . . it defines one of the challenges to explanations of prospective memory: What happens to allow recall to take place?

—Peter Morris, *Aspects of Memory*

The next three chapters consider the intriguing and central puzzle of how an intended action is activated at the appropriate window of opportunity. By definition, prospective memory tasks are those in which remembering to recall is the primary challenge. Existing models of recall and recognition based on laboratory studies of memory focus on the processes that occur once a person has been explicitly prompted to remember. Thus, these models do not consider and address the retrieval process of most interest in prospective remembering. We need other theoretical approaches to help us understand prospective remembering.

Fortunately, theorists have been fertile in developing ideas about how the cognitive system enables us to remember the intended action at the appropriate moment. These ideas fall into two broad classes: One class we will term *attentional monitoring* and the other we will term *spontaneous retrieval.* First we will describe the attentional monitoring approaches and the associated evidence for these approaches. In the following chapter, we will consider the competing spontaneous retrieval approaches that account for prospective memory by more automatic, less strategic processes.

Attentional Monitoring

A widely embraced view is that in order for the intended action to be performed at the appropriate moment, the environment must be monitored or checked for a signal. A hallmark of this view is the idea that the monitoring process exacts an attentional cost. That is, some attentional resources must be expended to monitor for a signal that indicates the intended response is appropriate. Further, these attentional resources are deployed prior to the prospective memory response. In an informal and implicit sense, this is the view assumed when people draw negative conclusions about the conscientiousness of someone who forgets a prospective memory task. When a parent forgets to pick up his child from tennis practice, people wonder how the parent could be so irresponsible or lazy or care so little for his child. This aspersion is based on the assumption that the person opted not to devote the required attentional resources to the prospective memory task. In one formal view, these attentional resources would be directed by a Supervisory Attentional System (Shallice & Burgess, 1991). So in a sense the criticism directed at the parent is that some supervisory (cognitive) processes that could have been engaged for successful prospective memory have lapsed because of the "supervisor's" laziness or misplaced priorities.

Test-Wait-Test-Exit

One influential and seminal monitoring model was proposed by Harris (1984; Harris & Wilkins, 1982), a pioneer in prospective memory research. Harris reasoned that the attentional costs of monitoring are sufficient to discourage continuous monitoring. Instead, he claimed, people only periodically evaluate whether the conditions are right for performing the intended activity. The dynamics of this periodic monitoring are captured by a procedure known as test-wait-test-exit (TWTE) (Miller, Galanter, & Pribram, 1960). Figure 2.1 provides a schematic of the TWTE process. The idea is that people will initially evaluate (test) early because the cost of responding late is high. Taking cookies out of the oven too late results in ruined cookies; remembering to tell your roommate that his girlfriend called to cancel their date only after the roommate has left results in an embarrassed and possibly angry roommate. Once the test reveals it is too

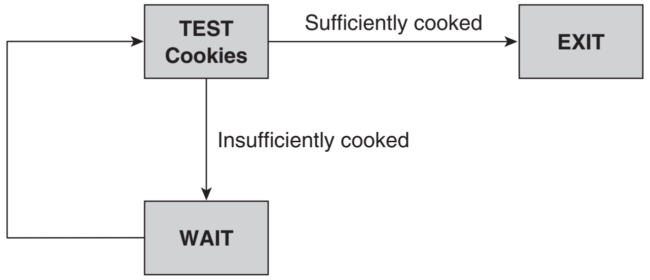

Figure 2.1 The Test-Wait-Test-Exit (TWTE) Model

early to perform the intended activity, a "wait" period follows, during which attention to events continues in a normal fashion. After some period of waiting, another test is initiated and so on, until a test confirms that it is appropriate to perform the intended action. At this point, the test-wait cycle is discontinued (exit).

Evidence for the TWTE process has been reported in laboratory prospective memory tasks in which monitoring can be explicitly identified and recorded by the experimenter. In these tasks, participants are engaged in an ongoing activity, and in addition they are required to make an intended response at a particular time of day or after a certain period of time has elapsed (time-based prospective memory). The laboratory tasks are designed to approximate everyday situations where people are involved in their daily activities, perhaps watching TV, and also have to remember to do something at a particular time (pick up a child from tennis practice at 5:00 P.M.) or after a period of time has elapsed (take cookies out of the oven in 10 minutes). For instance, in an experiment done by Harris and Wilkins (1982), participants watched a 2-hour movie, and in addition held a stack of cards on which designated times were printed (3 minutes or 9 minutes). Participants were instructed to hold up each card at the designated time and display it to a video camera. So, if a participant's first three cards indicated 9, 3, and 9 minutes, he or she was to wait 9 minutes and hold up the first card, wait 3 minutes and hold up the second card, and wait 9 minutes before holding up the third card.

The critical feature of these experiments is that the available clock is obscured so that checking the clock requires an overt behavior (Harris & Wilkins, 1982; see also Einstein, McDaniel, Richardson, Guynn, & Cunfer, 1995). Typically the clock is placed behind the participants so that they have to turn their heads to check the clock. These experiments show several important findings: First, they confirm that participants do periodically check the

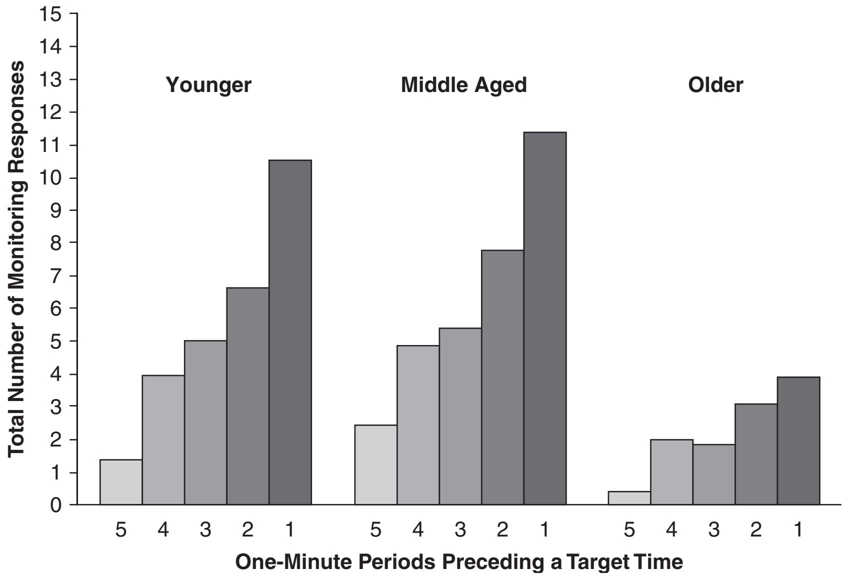

Figure 2.2 Mean Number of Monitoring Responses During the Five 1-Minute Periods Before the Target Time in an Experiment Performed by Einstein, McDaniel, Richardson, Guynn, and Cunfer (1995)

SOURCE: From Einstein, G. O., McDaniel, M. A., Richardson, S. L., Guynn, M. J. & Cunfer, A. R., Aging and prospective memory: Examining the influences of self-initiated retrieval processes. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 996–1007. Copyright © 1995, American Psychological Association. Reprinted with permission.

clock. Second, the clock-checking behavior is generally strategic, at least for many participants. Participants will check the clock at a modest rate until a short period before the target time. As the performance time approaches, monitoring frequency will significantly increase, as shown in Figure 2.2.

Third, the accuracy of prospective memory performance is associated with the monitoring behavior. Figure 2.2 shows that younger and middle-aged participants monitored more often than older participants did. Especially noteworthy is that older participants did not significantly increase their rate of monitoring as the target time approached, whereas the other participants did. These monitoring patterns paralleled prospective memory performance: Relative to younger participants, older adults showed significant decline in performance of the intended activity within a reasonable interval following the target time. Figuratively speaking, the older adults were more likely to burn the cookies! Harris and Wilkins

(1982) tested a middle-aged group of women and in this experiment correlated the frequency of monitoring during the period just preceding the target time with the promptness of the prospective memory response. Again, when monitoring frequency increased near the target time, prospective memory responses were more likely to be right on time. Late responses were associated with very infrequent monitoring as the target time approached. A similar pattern has been observed with 10- and 14-year-old children (Ceci & Bronfenbrenner, 1985).

These results offer practical insight for improving prospective memory. One day one of the authors of this book was supposed to pick up his son from tennis practice at 4:00 P.M. Being a prospective memory researcher, he engaged the TWTE process and monitored the clock early in the afternoon. Feeling confident about his ability to remember to pick up his son, he began to monitor less frequently as the afternoon progressed. The intended action occurred to him only when his son called—well after 4:00 P.M.—to ask how the "memory expert" could have forgotten to pick up his son. If we want to improve our prospective memory accuracy, we need to initiate more frequent monitoring as the target time approaches.

More frequent monitoring, however, does not ensure perfect prospective memory. A fourth intriguing finding is that when Harris and Wilkins's participants forgot to respond on time, over a quarter of the time they had monitored the clock within 10 seconds of the target time! Sellen, Louie, Harris, and Wilkins (1997) report a similar finding in an experiment in which subjects performed a prospective memory task in their usual work setting. Apparently, absorption in an ongoing activity can quickly disrupt maintenance of the intention in awareness (see also McDaniel, Einstein, Stout, & Morgan, 2003). Perhaps the fragileness of the intention in awareness even with appropriate monitoring partly accounts for prospective memory lapses that are considered egregious.

Factors Involved in Initiating Monitoring

A critical question not addressed by the TWTE description is, what processes lead us to initiate a check in the first place? Researchers do not have a clear answer, but several possibilities are evident in the literature. One idea was introduced earlier: A supervisory executive system stimulates a check of the environment for the appropriate opportunity to perform the intended action. For the time-based prospective memory tasks discussed here, perhaps this executive process depends on judgments of time derived from biological and/or cognitive clocks (Coren & Ward, 1989).

In a similar vein, certain personality variables such as compulsiveness and conscientiousness might affect the degree to which the cognitive system is engaged in monitoring. Consistent with this idea, a preliminary study in our laboratory (conducted by Edwards and Hagood) found a significant correlation between obsessive-compulsive tendencies and the extent to which resources were allocated for monitoring for a prospective memory task. According to Goschke and Kuhl (1993), another individual-difference characteristic that relates to monitoring is whether people have a "state" or an "action" orientation. Individuals with a state orientation find it difficult not to think about future intentions over a retention interval and tend to ruminate about future goals. In contrast, action-oriented people do not experience these kinds of intrusive thoughts over the retention interval. According to this view, people with a state orientation (as measured by Goschke and Kuhl's Action Control Scale) are more likely in certain prospective memory situations to keep intentions for to-be-performed activities in a highly activated state.

Another possibility is that initiation of monitoring is not really self-initiated or dependent on executive control. Checking behaviors may be stimulated by sometimes direct and sometimes subtle cues in the environmental context. One of our students mentioned that an absent glance at a clock can remind her that she needs to perform a task at a certain time later that day. About a third of Harris and Wilkins's participants indicated that events in the film reminded them of the prospective memory task. These events included discussions of time and visual views of clocks. Morris (1992) also has reported evidence of this kind of reminding.

Finally, Wilkins (cited in Harris, 1984) suggests that monitoring is driven by a random-walk process in which one's "train of thought" wanders randomly through a multidimensional semantic space. The idea is that the prospective memory intention is stored as a representation in this multidimensional space. Thus, having to take cookies out of the oven (an everyday prospective memory task) is stored in a particular area in the space; similarly, having to press a key on the keyboard (a laboratory prospective memory task) is stored in its own area in the space. As the train of thought moves through the semantic space, it may move close to the area where the intention is stored. The closer the train of thought is to that area, the more likely it will be to jump to the intention and prompt clock monitoring. If the intention is in the train of thought at the time for the intended action, the action will be performed (the cookies will be removed from the oven). If the time is too early, the random walk may or may not again venture close to the area associated with the intention. This idea has remained relatively undeveloped, though random-walk processes are implicated in other cognitive tasks such as lexical decision (Ratcliff, Gomez, & McKoon, 2004). One recent naturalistic time-based study suggests that subjects' patterns of thinking about the intention prior to the target time are more consistent with a TWTE formulation than a random-walk process (Kvavilashvili & Fisher, 2007).

Preparatory Attentional Processes

For event-based prospective memory tasks, Smith and her colleagues (2003; Smith & Bayen, 2004) propose a more specified view that assumes that monitoring is fairly continuously engaged in order to support prospective remembering. Event-based prospective memory tasks are those in which the intended action is to be executed upon the occurrence of a particular environmental event. For instance, the intention to give your colleague a message must be activated when you encounter your colleague. Smith's preparatory attentional and memory processes (PAM) theory proposes that a capacity-consuming "preparatory" process is engaged to monitor events as possible prospective memory targets (appropriate occasions for performing prospective memory tasks). Memory processes are also involved in discriminating nontarget events from target events and in recollecting the intended action once a target event is encountered.

When the PAM theory is applied to the everyday prospective memory task of remembering to give your colleague a message, the idea is that a preparatory process monitors the environment as events are encountered. These preparatory processes ensure that a recognition check (the memory component of PAM) is initiated for the environmental event that signals the appropriateness of executing the intended action. Preparatory processes might also include rehearsing the critical target event (Smith & Bayen, 2004). This theory takes the strong stance that retrieval of the prospective memory intention is not possible without the preparatory monitoring process.

A possible objection to this theoretical idea is that the attentional and supervisory resources needed to implement prospective remembering would be too costly to allow smooth functioning in day-to-day ongoing activity. We will revisit this issue later, but initially two arguments counter this objection: First, costs are relative. According to the monitoring view, the cost of monitoring is small relative to the cost of performing the prospective memory task early or late. Consider our example of taking cookies out of the oven too late, which can make the cookies inedible. Relative to the brief use of attentional resources that would be expended for periodic monitoring, this mistake is costly. Time and ingredients must be spent remaking the cookies and baking them again (or one must cope with the disappointment of having no cookies). Second, the cost of monitoring is not clearly specified in most models, so it is uncertain how costly monitoring is (see, for example, Shallice & Burgess, 1991).

What does the experimental evidence show regarding the existence of preparatory processes? Note that the assumed preparatory attentional processes cannot be as directly tested as the TWTE process because, in the event-based prospective memory tasks to which the model has been applied, the prospective memory cue is embedded in the ongoing activity in which participants are engaged. Thus, for these tasks there is no discernible behavioral movement that reveals monitoring. (See Chapter 8 for discussion of neuroimaging studies that may offer some insights.) One experimental approach is to increase the attentional demands of the ongoing activity by adding another task. Increasing attentional demands should reduce attentional resources available for monitoring for the prospective memory target. Consequently, if prospective memory requires monitoring, prospective memory performance should suffer.

Increasing Attentional Demands of the Ongoing Activity

In one experiment, Marsh and Hicks (1998) increased the attentional demands of the ongoing activity by asking subjects to perform two ongoing activities. As anticipated, subjects in the "attention-demanding" condition showed more prospective memory failures than did subjects in the standard condition in which performance of just one ongoing activity was required. An interesting aspect of Marsh and Hicks's findings is that prospective memory did not always decline when subjects performed two ongoing activities. When the second concurrent ongoing activity engaged the articulatory loop of working memory—that is, subjects were asked to repeat several words (Baddeley & Hitch, 1994)—prospective memory did not suffer (see Otani et al., 1997, for a similar finding). Prospective memory did suffer when the second ongoing activity was to generate a random order of digits. These results can be understood by assuming that monitoring requires resources associated with a Supervisory Attentional System (as mentioned earlier in this chapter). Generating random digits heavily draws on this central attentional system, whereas a task involving the articulatory loop is thought to require few, if any, central attentional resources (Baddeley & Hitch). In favor of the monitoring view, a number of other studies have also demonstrated that adding a concurrent task to the ongoing task disrupts prospective memory performance (McDaniel, Robinson-Riegler, & Einstein, 1998; Park, Hertzog, Kidder, Morrell, & Mayhorn, 1997).

Though suggestive, these results are not conclusive. Increasing attentional demands might disrupt prospective memory processes other than monitoring. Processes involved in becoming oriented to the prospective memory target, retrieving the intended action, scheduling execution of the various tasks (the ongoing task, the additional-attention-load task, and the prospective memory task), and maintaining the prospective memory intention in mind could all be compromised by increasing attentional demands.

The Cost of Adding a Prospective Memory Intention to the Ongoing Activity

To gain additional leverage for her monitoring view, Smith (2003) focused on evaluating the cost of a prospective memory intention on performance of the ongoing activity. In the laboratory setting, the idea is that preparatory processes need to be engaged on nontarget trials (ongoing task trials in which the prospective memory cue does not occur, and which therefore require no prospective memory response) as well as on target trials (in which the cue does occur) for successful prospective remembering. Smith reasoned that if nonautomatic preparatory processes (monitoring) need to be active to support prospective memory, attentional resources that could otherwise be deployed for the ongoing activity will be siphoned off for monitoring on nontarget trials (as they would on target trials). When resources devoted to the ongoing task are reduced, performance of the ongoing task should suffer relative to performance of the ongoing task on trials in which subjects are not given a prospective memory intention. The critical feature here is that the cost of the prospective memory intention should be evident on nontarget trials. Research prior to Smith's either focused on target trials or included target trials in assessing costs. This approach was not decisive, because trials on which the prospective memory target occurs would be expected to exhibit slower ongoing-task responding regardless of whether monitoring is present (Marsh, Hicks, & Watson, 2002).

To test the monitoring view, Smith (2003) asked subjects to perform a lexical decision task. This involves presenting subjects with a string of letters and asking them to decide as quickly as possible whether the letters form a word. On some trials they do (for example, *river*) and on some trials they do not (for example, *rovul*). Subjects tend to be highly accurate on this task; thus the interest is typically in the speed of responding. Smith found that lexical decision times on nontarget control trials were significantly slower when a prospective memory task was included in the procedure than they were when lexical decision was performed in the absence of a prospective memory intention. Subsequent experiments have reported similar results with a range of ongoing tasks, including category judgment, sentence stem completion (Einstein et al., 2005), and color matching (Smith

& Bayen, 2004). Table 2.1 provides a summary of these findings. The costs to the ongoing activity evident in Table 2.1 imply that subjects were engaged in monitoring for the prospective memory target events.

These results alone, however, do not clinch the idea that monitoring is a requisite process for prospective memory. Even though subjects in these experiments were presumably monitoring, it could be that monitoring was not functionally related to prospective remembering—that is, was the monitoring in fact associated with prospective memory performance? To answer this question, Smith (2003) examined the lexical decision reaction times (on nontarget trials) for those subjects who were at or above the mean on prospective memory performance relative to those subjects who were below the mean. Table 2.2 shows the reaction times in Smith's nontarget trials for these two groups of subjects. The subjects who had demonstrated better prospective memory performance clearly took more time to respond in the lexical decision trials than did subjects who had demonstrated poorer prospective memory performance. The implication is that prospective memory performance increased as monitoring increased (as evidenced by greater costs to performance of the lexical decision task).

A Formal Measurement Model

To mount further support for the PAM theory, Smith and Bayen (2004, 2006) developed the first mathematical model of prospective memory. They used mathematical modeling to estimate and validate the involvement of the preparatory attention processes (designated *P* in the model) and the memory processes, which recognize targets and distinguish them from nontargets (designated *M* in the model), in prospective memory performance. In one experiment, the importance of the prospective memory task relative to the ongoing task (color matching) was varied (Smith & Bayen, 2004). One group of subjects (indicated by striped bars in Figure 2.3) was told that the prospective memory task was more important than the color-matching task; the other group (indicated by solid bars in the figure) was told that color matching was more important than prospective memory. As expected, prospective memory performance was better when it was considered more important. However, this result does not tell us what underlying cognitive processes mediated the importance effect.

The key finding hinged on the P and M values estimated by the mathematical model of PAM. According to Smith's theory, the importance of the prospective memory task could prompt someone to increase engagement of the preparatory attentional processes (monitoring) but possibly have little effect on the memory processes (that is, recognition of the target would not necessarily improve because of importance). As Figure 2.3 reveals, the value

Table 2.1 Experiments Finding Significant Costs to Response Latency in Ongoing Activity Due to Prospective Memory (PM)

Study	*Ongoing Activity*	*Cost*	*PM target(s)*
Einstein et al. (2005)	*Category Judgments*		
Experiment 1	High PM emphasis	90	one word
	High PM emphasis	410	one syllable
	Moderate PM emphasis	284	one syllable
Experiment 2	Moderate PM emphasis	198	one syllable
	Sentence Completion		
Experiment 3		322	six unrelated words
Experiment 4		192	one word
Guynn (2003)	*Continuous Detection Task*		
	Blocked control and PM trials	121	one category (fruit)
	Alternating control and PM trials	140	one category (fruit)
Marsh, Hicks, Cook, Hansen, & Pallos (2003)	*Lexical Decision*		
Experiment 1		87	one category (animal)
Experiment 3		229	eight unrelated words
		302	eight unrelated words
		216	eight related words
Smith (2003)			
Experiment 1		335	six unrelated words
Experiment 2		183	six unrelated words
Smith & Bayen (2004)	*Color Matching*		
Experiment 1	High PM emphasis	579	six unrelated words
	Moderate PM emphasis	371	six unrelated words
Experiment 2	High PM emphasis	641	six related words
	High PM emphasis	498	six unrelated words
	Moderate PM emphasis	333	six related words
	Moderate PM emphasis	249	six unrelated words

NOTE: Cost is the difference in reaction times (in milliseconds) on nontarget trials in the prospective memory condition minus the reaction times on matched trials in the control condition (no prospective memory task).

Table 2.2 Latencies for Ongoing Activity as a Function of Prospective Memory (PM) in Two Experiments (Smith, 2003)

	Latencies (ms) for Ongoing Lexical Decision Task	
Study	*Subjects With PM Above Mean*	*Subjects With PM Below Mean*
Experiment 1	1,149	972
Experiment 2		
Orthographically Distinct Words	1,131	950
Orthographically Common Words	1,022	801

of P but not the value of M increased when the prospective memory task was considered more important. (The error bars in Figure 2.3 represent 95% confidence intervals [Smith & Bayen, 2004].) These results support Smith's theory and suggest that the effects of importance on prospective memory performance are mediated through variations in the involvement of the preparatory attentional processes. Converging with this assertion, the cost to the ongoing activity on nontarget trials was greater when the prospective memory task was deemed important than it was when the ongoing task was deemed important (see Table 2.1 for means).

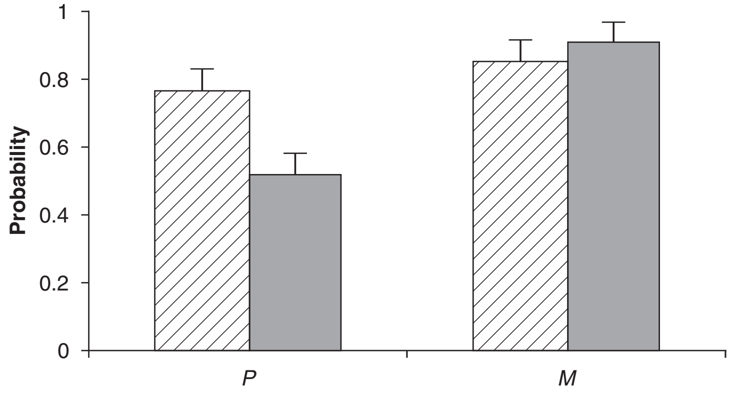

Figure 2.3 Estimates for Smith and Bayen's (2004) Experiment 1

SOURCE: From Smith, R. E. & Bayen, A., Multinomial Model of Event-Based Prospective Memory, in *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30.*

To Monitor or Not to Monitor: When Is the Question

The PAM model takes the clear stance that nonautomatic preparatory attentional processes must be engaged during the interval prior to the occurrence of the target event. One straightforward interpretation of this model is that prospective memory requires that monitoring continuously occur between the formation of the intention and its subsequent execution. This account may apply in some laboratory circumstances, but we think it implausible that in everyday settings event-based prospective memory requires some level of nonautomatic monitoring of the environment for the occurrence of the target events (cf. Smith, 2003, p. 349). Many times the opportunity for executing the prospective memory intention is hours or days removed from formation of the intention. These kinds of intervals would not favor continuous monitoring. Maintaining a nonautomatic monitoring process over hours or days in the face of everyday demands would seem an insurmountable challenge for the cognitive system. Indeed, one general approach in cognition assumes that extensive reliance on conscious attentional processes is exhausting and that the cognitive system tends to rely on more automatic processes to mediate behavior (Bargh & Chartrand, 1999). Even in laboratory settings, when subjects must maintain a retrieved intention for up to half a minute before executing the intended action, expenditure of resources to maintain the intention in mind appears to wane after as little as 5 seconds (Einstein, McDaniel, Williford, Pagan, & Dismukes, 2003).

Moreover, we suspect that most people would find it unsatisfactory in everyday settings to exact a cost on important ongoing activities for the purpose of supporting a preparatory attentional monitoring process. The decline in performance of ongoing activities that would accrue over the course of the day would potentially be prohibitive. We think it likely that people prefer to allocate their attentional resources to the task at hand without also having to allocate attention to other demands such as monitoring to support prospective remembering. Therefore, if preparatory attentional processes had to be engaged in the interval after forming an intention for prospective remembering, prospective remembering in everyday circumstances would perhaps be a rare event. Based on these conjectures, other ideas about monitoring dynamics merit consideration. To finish our discussion on monitoring, we mention two approaches that have been suggested.

Strategic Allocation of Monitoring

Consider the prospective memory task of remembering to buy milk before returning home for the day. According to monitoring theory, this task would be accomplished by monitoring for opportunities to buy milk throughout the day. However, in everyday settings this task is more likely to be formulated as the intention to buy milk on the drive home from work. Now the intention to buy milk has been associated with a particular context that potentially restricts the window in which one needs to allocate resources for monitoring. Marsh, Cook, and Hicks (2006) suggest that people use these contextual associations for strategically allocating monitoring resources. The idea is that, rather than monitoring every event (or every trial in an experimental setting), one does not allocate resources to monitoring until one encounters the anticipated context for completing the prospective memory task. In our example, monitoring for a store to buy milk would only be initiated in the critical context associated with the intention—when in the car driving home. Thus, contextual markers may allow monitoring to be strategically deployed so that attentional resources presumably required for successful prospective remembering do not necessarily disrupt one's daily activities.

To test this idea, Marsh, Hicks, and Cook (in press) developed a new twist on the typical laboratory paradigm. Specifically, they performed an experiment in which the subjects' ongoing task was lexical decision and their prospective memory task was to press a designated key if they ever encountered an animal word. The new twist was that subjects were also told that the animal words would appear in Phase 3 of the experiment, Phase 1 being a series of lexical decision trials, Phase 2 a set of questionnaire tasks, and Phase 3 another set of lexical decision trials. Subjects in a control group were given no prospective memory instructions. Of interest was the costs to lexical decision (in terms of latency to respond) of adding the prospective memory task. Based on the findings reviewed above, one might expect that the prospective memory task would incur costs to the ongoing activity throughout the experiment.

On the other hand, if subjects given the prospective memory task used the phases of the experiment as contextual markers to strategically restrict monitoring to an appropriate context, costs to lexical decision would be restricted to Phase 3. This is exactly what happened. As can be seen in Figure 2.4, lexical decision latencies were equivalent for subjects in both the control and prospective memory conditions in Phase 1, whereas in Phase 3 lexical decision latencies were slower for subjects in the prospective memory condition. This pattern implies that subjects limited monitoring to an appropriate context—the context in which the prospective memory target event was expected to occur. In another series of experiments, Cook, Marsh, and Hicks (2005) reported the flip side: Prospective memory performance was significantly reduced when the moment for performing the prospective memory task did not occur in the expected context.

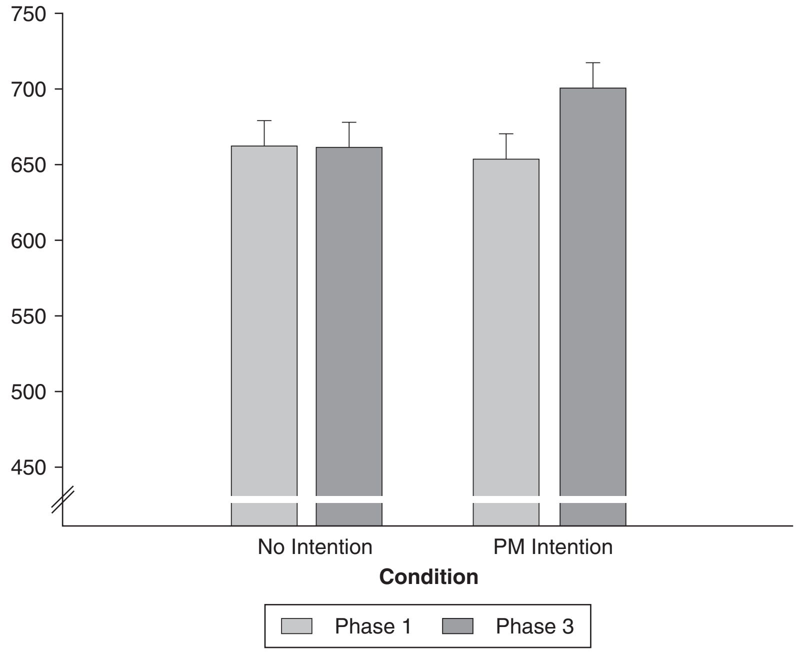

Figure 2.4 Reaction Times of Subjects in the No-Intention Control Condition and the Prospective Memory (PM) Condition in an Experiment Performed by Marsh, Hicks, and Cook (2006)

SOURCE: From Marsh, R. L., Hicks, J. L., & Cook, G. I., Task interference from prospective memories covaries with contextual association of fulfilling them, in *Memory and Cognition 34,* Issue 5, copyright © 2006, Psychonomic Society. Reprinted with permission.

The alert reader may note that tying monitoring to particular contexts does not completely account for prospective memory retrieval. In a sense, this view implicitly creates another prospective memory task—remembering to monitor when a target context is present. A person might begin to monitor for a store (to purchase milk) only during the drive home, but how does she remember to begin monitoring for the store once she starts her drive home? That is, how is the intention to monitor itself brought to mind during the specified context? In the next chapter, we approach prospective memory retrieval from a completely different perspective in order to gain leverage on this perplexing issue.

Prospective Memory Retrieval Mode

In Chapter 1, we mentioned that in laboratory retrospective memory tasks the experimenter's instruction to engage in recall or recognition stimulates the subject to adopt a retrieval mode. The retrieval mode is a hypothetical cognitive (or neurocognitive) set in which stimuli are treated as cues for retrieving information (Tulving, 1983). In contrast, we suggested that prospective memory tasks do not stimulate the adoption of a retrieval mode. There is not complete agreement on this point, however. Guynn (2003) has proposed that upon forming an intention, people put themselves in a prospective memory retrieval mode. Her view is that once a prospective memory intention has been formed, the cognitive system is placed in a set of readiness to treat stimuli as retrieval cues for the prospective memory intention. According to this view, being in a retrieval mode increases sensitivity to particular stimuli as cues for retrieving the prospective memory intention. The increased sensitivity might be achieved by utilizing resources to maintain the prospective memory intention at an increased level of subthreshold activation (cf. Mantyla, 1996; Yaniv & Meyer, 1987). It should be noted that in Guynn's model, the retrieval mode is one of two monitoring processes (the other process is checking of the environment for the target event).

Regardless of the exact mechanism, for present purposes the important point is that maintaining a prospective memory retrieval mode presumably would require relatively few cognitive resources. The basis for this claim hinges on research examining the effects of divided attention on encoding and retrieval in retrospective memory tasks (Craik, Govoni, Naveh-Benjamin, & Anderson, 1996). Unexpectedly, even though dividing attention at encoding reduced memory performance, dividing attention at retrieval produced little if any decline in retrieval performance relative to not dividing attention. During retrieval, however, there was some impairment in the accuracy of performance of the divided-attention task. One straightforward interpretation of this pattern is that maintaining a retrieval mode places only modest demands on limited-capacity resources. Turning back to prospective memory, the implication is that a retrieval mode would produce minimal disruption to ongoing activities (perhaps no disruption if the ongoing activity was not overly demanding). Consequently, such a mechanism might be a candidate for explaining how monitoring is mediated in everyday prospective memory tasks. We must emphasize that to this point little evidence has been marshaled for a prospective memory retrieval mode (for example, see Guynn, 2003). Doubtless, more extensive theoretical work on this issue will emerge as researchers devote more attention to monitoring processes in prospective memory.

Summary

A fundamental challenge in understanding prospective memory is specifying the cognitive processes that activate (recall) the intended action at the appropriate moment. One long-standing theoretical idea is that the cognitive system monitors the environment for the appropriate moment. Because attentional resources are assumed to be required for monitoring, this view regards prospective remembering as a resource-demanding process.

The test-wait-test-exit model is a description of a possible strategy that people adopt to efficaciously expend resources for monitoring. Under this view, continuous monitoring is too costly and fatiguing, and thus periodic checking is preferred. The TWTE description is consistent with overt clock-monitoring behaviors evidenced in laboratory time-based prospective memory tasks. An important and complicated theoretical issue is what processes stimulate the periodic checks (or monitoring) of the environment.

Monitoring processes are more covert in event-based prospective memory tasks (that is, subjects need not check a clock), and accordingly are not as easy to study. One experimental technique used to infer the involvement of monitoring in event-based prospective memory is to examine whether adding attention-demanding secondary tasks attenuates prospective memory performances. Some studies do report prospective memory decline under extra attentional load; however, interpretation of this pattern is potentially ambiguous. A more compelling experimental technique is to assess the costs of performing the ongoing activity when a prospective memory task is added. Much recent research has exploited this technique and frequently found that a prospective memory task produces significant costs to the speed at which the ongoing task is performed.

The above findings are marshaled to support a contemporary monitoring theory: the preparatory attentional and memory model. According to this model, on every trial subjects must devote attention to initiating a recognition check for the prospective memory target event. It is important to note that some theorists take the strong stance that prospective remembering is not possible without these preparatory attentional processes (Smith, 2003; Smith & Bayen, 2004). We examine this assertion directly in the next chapter.