APPLIED COGNITIVE PSYCHOLOGY
Appl. Cognit. Psychol. **14**: S127–S144 (2000)

Strategic and Automatic Processes in Prospective Memory Retrieval: A Multiprocess Framework

MARK A. McDANIEL,[1]* and GILLES O. EINSTEIN[2]

[1]*University of New Mexico, USA*
[2]*Furman University, USA*

SUMMARY

Prospective memory situations involve forming intentions and then realizing those intentions at some appropriate time in the future. An interesting feature of most prospective remembering is that recollection of the intended action occurs without an explicit request to attempt retrieval, and we present two views on how this type of remembering can be accomplished. One could strategically monitor the environment for the presence of the target event, or one could rely on anticipated environmental conditions more or less automatically reinstating the intended action. We present data supporting both views and argue that people use multiple approaches for solving the problem of retrieving an intention (prospective memory) after a delay. Moreover, we suggest that the extent to which prospective remembering is supported by relatively automatic processes (versus strategic resource-demanding monitoring) and the probability with which prospective memory is likely to be successful when relying on automatic processes varies as a function of the characteristics of the prospective memory task, target cue, ongoing task, and individual. We argue that the complexity of the empirical findings can best be understood by appealing to this multiprocess view of prospective memory. Copyright © 2000 John Wiley & Sons, Ltd.

In recent years the literature has shown increasing interest in a type of memory task in which an individual must remember to perform an intended action at some designated point in the future (e.g. see Brandimonte *et al.*, 1997). This type of memory has been termed *prospective memory*, and for consistency with previous terminology we will continue to use that term (though see Ellis, 1996, for an alternative label). Everyday examples of prospective memory include remembering to buy bread on the way home from work, remembering to give friends a message upon next encountering them, and remembering to take medication. Real-world prospective memory tasks often require that we remember to perform an action while we are busily absorbed by another task. To capture this aspect of prospective memory, typical laboratory paradigms of prospective memory involve asking participants to press a special key on the keyboard when a particular target word is encountered in the course of performing some ongoing activity (e.g. Einstein and McDaniel, 1990; Einstein *et al.*,1995).

One challenge for researchers in this area has been to define the characteristics that distinguish prospective memory tasks from much more extensively studied direct retrospective memory tasks like recall and recognition. Because prospective memory is a complex activity that involves many components (Dobbs and Reeves, 1996; Ellis, 1996),

*Correspondence to: Mark McDaniel, Department of Psycology, University of New Mexico, Albuquerque, NM 87131, USA. E-mail: mcdaniel@unm.edu

Received 14 September 2000
Accepted 26 November 2000

there are likely several dimensions on which prospective and retrospective memory tasks differ (cf. Burgess and Shallice, 1997). For present purposes, the difference we wish to highlight is the following. In laboratory investigations of direct retrospective memory, there is a request that the person attempt to recollect prior episodes (i.e. instructions explicitly tell the subject to try to recall or recognize previously presented material). In Tulving's (1983) terminology, on direct retrospective tasks the rememberer is directed to be in a retrieval mode. Clearly, in real-world retrospective remembering, retrieval is not always prompted by a request to remember (Ebbinghaus, 1964); however, direct retrospective memory as studied in the laboratory is activated by a direct request to remember. In contrast, in prospective memory tasks, in both laboratory and everyday settings, there is rarely a request for a memory search; instead recollection of the intended action at the appropriate instance somehow occurs without some agent stimulating retrieval (see Einstein and McDaniel, 1996; McDaniel, 1995, for amplification). (Indeed, this core component of prospective memory has made laboratory study of prospective memory somewhat challenging, see Einstein and McDaniel, 1990; Harris, 1984; Kvavilashvili, 1987.) Thus, in a prospective memory task, attention somehow needs to be switched from the ongoing task to thinking about the intended action and performing it.

The main goal of the present article is to build an understanding of how this is accomplished. We briefly review several proposed theoretical approaches to explain how attention is switched from the ongoing activity to the intended action at the appropriate time. Consideration of the existing findings from the perspective of these theoretical approaches reveals some puzzling empirical patterns. Motivated by these apparently discrepant findings and by rational considerations, we propose a *multiprocess* framework that attempts to capture the complexity of prospective memory retrieval processes. This view includes identification of factors that we suggest are critical for a systematic and coherent understanding of the dynamics by which the multiple processes support prospective memory retrieval. We appeal to the existing empirical base for initial support of our theoretical proposals.

Before proceeding, it is worth mentioning that our focus will be restricted to event-based prospective memory tasks. This term refers to the situation where the intended action is appropriate when some external event occurs (Einstein and McDaniel, 1990). As examples, relaying an intended message to a colleague is appropriate when you see your colleague, and buying bread on the way home is appropriate when you pass the grocery. Aspects of the theoretical work presented herein may also be relevant to time-based tasks (the intended action is performed at a certain time of day or after a certain period of time has elapsed). However, time-based tasks will not be explicitly considered.

CURRENT APPROACHES

One approach assumes that switching of attention from an ongoing activity to an intended action is a voluntary, strategic process. This process would be mediated by an executive attentional system (or supervisory attention system (SAS) in Shallice and Burgess', 1991, terms). This system would first be involved in encoding the association between the external event pertinent to the intended action and the intended action. More importantly, the SAS would monitor the environment for the target event (cue or marker) to signal the appropriateness of performing an action (see Burgess and Shallice, 1997; Ellis, 1996), and once the event were encountered would interrupt the ongoing activity in order to execute the intended activity (or at least provide an opportunity for executing the activity).

This monitoring process has not been well detailed, but we suggest there are several possible ways in which it could happen. For example, some executive resources could be continuously committed to monitoring the environment for cues or markers associated with the intended action (e.g. Smith, 2000, under review). Another possibility is that the executive system periodically brings to mind the intended action, and this serves to maintain the activation of the cue–intention association (Guynn *et al.*, in press) so that it is more readily activated when the triggering event occurs.

Regardless of which of these particular processes occurs, the key assumption is that some attentional resources are voluntarily deployed for strategically considering environmental events (in regard to the prospective memory task) and/or periodically bringing the intended action to mind. Support for this assumption has been provided by Smith (2000), using performance on the ongoing activity as an index of attentional resources recruited during a prospective memory task. She found that when subjects were given prospective memory instructions, even on trials for which the prospective memory target cue did not appear, the speed of performing the ongoing task slowed down substantially relative to control trials performed without prospective memory instructions. The implication is that attentional resources were being allocated during the prospective memory phase to consciously evaluate events with regard to the prospective memory task, thereby reducing resources available for performing the secondary task.

An alternative theoretical approach suggests that encountering the prospective memory target event relatively automatically brings to mind the intended action. This process could be supported by an involuntary automatic associative memory system that delivers to consciousness information previously associated with attended environmental stimuli (Guynn *et al.*, in press; McDaniel *et al.*, 1998). This system is assumed to support conscious recollection when an external cue automatically interacts with a memory trace (in this case a previously encoded intended action). If the cue is good enough (i.e. if it produces an interaction with a memory trace), then the associative system rapidly, obligatorily, and with few cognitive resources delivers to consciousness the information previously associated with the cue (Moscovitch, 1994). A related theoretical mechanism is that of activation spreading from an activated node (representing an encountered item) through an associative network (Anderson, 1976, 1983; Lang, 2000, presentation at the University of New Mexico, June, has applied this formalism to prospective memory).

The idea here is that in event-based prospective remembering there is no strategic monitoring for a target. Once the prospective memory target is encountered, the putative automatic associative system either reflexively retrieves the intended action (or activates the action through spreading activation) and prospective remembering occurs, or the intended action is not automatically brought to mind (retrieved) and prospective-memory failure occurs. This idea articulates with the phenomenological reports of participants in our prospective memory studies. They indicate that their prospective remembering was not due to self-initiated strategies; instead the memory just popped into mind when the target event appeared (Einstein and McDaniel, 1990).

Consistent with this account, unfamiliar prospective memory targets (e.g. *monad*) produce better prospective memory than familiar targets (*belt*) (Einstein and McDaniel, 1990; McDaniel and Einstein, 1993). One interpretation of this pattern is based on theoretical characteristics of activation in associative networks. The amount of activation emanating from the target node to the intended action is assumed to be a negative function of the number of associations connected to the target node (Anderson, 1983). Because an unfamiliar target would have few associations, there would be a higher probability that the activation spreading from that target would activate the associated intended action sufficiently to bring the action into working memory. Also in line with this account, Guynn *et al.* (1998) reported that experimenter-provided prospective memory reminders that instructed subjects to think of the target event and the associated intended activity substantially improved prospective memory relative to a no-reminder control. There was no such improvement for reminders that referred only to the target event. If reminders were stimulating strategic evaluation of the relevance of events for the prospective memory task (monitoring), then target-event reminders should also have improved prospective memory. Accordingly, this pattern suggests that the associative linkage between target and intended action is primary for activation of the intended action upon encounter of the target event, with such activation presumably being reflexive and non-strategic.

There are at least two lines of evidence, however, that do not consistently support either the strategic/attentional approach or the relatively automatic memory-based approach. One pertinent set of findings is from the literature that focuses on age-related effects in prospective memory. On the assumptions that attentional resources decline with age (Salthouse, 1991) and that attentional resources are involved in prospective remembering, age-related decrements in prospective remembering would be expected because older adults cannot effectively initiate the strategic processing necessary for prospective memory (see also Craik, 1986). On the other hand, if prospective remembering is a relatively automatic process, then age differences should not emerge. In accord with the attentional-resource view, a number of studies consistently show age-related reductions in prospective memory performance (e.g. Craik, 2000; Kvavilashvili *et al.*, 2000; Uttl and Graaf, 2000 (all presentations at the First International Conference on Prospective Memory, Hatfield, UK); Maylor, 1993, 1996; Park *et al.*, 1997; d'Ydewalle, 1996, presentation at the International Conference on Memory, Abano Terme, Italy). Counter to the attentional view, however, and in favour of the automatic view, many other studies find no significant differences in levels of prospective memory (event-based) between young and older adults (Cherry and LeCompte, 1999; Einstein and McDaniel, 1990; Einstein *et al.*, 1992, 1995, 1997).

Another line of work has attempted to directly manipulate the availability of attentional resources for the prospective memory task by requiring some subjects to perform a prospective memory task and a secondary task designed to capture some attentional resources (e.g. monitor randomly presented digits for two consecutive odd digits). By tying up some attentional resources through the secondary task, fewer resources would be available for prospective memory and performance should suffer accordingly (if such resources are needed for prospective memory). Consistent with the view that attentional resources are involved in prospective remembering, McDaniel *et al.* (1998, Experiment 3), Einstein *et al.* (1997), and Marsh and Hicks (1998) showed that college-age participants in the more attention-demanding secondary-task conditions performed significantly less well on the prospective memory task relative to the participants in the 'full-attention' conditions. Other results, however, implicate a more automatic prospective memory process. Einstein *et al.* (2000, Experiment 1, 1997) and Otani *et al.* (1997) found no significant decrement in prospective memory when college-age students were required to perform a similar secondary task. It should be noted, however, that prospective memory decrements resulting from dividing attention are not necessarily incompatible with the automatic-associative activation view of prospective memory retrieval. One reason is that divided attention may interfere with full processing of the target event and this is a condition that is presumed to be necessary for automatic retrieval (Moscovitch, 1994). Also, as described more fully in Einstein *et al.* (1997), dividing attention may reduce prospective memory performance not by interfering with retrieval of the intended action but instead by increasing the working memory demands to the point that it compromises the ability to select and schedule the retrieved intention while it is still available in working memory.

THE MULTIPROCESS FRAMEWORK

Partly in light of the apparently discrepant patterns just noted, we suggest that there are several kinds of processes that can support prospective remembering. We propose that prospective memory retrieval can depend on strategic or attention-demanding processes. Such processes could include executive-guided monitoring that individuals would voluntarily engage to increase the likelihood of prospective remembering. Prospective remembering can also depend on relatively automatic processes. This description of varied processes seems to match people's introspective impression that sometimes the intended action 'pops into mind' (Einstein and McDaniel, 1990), whereas in other cases remembering the intended action is a planful process that includes self-remindings (Ellis and Nimmo-Smith, 1993).

In terms of automatic processes, we further suggest that several distinct systems or processes can be potentially involved. One type of automatic process is attentional and is associated with an exogenous attentional system (e.g. Egly *et al.*, in press). That is, the attentional processes are not initiated through executive or self-initiated direction. Instead, this system is responsive to salient or unusual stimuli, and produces involuntary orienting responses. Accordingly, in some cases prospective memory target events will involuntarily capture attention (we will elaborate on this below), and on so doing, stimulate spontaneous and relatively resource-free retrieval of the intended activity (provided that the intended activity is straightforward, i.e. does not include an extensive list of actions to perform; cf. Einstein *et al.*, 1992; Robinson-Riegler, 1994, unpublished dissertation). For the sake of completeness, we point out that if the intended activity were complex or not well associated with the target event, then the initial involuntary orienting may be followed by a controlled search of memory.

Another type of automatic process is memory-based. There are several relatively automatic memory processes that might serve prospective memory. One is an associative-based process as described earlier in this article (detailed in Guynn *et al.*, in press; McDaniel *et al.*, 1998), and the other is akin to a context-free recognition process (Mandler, 1980; see McDaniel, 1995, and Einstein and McDaniel, 1996, for theoretical details of this familiarity plus search process in prospective memory; see West and Herndon, 2000, presentation at the 41st Annual Meeting of the Psychonomic Society, New Orleans, for neurophysiological evidence consistent with such a process). These fairly automatic processes would support a more spontaneous retrieval process for prospective remembering, a process desirable in the event that strategic monitoring is not or cannot be engaged. In sum, we suggest that there may be a handful of relatively automatic processes that can support prospective-memory retrieval, with one process mediated by an attentional system and others by memory systems.

As briefly noted above, the retrieval processes can be delineated with even more complexity. Thus far, we have focused on processes by which the target event may come to stimulate awareness that some intended action must be performed at this particular moment (the prospective component; Einstein and McDaniel, 1990; Einstein *et al.*, 1992; McDaniel, 1995). Additional processes may be involved in then retrieving the particular intended action to be performed. To help circumscribe the issues for this article, we assume that as generally studied in the laboratory, memory of the intended action is straightforward. It is possible, however, that complicated intended actions may pose memory challenges additional to those for remembering that something needs to be done.

Before further developing the multiprocess theory, we pause to address a possible criticism. Some might object that the multiprocess assumption is an inelegant and unnecessarily complex view of prospective remembering, and might advocate instead for more parsimonious efforts to further refine either of the views reviewed earlier to accommodate the data. We think there are good arguments for assuming that the cognitive system exploits several possible ways to solve the prospective memory problem—that is, the problem of remembering to perform an action in the future without an external agent stimulating a retrieval search. Prospective memory tasks *per se* are ubiquitous in nearly all our daily activities. Moreover, prospective memory tasks are intimately related to human planning and future-oriented behaviours. Arguably, such higher-order cognitive activities have contributed fundamentally to the adaptability of the human as individuals and as a species. Indeed, Burgess (2000, presentation at the First International Conference on Prospective Memory, Hatfield, UK) has made the case that a high proportion of important human cognitive activities can be considered prospective memory. One way to help ensure that prospective remembering is effectively and flexibly supported across the wide variety of contexts in which prospective memory tasks occur, is by exploiting several central cognitive processes. That is, by positing multiple means by which retrieval of the intended action can be accomplished, our multiprocess view allows a more forgiving and potentially adaptable scheme to support prospective remembering. Further, the multiprocess framework is compatible with the idea that people can modulate the way they approach different prospective memory tasks.

In the following sections we suggest a set of critical factors that illustrate the range of contexts in which prospective remembering occurs and that determine the extent to which prospective remembering depends on strategic, attention-demanding processes versus relatively more automatic processes. These factors include prospective-memory-task importance, properties of the prospective-memory cues, properties of the ongoing activity, planning, and individual differences.

IMPORTANCE OF THE PROSPECTIVE MEMORY TASK

Some researchers have observed that the perceived importance of the prospective-memory task (e.g. important appointments) seems to increase the likelihood of prospective remembering (Andrzejewski *et al.*, 1991; Kvavilashvili, 1987). The few studies conducted on this issue do tend to show a positive relationship between perceived importance and levels of prospective remembering (see Kliegel *et al.*, in press). Less attention has been directed at illuminating the processes that mediate importance effects. By the multiprocess framework, tasks deemed important will tend to encourage more strategic monitoring in the hope of ensuring better performance. For less important tasks, because strategic processes are effortful, prospective remembering may be left to more spontaneous, relatively automatic processes.

This idea is supported by several recently completed experiments in which instructions were used to vary the importance of the prospective memory task. In an unpublished study (conducted with Julie Jones), we assessed the degree of strategic monitoring (or attentional resources) for both important and 'unimportant' prospective memory conditions by measuring latencies to perform an ongoing task. For the condition stressing the importance of the prospective memory task, prospective memory responding occurred 87% of the time, and there was a significant increase in latency for the ongoing task relative to a control condition that was not required to perform the prospective memory task. This cost in the speed of performing the ongoing task implies that attentional resources were deployed for strategic monitoring, a process that did support high levels of prospective memory. For the condition that minimized the importance of prospective memory, prospective-memory levels were still fairly high (68%), but there was no increase in response latencies for the ongoing task relative to the control condition. Thus, for this less-important condition prospective remembering seemed to be accomplished with minimal attentional resources, and was instead perhaps accomplished through spontaneous memory processes. This pattern as a whole is consistent with the idea that the perceived importance of the prospective memory task modulated whether strategically-allocated attentional resources or more automatic processes were involved in prospective remembering.

Similarly, Kliegel *et al.* (in press) reported that cover task performance was less accurate (subjects failed to complete trials) when the instructions emphasized the importance of the prospective memory task than when the same prospective memory task was not identified as important. This negative effect of importance on the ongoing activities occurred both when prospective memory levels improved under importance instructions (Experiment 1, time-based task) and when prospective memory did not improve with importance (Experiment 2, event-based task). Thus, importance may not necessarily improve prospective memory levels even though strategic processes are more engaged. This pattern is accounted for straightforwardly with the multiprocess theory that assumes that alternative, perhaps more automatic processes can also support prospective remembering. In the Kliegel *et al.* study, relatively automatic processes appeared to support performance on the event-based task because prospective memory performance did not decline when attentional resources were additionally challenged with a secondary task (digit detection).

From a social perspective, Winograd (1988) speculated that people make social attributions about how important another individual considers a prospective memory task based on how successfully that individual remembers to do the task. Thus, if a spouse or person with whom we are romantically involved forgets our birthday, we tend to make inferences about how important the person considers that event. In line with our framework, people likely believe that executive processes can be recruited to ensure successful prospective remembering, if the task is important enough to warrant the effort. It is interesting to note, however, that the Kliegel *et al.* (in press) study suggests that in some cases recruiting additional executive resources for important prospective memory tasks may not improve prospective remembering.

PARAMETERS OF THE PROSPECTIVE MEMORY CUES

The nature of the target events that act as cues in event-based prospective memory tasks are inherently important for determining the kinds of processes that support prospective memory retrieval.

Target distinctiveness

In some instances target events might be unusual relative to prior knowledge, distinctive relative to the existing context, or salient in some way. Several examples from laboratory paradigms include presenting low-meaningful words as targets (e.g. monad; Einstein and McDaniel, 1990; McDaniel and Einstein, 1993), presenting targets in upper case font when the remainder of the words in the cover task are in lower case (Brandimonte and Passolunghi, 1994; Einstein *et al.*, 2000; West and Crewdson, 2000, presentation at the First International Conference on Prospective Memory, Hafield, UK), and increasing the size of target-cue pictures (Uttl and Graf, 2000). We suggest that such stimuli involuntarily capture attention (cf. Egly *et al.*, in press), prompting an analysis of the significance of the item beyond its function in the ongoing activity (cf. Schutzwold, 1998). The distinctiveness of the target not only produces attentional switching from the ongoing activity, but also in many cases provides a frame for quickly recognizing its significance (signals execution of the intended action).

There are several convergent findings that are consistent with the claim that distinct targets may engage an involuntary orienting process that supports prospective remembering. First, this process (prompted by distinctive targets) should provide a constant, reliable mechanism for prospective-memory performance. When perceptually distinct targets (upper case words) are used, absolute levels of prospective memory performance are nearly perfect (Einstein *et al.*, 2000; West and Crewdson, 2000). Second, such a process would be expected to produce better performance than other prospective memory processes that are arguably prone to fluctuation and may be somewhat inconstant (e.g. a controlled, resource-demanding monitoring process or a probablistic associative memory process). In line with this expectation, when the very same target is presented in a non-distinctive format (e.g. lower-case), prospective memory levels are significantly lower (Einstein *et al.*, 2000, for older adults; McDaniel *et al.*, 1997, presentation at the 38th Annual Meeting of the Psychonomic Society, Philadephia reported a similar finding for younger adults). Third, an involuntary orienting process should be less subject to disruption than a more strategic, resource demanding process. McDaniel *et al.* (1997; see also Einstein *et al.*, 2000) found that the distinctive targets (upper-case) maintained high prospective memory performance in the face of a secondary task, whereas when the targets were not distinctive (lower-case) prospective memory declined when a secondary task was added.

Associativity of target with the intended action

The target can vary in the degree to which it is associated with the intended action. As one everyday example, the target ‘grocery store’ might be highly associated with the intention to buy orange juice (for someone who always buys orange juice at the grocery store). Grocery store would not typically be associated with the intention to buy shoe polish (whereas a shoe store might be). We suggest that this variation can affect the involvement of an automatic associative memory-based process (or system) in prospective remembering. Briefly, this memory process reflexively, automatically, and rapidly delivers to awareness stored events (e.g. a word) associated with a processed stimulus, provided that the processed stimulus is sufficiently associated to that event (see Moscovitch, 1994). For highly associated target–intended action pairings, such automatic and reflexive retrieval of the intended action may be one route to prospective remembering (Guynn *et al.*, in press; McDaniel *et al.*, 1998). For less highly associated target–intended action pairings, this automatic associative process would not be as likely to provide the intended action upon processing of the target event. In line with this claim, Wilson (2000, poster presented at the First International Conference on Prospective Memory, Hatfield, UK) reported that prospective memory was significantly better when the target events were related to the action (e.g. remembering to remove a bookmark from a book when shown a picture of a book and mark) than when the target events were unrelated to the intended action (e.g. remembering to remove a floppy disk from a box when shown a picture of the university entrance gate).

The just-cited differences in performance between related and unrelated target–intended action pairs are open to other interpretations, however. Perhaps a monitoring process successfully identified the targets, but then a subsequent retrospective memory search failed to retrieve the unrelated action. Or the targets in the related pairs could have been more salient than the targets in the unrelated pairs. A study in our laboratory (in collaboration with Guynn; reported by McDaniel and Einstein, 2000, presentation at the First International Conference on Prospective Memory, Hatfield, UK) attempted to rule out these alternative possibilities. The prospective memory task was to write down a response word upon presentation of a particular target word. The target words (two for each subject) were the same in all conditions, with the response varying. In the related target–intended action condition, the response words were high associates of the target (e.g. spaghetti–sauce). In the unrelated target–intended action condition the response words were not associated (e.g. spaghetti–steeple). Prospective memory performance was examined only for subjects who could perfectly recall the paired action both during instructions and at the end of the experiment. To provide a more diagnostic index of the processes underlying prospective remembering, for half of the trials a secondary task was added to reduce attentional resources available for the prospective memory task. Additionally, in some conditions the words presented on the non-target trials had all been presented earlier in the experiment to study for a recognition test. We reasoned that if prospective memory were mediated by a process that depended on identifying the significance of the cue, then the familiar non-targets (familiar in the experimental context) might disrupt this process. However, a reflexive, automatic associative retrieval process would not depend on identifying the significance of the cue, and should not be affected by trials with familiar non-targets.

The results converged on the idea that for different kinds of target–action situations, prospective remembering is supported by a variety of processes. The highly related target–response conditions produced high performance ($M = 0.88$) that was not disrupted by either divided attention or by non-target familiarity. This pattern dovetails precisely with the notion of an automatic associative process reflexively delivering the intended action to awareness. In contrast, the unrelated target–response conditions showed a significant decrement when attention was divided ($M = 0.66$ vs. 0.82 for full attention) and a marginally significant decline when non-target trials were composed of familiar words (words on non-target trials previously presented in the experiment) ($M = 0.69$ vs. 0.80

with non-targets not previously presented). This result implicates processes other than reflexive associative processes—processes that require attentional resources (e.g. monitoring) or are sensitive to increased familiarity from recent encoding of the target event (cf. Einstein and McDaniel, 1996; McDaniel, 1995).

PARAMETERS OF THE ONGOING TASK

The ongoing activity that occupies the person during the period that the intended action is to be executed will significantly determine the degree to which strategic, attentional processes versus more spontaneous, less strategic processes will be involved in prospective remembering. In developing this claim, we propose that this factor has played a critical role in the divergent age-effects reported in the literature.

Ongoing task and focal processing

If performing the ongoing task requires focal processing of the prospective memory cue, then the cue is sufficiently processed to enable involuntary (automatic) retrieval of the intended action (as discussed above). An everyday example is when I intended to bring home several floppy disks from my office for my daughter. Though the intention had been formed the previous week and I was hopeful I could strategically prompt myself to retrieve the intention once at the office, I had not remembered the task on any day of that week. (As suggested earlier, my daughter probably made an inference about how important I considered this task to be.) Monday of the following week, I was carefully reviewing my floppy disks for a particular file and in so doing became aware that I needed to take some blank disks home. The idea illustrated here is that when the disks became a focus of attention of an ongoing task, those cues (the disks) seemed to automatically stimulate retrieval that I had also to complete the task of returning home with several blank disks.

On the other hand, if the prospective memory cue is encountered but is not part of the information constellation being extracted for performing the ongoing task, then prospective remembering will require more strategic attentional resources to monitor for the cue (marker) signaling the appropriateness for performing the intended action. For instance, if my ongoing activities at the office focused on telephone-related tasks or journal reading, then even though the disks are in plain sight at my desk they would not receive the focal processing that my telephone directory and journals would receive. Accordingly, some strategic monitoring would be needed to ensure that I focus sufficiently on the disks to pick them up for my daughter. The laboratory analogue would be having to perform an intended activity when the target event is not a critical piece of information for performing the ongoing activity, such as performing an intended activity when the background on which the stimulus is presented has a certain thatched pattern (Park *et al.*, 1996) or when famous faces that are to be named are wearing eyeglasses or smoking a pipe (Maylor, 1993, 1996).

This formulation provides a ready account of some of the diverging patterns reviewed above for ageing and prospective memory. Studies using paradigms in which the prospective memory target is focally processed as part of the ongoing activity report small (non-significant) or no age-related decrements (Einstein and McDaniel, 1990; Einstein *et al.*, 1995, 1997). This is presumably because the prospective memory target relatively automatically stimulates retrieval of the intended activity. Significant age-related declines in prospective remembering are reported for those situations in which the target event is not a focal component for performing the ongoing activity. A reasonable assumption is that in these paradigms prospective memory performance largely requires executive (attentional) resources to periodically monitor for the target information that is peripheral to the ongoing activity (i.e. 'eyeglasses' or 'pipe' in Maylor's, 1993, 1996, paradigm and a particular screen background in Park *et al.*'s, 1996, paradigm). Accordingly, because of age-related declines in such resources (e.g. Craik and Byrd, 1982; Salthouse, 1991), concomitant age-related declines in prospective memory are observed.

We want to emphasize that a target might be embedded in an ongoing processing task, but the ongoing task might still not focus processing on that target's features that were initially associated with the intended action. Examples of this situation in recent studies are when the target cue is a particular pair of letters embedded in a word, and the ongoing activity is to process the meaning of the word. The converse is also possible, with the target being a colour word ('red', 'blue') and the ongoing activity is to look for particular graphemic features of a list of words (Maylor, 2000, presentation at the First International Conference on Prospective Memory, Hatfield, UK). In this case, automatic retrieval of the intended activity is unlikely, and therefore prospective memory must be supported by a more strategic or self-initiated process. This analysis offers an explanation for the 'task-appropriate' processing effect reported by Maylor (2000; also Marsh, Hicks, and Hancock, this issue). The effect is that the foregoing situations produce worse prospective memory than when the target attributes of the word match the processing required by the ongoing task. In the mismatched conditions, prospective remembering would need to depend heavily on strategic processes, whereas in the matched conditions more automatic processes would contribute as well as strategic processes to prospective remembering. It is possible that properties of the prospective memory cue could obviate the need for strategic processes presumably required when the focus of the ongoing activity is mismatched with the critical target feature(s). If so, then we would expect the task-appropriate effect to be eliminated. One already-discussed factor that we assume recruits a relatively automatic (attentional) mechanism to support prospective remembering is the salience or distinctiveness of the target cue. Consistent with these notions, Marsh, Hicks, and Hancock (this issue) eliminated the task-appropriate effect when the target cue was made salient by surrounding the target with angle brackets.

Further, our analysis is also entirely compatible with the finding that age-related declines in prospective memory are significantly greater for the mismatched target–ongoing task conditions than for the matched conditions (Maylor, 2000). Again, the idea is that in the matched conditions, relatively more automatic or spontaneous processes can support prospective remembering, thereby enhancing performance for the older adults. The same theme holds for anticipated effects of divided attention (inclusion of additional secondary tasks). We would anticipate that matched target–ongoing task conditions would be less disrupted by divided attention (because of the contributions of automatic retrieval processes) than would mismatched target–ongoing task conditions.

While on the topic of age-related effects, our framework underscores the point that age effects in prospective memory will interact with any factors (including those already identified in this article) that modulate the degree to which strategic and attentional resources are required for prospective remembering. All other things being equal (e.g. see the next section), conditions that are favourable to automatic retrieval of the intended action will not show robust age differences. If the conditions demand more strategic processes, age differences are more likely.

Ongoing task absorption

The ongoing activity can vary in terms of how absorbing, engaging, or demanding it is. The more absorbing the ongoing activity, the less likely that resources will be available for strategic approaches to prospective remembering or that subjects will successfully deploy strategic approaches. There are many aspects that will determine level of absorption, including the ongoing task itself, its speed of presentation, individual interests, and the physiological state of the organism. It is beyond the scope of this article to provide a detailed specification of the factors that determine whether or not an ongoing activity will be absorbing. However, based on informal analysis, we can appeal to the existing research to initially examine this claim of the multiprocess view. Kvavilashvili (1987) assessed whether subjects thought of the intended action during the interval after the intention was formed but prior to the time appropriate for performing the intended action. She also manipulated whether or not there was ongoing activity during the interval, and if there was ongoing activity whether or not it was interesting for the subjects. As the ongoing activity presumably increased in absorption (no activity, uninteresting, interesting), the proportion of subjects who reported thinking about the intended action decreased (42%, 20%, and 8% respectively). Presuming that subjects' reports of remembering the intended action periodically during the ongoing activity may index at least in part strategic processes (e.g. self-initiated remindings), then this pattern is in line with the claim that prospective memory retrieval will reflect less strategic processes as the ongoing activity becomes more absorbing.

Another study (conducted in our laboratory with Kraig Finstad) examined prospective memory when four different ongoing word activities (e.g. word rating, anagram, definition task) were presented to some subjects. In this condition, a single activity was presented for a block of trials, then a second activity was presented for a block of trials, and so on until the fourth activity had been presented. Other subjects received just one of the four ongoing activities throughout the prospective memory trials. Across both conditions, the prospective memory target events were identical. It seems likely that as a single ongoing task is repeatedly presented, it becomes less absorbing to the subject. In contrast, changing the activity periodically might retain a higher level of absorption in the ongoing activity. If this assumption is well founded, then the multiprocess view would anticipate that the less-absorbing single-ongoing task condition would allow a higher level of strategic monitoring than the multiple-ongoing task condition. With more monitoring, prospective memory performance should improve. In line with this idea, the single-ongoing task condition produced significantly higher prospective memory performance than the multiple-task condition. Note that this effect was not a foregone conclusion. Hicks *et al.* (2000) reported that a similar type of comparison implemented for the retention interval (not the ongoing task) produced the opposite pattern.

In other research, prospective memory for planned actions during the course of an average week was examined (Rendell and Craik, this issue). The ongoing activity was either a board game simulating a week (Experiment 1) or an actual week (Experiment 2). Across situations, the intended activities to be performed were identical or a close match with each other. The prospective memory target events were chosen to be normal events in the course of everyday living (e.g. breakfast, dinner, refrigerator), and thus would not be considered particularly distinctive. Because performance on the board game tended to be at ceiling, the researchers added more demands to the board game so that it created a more involved set of ongoing activities. Significant age-decrements were reported for prospective memory when the board game (virtual week) was the ongoing activity but not an actual week. Consistent with the current analysis, one suggested interpretation of this pattern (Craik, 2000) is that ongoing activities during an actual week were less demanding than for they were for the virtual week, thereby allowing the older adults to recruit more strategic processes to support prospective remembering. We do acknowledge that the complete pattern of prospective memory results was more complex than could be described here, and additional factors like perceived importance of the prospective memory task might also have contributed to the results (see Rendell and Craik).

Rendell and Forbes (2000, unpublished manuscript) reported results consistent with the foregoing findings and with the idea that more absorbing ongoing tasks will leave fewer resources for strategic processes in prospective remembering (thereby generally producing age-related decrements in prospective memory). For some subjects, these researchers modified Maylor's (1996) famous-face-naming ongoing task, which is assumed to be very engaging for older adults. They presented the same faces to some subjects, but required estimates of how old the faces appeared. This ongoing task was assumed to be less challenging for older adults than face naming. The prospective memory task was the same in both conditions—to circle the response when a face wearing glasses appeared. Replicating Maylor, when the ongoing task was the more engaging face-naming task, there were robust age-related declines in prospective memory. In contrast, when the ongoing task required age estimates of the faces, older adults were equivalent to younger adults on prospective memory performance.

In general, the idea is that more absorbing or demanding ongoing activities should have a greater negative effect on prospective remembering when the conditions require a more strategic approach to prospective memory (e.g. when the target event is not distinctive) or for subjects who adopt a more strategic approach (see section on individual differences below).

PLANNING

Burgess and Shallice (1997) and Mäntylä (1996) have argued that the degree and type of planning that one does for a prospective memory task affects later remembering (see also Kliegel *et al.*, 2000). The planning that one engages in is likely to affect the nature and activation of the prospective memory representation (Mäntylä, 1996), and this in turn should affect the extent to which prospective remembering is likely to occur with more spontaneous or automatic processes. In a recent study conducted with Zack Morgan, we presented participants with a highly salient target (a capitalized word appearing in a sentence with non-capitalized words) and this was their cue to plan to perform an action (press a designated key on the keyboard) when they received trivia items ten seconds later. The sentences containing capitalized words sometimes appeared in conjunction with divided attention (a difficult digit-detection task) and sometimes not. Interestingly, dividing attention only during the presentation of the capitalized word (and not during the delay or execution phase) reduced the prospective memory performance of younger and older adults by 11% and 25%, respectively. It is important to note that in previous research (Einstein *et al.*, 2000) both younger and older participants performed nearly perfectly when they were allowed to press the key as soon as the capitalized word occurred, regardless of whether or not attention was divided. This result indicates that participants are able to notice the highly salient capitalized word, even under highly demanding divided attention conditions. Our interpretation of the negative effects of dividing attention in the delayed task is that the difficult digit-detection task interfered with re-planning the later action. Thus, when attention was not divided during presentation of the capitalized words, participants had more resources available to effectively plan their intention (e.g. 'When I get to the trivia items, I need to press the key') and this opportunity for planning significantly benefits prospective memory performance.

It is likely that planning affects prospective memory performance through some of the mechanisms mentioned earlier. Mäntylä (1993), for example, has shown that priming target events prior to the implementation of prospective memory task improved prospective remembering for both younger and older adults. Mäntylä's interpretation of this finding is that the priming of the target events (roughly analogous to planning) increases activation for their representations. This in turn makes them more sensitive to the target events when they occur later. Perhaps the increase in familiarity accomplished through such priming involuntarily captures attention. Another result that is consistent with this idea is Ellis and Milne's (1996) finding that planning for specific target events relative to general categories of events improves prospective memory under certain conditions (see also Einstein *et al.*, 1995).

Other research by Guynn *et al.* (1998) examining the effectiveness of different kinds of reminders suggests that the most effective type of planning may be that which serves to strengthen the association between the target event and the action. Guynn *et al.* found that reminders that included both the target event and the intended action were more effective than those that presented only the target event or only the intended action. This result is consistent with the view presented earlier that strengthening the association between the target event and the intended action increases the likelihood that prospective memory retrieval is accomplished by an automatic associate system.

Consistent with the general theme of this article, it seems that the type and degree of planning that one does will affect the extent to which one can rely on automatic or spontaneous processes for successful prospective memory. For instance, it may be that good planning obviates the need for strategic monitoring. Also, it seems likely that some conditions require more planning than others. For example, with very salient target events, less planning may be needed.

INDIVIDUAL DIFFERENCES

The degree to which automatic versus strategic processes are engaged in a prospective memory task is likely to depend on various individual difference factors. In addition to the obvious implications of individual differences in various cognitive capacities (e.g. working memory capacity), it is likely that variables other than purely cognitive ones will affect prospective memory performance and perhaps more so than retrospective memory performance (Meacham, 1988; Searleman, 1996; Winograd, 1988). For instance, Goschke and Kuhl (1993) suggest that individuals with a certain personality profile may prefer to keep the intended action activated (in mind, perhaps a kind of monitoring) more so than those with other personality profiles. Specifically, they believe that people with a 'state orientation' are more likely to ruminate about current concerns and thus keep unfulfilled intentions more highly activated than those with an 'action orientation'. Interestingly, Goschke and Kuhl showed that those with state orientation were more likely to keep intentions activated in mind regardless of whether the intended action was externally cued or self-initiated. By contrast, action-oriented people only showed increased activation for unfulfilled intentions when the intended activities were to be self-initiated. Beyond suggesting that people differ in the extent in which they monitor for the presence of a targeted event, these results indicate that some personality types will be sensitive to specific task demands and adjust their approach to prospective memory tasks depending on their conditions and others will not.

In general, there has been little research on how individual differences in personality variables are related to prospective memory. In light of the multiprocess framework, it seems reasonable to predict that people who score high on personality characteristics like conscientiousness and compulsiveness should do well on prospective memory tasks in general, but especially so (relative to people who are low on these dimensions) on prospective memory tasks that would benefit from strategic monitoring (e.g. those with a non-distinctive target event). On the other hand, it may be that people who are moderate or low on these dimensions, like Goschke and Kuhl's (1993) action-oriented participants, are more likely to adjust their strategy depending on the task and thus may be more likely to strategically monitor for the target event under the appropriate conditions. If this is the case, then differences in personality characteristics may not show up on prospective memory performance *per se* but rather than on the 'costs' of the prospective memory task on performing the ongoing activities.

Although there are few data on the relation between personality variables and prospective memory performance, Searleman (1996) found that Type A personalities (people who have an urgent need to complete tasks) performed better on certain kinds of prospective memory tasks. Specifically, they remembered more often or more quickly on tasks that were perceived to be important to them personally or to someone else. People who scored high on the obsessive–compulsive dimension did not perform prospective memory tasks any differently from those who were low on this dimension. Thus, at present, it seems that at least some personality characteristics are related to higher prospective memory performance under certain conditions, and one explanation of these results is that this is accomplished with increased strategic monitoring of the prospective memory task. If this is the case, then the multiprocess view predicts that the effects of personality characteristics will be more pronounced when the planning and retrieval conditions are less likely to produce automatic retrieval.

SUMMARY

We opened this paper with the observation that one of the key features of prospective memory is that prospective memory retrieval must be accomplished without an agent prompting remembering (i.e. without a direct request to remember as in the case with laboratory tests of direct retrospective memory). That is, in contrast to the type of retrospective memory that is typically studied in the laboratory, in which a person is prompted (by an experimenter, a recall sheet, etc.) to engage in retrieval, prospective memory typically requires that at some point in the future, the individual remembers to perform the action without an external agent putting him or her in a retrieval mode. We characterized this as a 'problem' that is encountered when considering a prospective memory demand. Our central claim is that there are multiple methods for solving a prospective memory problem, and which method will be useful is likely to depend on some of the variables reviewed such as the importance of the prospective memory task, the nature of the cues and their relation to the intended action, the nature and constraints of the ongoing task, and individual differences in both cognitive and personality variables. These conditions are also likely to affect the type and degree of planning performed.

We believe that the particular constellation of processes involved in a prospective memory situation is likely to vary across prospective memory tasks and individuals. For example, with a prospective memory task in which the target events are not very salient and in which the ongoing task does not focus processing on the target event, prospective memory retrieval is less likely to occur automatically and performance should be highly sensitive to attempts to strategically monitor. Consequently, with these conditions, there should be larger effects of dividing attention and age relative to conditions in which salient target events are used (cf. Maylor, 2000). One important implication of this view is that we should no longer confine ourselves to questions such as 'Does ageing affect prospective memory?' 'Does dividing attention affect prospective memory?' 'Is working memory involved in prospective memory?' or 'Is prospective memory mediated by frontal neuropsychological systems?' Rather, in an attempt to understand the particular cognitive processes involved in different prospective memory situations, we should focus on how these factors interact with different conditions (e.g. which types of prospective memory task are particularly sensitive to divided-attention effects, ageing, and working memory).

Another implication of this framework is that it may be fruitful to investigate meta-prospective memory processes. It is likely that individuals use different approaches to solving a prospective memory problem. The probability with which people rely on relatively spontaneous processes versus strategic monitoring in a particular task should be related to their sensitivity to the various variables described in this paper. Understanding of meta-cognitive processes as they relate to prospective memory has the potential to help us understand some of the variability in prospective memory data and may help us understand other effects such as age differences in prospective memory.

In this paper we have presented the view that people can rely either on strategic or relatively automatic processes for prospective memory retrieval and do so to different degrees depending on the task. Our sense is that there is probably a bias in the system to minimize the cognitive demands of the prospective memory task (of course, as described earlier, it is likely to be influenced by numerous factors such as the importance of the prospective memory task). Such a view of memory would be adaptive in the sense that the cognitive system would not be overly burdened by prospective memory demands. In the Smith (2000) study reported earlier, adding a prospective memory task to the demands of participants, on average, slowed down the speed of lexical decisions by 200-300 milliseconds. If this kind of allocation of resources observed by Smith were typical of prospective memory tasks in general, then successful prospective memory would come at quite a cost to the processing of ongoing events. Given these kinds of costs and the prevalence of prospective memory demands in our lives, it seems that it would be adaptive in many situations to rely on relatively automatic processes.

In closing, the multiprocess framework describes how prospective memory retrieval is accomplished and proposes that the specific retrieval processes depend on a variety of conditions. We have presented the framework to help organize the rapidly developing and somewhat disparate database on prospective memory. But we acknowledge that the multiprocess framework does not yet have the specificity to necessarily produce precise predictions. We are hopeful that the framework has heuristic value and can serve a guiding function for further research in this challenging area.

ACKNOWLEDGEMENTS

Preparation of this article was supported by NASA grant NCC-2-1085. We thank Key Dismukes for prior discussions on some of the ideas presented herein.

REFERENCES

Anderson JR. 1976. *Language, Memory,* and Thought. Erlbaum: Hillsdale, NJ.

Anderson JR. 1983. *The Architecture of Cognition*. Harvard University Press: Cambridge, MA.

Andrzejewki SJ, Moore CM, Corvette M, Herrmann D. 1991. Prospective memory skill. *Bulletin of the Psychonomic Society* **29**: 304–306.

Brandimonte M, Einstein GO, McDaniel, MA. (eds) 1996. *Prospective Memory: Theory and Application*. Erlbaum: Mahwah, NJ.

Brandimonte MA, Passolunghi MC. 1994. The effect of cue-familiarity, cue-distinctiveness, and retention interval on prospective remembering. *The Quarterly Journal of Experimental Psychology* **47A**: 565–587.

Burgess PW, Shallice T. 1997. The relationship between prospective and retrospective memory: Neuropsychological evidence. In *Cognitive Models of Memory*, Conway MA (ed.). MIT Press: Cambridge, MA; 247–272.

Cherry KE, LeCompte DC. 1999. Age and individual differences incluence prospective memory. *Psychology and Aging* **14**: 60–76.

Craik FIM. 1986. A functional account of age differences in memory. In *Human Memory and Cognitive Capabilities: Mechanisms and Performances*, Klix F, Hagendorf H (eds). Elsevier: Amsterdam; 409–422.

Craik FIM, Byrd M. 1982. Aging and cognitive deficits: The role of attentional resources. In *Aging and Cognitive Processes*, Craik FIM, Trehub SE (eds). Plenum Press: New York; 191–211.

Dobbs AR, Reeves MB. 1996. Prospective memory: More than memory. In *Prospective Memory: Theory and Applications*, Brandimonte M, Einstein GO, McDaniel MA (eds). Erlbaum: Mahwah, NJ; 199–226.

Ebbinghaus H. 1964. *Memory: A Contribution to Experimental Psychology.* Dover: (New York original work published 1885; translated 1913).

Egly R, Rafal R, Henik A, Berger A. in press. Reflexive and volumtary covert orienting in detection and discrimination tasks. *Journal of Experimental Psychology: Human Perception and Performance*.

Einstein GO, Holland LJ, McDaniel MA, Guynn MJ. 1992. Age related deficits in prospective memory: The influence of task complexity. *Psychology and Aging* **7**: 471–478.

Einstein GO, McDaniel MA. 1990. Normal aging and prospective memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **16**: 717–726.

Einstein GO, McDaniel MA. 1996. Retrieval processes in prospective memory: Theoretical approaches and some new empirical findings. In *Prospective Memory: Theory and Applications*, Brandimonte M, Einstein GO, McDaniel MA (eds). Erlbaum: Mahwah, NJ; 115–124.

Einstein GO, McDaniel MA, Manzi M, Cochran B, Baker M. 2000. Prospective memory and aging: Forgetting intentions over short delays. *Psychology and Aging* **15**: 671–683.

Einstein GO, McDaniel MA, Richardson SL, Guynn MJ, Cunfer AR. 1995. Aging and prospective memory: Examining the influences of self-initiated retrieval processes. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **21**: 996–1007.

Einstein GO, Smith RE, McDaniel MA, Shaw P. 1997. Aging and prospective memory: The influence of increased task demands at encoding and retrieval. *Psychology and Aging* **12**: 479–488.

Ellis JA. 1996. Prospective memory or the realization of delayed intentions: A conceptual framework for research. In *Prospective Memory: Theory and Applications*, Brandimonte M, Einstein GO, McDaniel MA (eds). Erlbaum: Mahwah, NJ; 1–22.

Ellis JA, Milne A. 1996. Retrieval-cue specificity and the realisation of delayed intentions. *Quarterly Journal of Experimental Psychology* **49(A)**: 862–887.

Ellis JA, Nimmo-Smith I. 1993. Recollecting naturally-occurring intentions: A study of cognitive and affective factors. *Memory* **1**: 107–126.

Goschke T, Kuhl J. 1993. Representation of intentions: Persisting activation in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **19**: 1211–1226.

Guynn MJ, McDaniel MA, Einstein GO. 1998. Prospective memory: When reminders fail. *Memory and Cognition* **26**: 287–298.

Guynn MJ, McDaniel MA, Einstein GO. in press. Remembering to perform actions: A different type of memory? In *Memory for Action: A Distinct form of Episodic Memory*, Zimmer HD, Cohen RL (eds).

Harris JE. 1984. Remembering to do things: A forgotten topic. In Harris JE, Morris PE (Eds.), *Everyday Memory, Actions, and Absent-mindedness* (pp. 71–92). Academic Press: London, England.

Hicks JL, Marsh RL, Russell EJ. 2000. The properties of retention intervals and their affect on retaining prospective memories. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **26**, 1160–1169.

Kliegel M, Martin M, McDaniel MA, Einstein GO. in press. Varing the importance of a prospective memory task: Differential effects across time- and event-based prospective memory. *Memory.*

Kliegel M, McDaniel MA, Einstein GO. 2000. Plan formation, retention, and execution in prospective memory: A new approach and age-related effects. *Memory and Cognition* **28**: 1041–1049.

Kvavilashvili L. 1987. Remembering intentions as a distinct form of memory. *British Journal of Psychology* **78**: 507–518.

Mandler G. 1980. Recognizing: The judgment of previous occurrence. *Psychological Review* **87**: 252–271.

Mäntylä T. 1993. Priming effects in prospective memory. *Memory* **1**: 203–218.

Mäntylä T. 1996. Activating actions and interrupting intentions: Mechanisms of retrieval sensitization in prospective memory. In *Prospective Memory: Theory and Applications*, Brandimonte M, Einstein GO, McDaniel MA (eds). Erlbaum: Mahwah, NJ; 93–113.

Marsh RL, Hicks JL. 1998. Event-based prospective memory and executive control of working memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **24**: 336–349.

Maylor EA. 1993. Aging and forgetting in prospective and retrospective memory tasks. *Psychology and Aging* **8**: 420–428.

Maylor EA. 1996. Age-related impairment in an event-based prospective memory task. *Psychology and Aging* **11**: 74–78.

McDaniel MA. 1995. Prospective memory: Progress and processes. In *The Psychology of Learning and Motivation* (Vol. 33), Medin DL (ed.). Academic Press: San Diego, CA; 191–222.

McDaniel MA, Einstein GO. 1993. The importance of cue familiarity and cue distinctiveness in prospective memory. *Memory* **1**: 23–41.

McDaniel MA, Robinson-Riegler B, Einstein GO. 1998. Prospective remembering: Perceptually driven or conceptually-driven processes? *Memory and Cognition* **26**: 121–134.

Meacham JA. 1988. Interpersonal relations and prospective remembering. In Gruneberg MM, Morris PE, Sykes RN (Eds.), *Practical Aspects of Memory: Current Research and Issues* (Vol. 1, pp. 354–359). Wiley: Chichester, England.

Moscovitch M. 1994. Memory and working with memory: Evaluation of a component process model and comparisons with other models. In *Memory Systems*, Schacter DL, Tulving E. (eds). The MIT Press: Cambridge, MA; 269–310.

Otani H, Landau JD, Libleman TM, St. Louis JP, Kazen JK, Throne GW. 1997. Prospective memory and divided attention. *Memory* **5**: 343–360.

Park DC, Hertzon C, Kidder, DP, Morrell RW, Mayhorn CB. 1997. Effect of age on event-based and time-based prospective memory. *Psychology and Aging* **12**: 314–327.

Robinson-Riegler B. 1994. *The Recognition–recall Hypothesis of Prospective Memory.* Unpublished doctoral dissertation, Purdue University.

Salthouse TA. 1991. *Theoretical Perspectives on Cognitive Aging*. Erlbaum: Hillsdale, NJ.

Schutzwold A. 1998. Surprise and schema strength. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **24**: 1182–1199.

Searleman A. 1996. Personality variables and prospective memory performance. In *Basic and Applied Memory Research: Practical Applications* (Vol. 2), Hermann D, McEvoy C, Hertzog C, Hertel P, Johnson MK (eds). Erlbaum: Mahwah, NJ; 111–119.

Shallice T, Burgess PW. 1991. Deficits in strategy application following frontal lobe damage in man. *Brain* **114**: 727–741.

Tulving E. 1983. *Elements of Episodic Memory.* Oxford University Press: New York.

Winograd E. 1988. Some observations on prospective remembering. In *Practical Aspects of Memory* (Vol. 1), Gruneberg MM, Morris PM, Sykes RN (eds). Wiley: Chichester; 348–353.

