Cue-Focused and Reflexive-Associative Processes in Prospective Memory Retrieval

Mark A. McDaniel
University of New Mexico

Melissa J. Guynn
New Mexico State University

Gilles O. Einstein
Furman University

Jennifer Breneiser
University of New Mexico

Several theories of event-based prospective memory were evaluated in 3 experiments. The results depended on the association between the target event and the intended action. For associated target–action pairs (a) preexposure of nontargets did not reduce prospective memory, (b) divided attention did not reduce prospective memory, (c) prospective memory was better than when the target event and intended action were not associated, and (d) prospective memory was characterized by retrieval of the precise intended action. These results converge on the view that retrieval is mediated by a reflexive-associative process. In contrast, for unassociated pairs (a) preexposure of nontargets reduced prospective memory, and (b) divided attention reduced prospective memory. These results implicate cue-focused retrieval processes and are most consistent with a discrepancy-plus-search model. The entire pattern implicates both cue-focused and reflexive-associative processes and more generally supports a multi-process framework of prospective memory (M. A. McDaniel & G. O. Einstein, 2000).

In the last decade, memory researchers have shown increased interest in the ubiquitous real-world memory task of remembering to perform an intended action at some appropriate point in the future (following the literature and for convenience, we label this prospective memory). Examples of prospective memory tasks include remembering to buy bread on the way home from work, remembering to pick up a child from tennis practice, and remembering to take medication. In considering prospective memory in relation to the more typical retrospective memory tasks that have received extensive attention in the literature, a central feature of prospective memory is that the rememberer must recollect the intended action at the appropriate instance without an agent stimulating retrieval (e.g., Craik, 1986; Einstein, Holland, McDaniel, & Guynn, 1992; McDaniel & Einstein, 2000). By contrast, a hallmark of explicit retrospective memory tasks is that an agent (e.g., an experimenter, printed instructions) directs the participant to engage in a memory search.

This differentiation between retrospective and prospective memory raises a compelling theoretical question. According to most theories of recall and recognition developed over the past four decades, retrieval is activated (“turned on”) by the explicit request to remember (see Kavvlishvili & Mandler, 2004, and Moscovitch, 1994, for exceptions). That is, retrieval processes do not spontaneously respond to environmental cues, but when recall is requested, processes are turned on to assemble cues and retrieval structures (e.g., search of associative memory [SAM]; Raajimakers & Shiffrin, 1980), or when recognition is requested, matching processes are activated (e.g., MINERVA 2; Hintzman, 1988). Because there is no request for prospective memory, as they stand, these models do not apply to prospective memory. Moreover, as Mandler (1980) noted, theories and laboratory paradigms of recognition are directed at judgments about the previous occurrence of a stimulus. Some have suggested that an environmental event is recognized as the prospective memory cue, yet when the term recognition is applied to prospective memory, it implies that the significance of the environmental event is realized, and not that one has made a judgment about a previous occurrence. Experimental psychologists have not considered recognition in terms of significance (cf. Mandler, 1980), and thus invoking recognition as an explanation falls short of a satisfactory explication of prospective memory. In sum, prominent models of memory do not necessarily illuminate the mechanisms by which prospective memory retrieval is accomplished, and thus our objective is to provide initial perspectives and evidence toward this end.

Theorists have developed some ideas about the processes involved in prospective memory retrieval (Burgess & Shallice, 1997; Einstein & McDaniel, 1996; Guynn, 2001, 2003; Guynn, Mc-
Daniel, & Einstein, 2001; Mantyla, 1996; Marsh & Hicks, 1998; McDaniel, 1995; McDaniel, Robinson-Riegler, & Einstein, 1998; Smith, 2003). For the most part, however, these ideas have been recruited to provide theoretical elaboration of the empirical findings (e.g., McDaniel et al., 1998). There is as yet little research that has developed and provided direct tests of theoretical processes that might subserve prospective memory retrieval. In the current article, we develop several theoretical views and then report a series of experiments that evaluate these views. For the present purposes, we limit our scope to event-based prospective memory tasks (Einstein & McDaniel, 1990) in which the intended action must be remembered when some external target event occurs in the environment.

Cue-Focused Processes

One general view is that retrieval involves noticing the target event as a cue for an intended action, which in turn prompts retrieval of the particular intended action (e.g., Einstein & McDaniel, 1996; Ellis, 1996; Mantyla, 1996; Marsh & Hicks, 1998; McDaniel, 1995). One possibility for how the target event gets noticed when one is not in a retrieval mode (Tulving, 1983) is that individuals monitor the environment for the target event (e.g., Burgess & Shallice, 1997; Guynn, 2001, 2003; Smith, 2003). A specific mechanism proposed to support monitoring is the supervisory attentional system (SAS; Shallice & Burgess, 1991). Briefly, the SAS monitors for a marker that signals the appropriateness of executing the intended action and, on detecting the marker, switches attention to the intended action. On this view, the realization of the intended action (cf. Ellis, 1996) is an attentional process supported by executive attentional systems and not a memory process per se.

Rational and empirical considerations suggest that monitoring may be relied on in some cases, such as when the prospective memory task is important (Kliegel, Martin, McDaniel, & Einstein, 2001, in press) or when there are many markers (Smith, 2003). For many prospective memory tasks, however, individuals may not expend the resources that presumably are required to sustain the ongoing activities and to support the processes required for monitoring. Thus, at least some of the time, if not most of the time, processes other than monitoring may be involved in prospective memory retrieval.

Accordingly, McDaniel and Einstein (Einstein & McDaniel, 1996; McDaniel, 1995) suggested that noticing the target event as a cue might involve processes similar to those involved in the experience of familiarity, which has been assumed to support recognition in everyday contexts when the individual is not attempting to recognize an event in a specified context (i.e., not trying to recognize whether particular items occurred in a word list presented in an experiment; Jacoby & Dallas, 1981; Mandler, 1980). In this article, we borrow from Whittlesea and Williams’s (2001a, 2001b) discrepancy-attribution hypothesis of familiarity to specify how the target event gets noticed. In this formulation, individuals chronically evaluate the coherence and quality of their processing, with such evaluations sometimes producing discrepancies in the expected and actual dynamics of processing. Whittlesea and Williams (2001a) suggested that in a recognition context, individuals attribute that discrepancy to the familiarity of the item, which becomes the basis for a positive (and sometimes false) recognition response.

Paralleling Whittlesea and Williams (2001a, 2001b), we suggest that one basis for noticing the target event is a discrepancy between the expected and actual quality of processing for the target event in that context. This discrepancy may elicit a sense of significance (cf. Jacoby & Dallas, 1981; Mandler, 1980) for the target event, which then may stimulate allocation of attention (Whittlesea & Williams, 2001a) to determine what the target event might signify. The significance of the target event is determined on retrieval of the prospective component (cf. Einstein & McDaniel, 1990; Uttl & Graf, 2000). Retrieval could entail recovering either the general notion that something needs to be done (e.g., “I need to stop at that grocery store”) or the complete remembering of the particular intended action (e.g., “I need to buy bread”). We prefer the term significance to McDaniel and Einstein’s (Einstein & McDaniel, 1996; McDaniel, 1995) term familiarity for several reasons. In many everyday cases, the target event will be familiar and encountered in familiar circumstances, and therefore familiarity is not likely to cause special noticing. Moreover, from a discrepancy-attribution perspective, discrepancy between the expected and actual quality of processing in a prospective memory context is not even likely to produce an attribution of familiarity.

Reflexive-Associative Processes

On the basis of the observation that event-based prospective memory bears striking similarity to cued recall (McDaniel & Einstein, 1993) and inspired by a memory model that posits an automatic-associative memory subsystem (Moscovitch, 1994), we recently proposed an alternative to the cue-focused views (Guynn et al., 2001; McDaniel et al., 1998; see also Cohen & O’Reilly, 1996, for a similar idea). Borrowing directly from Moscovitch (1994), we assumed that an “automatic-associative” memory system accepts externally encountered cues that are consciously attended and that the cues interact with memory traces previously associated with the cues. If a cue produces enough interaction with a memory trace, then the system delivers to awareness the information associated with the cue. Critical for purposes of prospective memory, this information is retrieved rapidly, obligatorily, and with few cognitive resources. This mechanism could thus mediate prospective memory retrieval if the target event interacts sufficiently with the representation of the intended action so that the intended action is delivered to awareness. Note that in contrast to the cue-focused views, the target event is not necessarily recognized as a cue—there is no necessary prior identification of the target event’s significance that then prompts memory search. The target event simply stimulates (or fails to stimulate) a reflexive-associative process that brings the intended action to awareness.

Three lines of evidence provide preliminary support for this model. First, Guynn, McDaniel, and Einstein (1998) reported that reminders that required participants to focus on the association between the target event and intended action produced better prospective memory than did reminders that required participants

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1In experimental demonstrations, the attribution of discrepancy has been related to the intent (evaluation) of the ongoing task. Theoretically, however, attributions need not be linked to the ongoing task but can be related to other concerns. For instance, Whittlesea and Williams (2001a) observed that in the clerk-on-the-bus example (Mandler, 1980), fluent processing of a known but not currently recognized individual could be attributed to attractiveness.
to focus on the target event alone. Second, in a small pilot study, Guynn et al. (2001) reported that target events paired with associated intended actions (based on preexperimental experience) produced better prospective memory than did the identical target events paired with unassociated intended actions. Third, there are conditions under which older adults perform as well as younger adults in event-based prospective memory (Cherry & LeCompte, 1999; Einstein et al., 1992; Einstein & McDaniel, 1990; Einstein, McDaniel, Richardson, Guynn, & Cunfer, 1995), which is consistent with a reflexive-associative process that requires few cognitive resources.

### Multiprocess Framework

A more complex multiprocess view (cf. McDaniel & Einstein, 2000) is that either cue-focused discrepancy attribution processes or reflexive-associative processes may play a role in prospective memory retrieval. The idea is that if the target event is sufficiently associated with the intended action, then reflexive and obligatory retrieval of the intended action should occur. In contrast, when the target event is not as well associated with the intended action, then discrepancy-plus-search processes (and perhaps other cue-focused processes) should predominate. We emphasize that a particular context or a particular target–action relation probably does not constrain prospective memory retrieval to be always accomplished by a particular process, but that with appropriate experimental conditions, one process may be more frequently manifested than another. Across these conditions, particular experimental manipulations would be expected to produce different effects as a function of the retrieval process assumed to be more prominent. Experiments 2 and 3 implemented this approach to inform the above models of prospective memory retrieval. To provide a foundation for these experiments, in Experiment 1 we focused on supplying evidence for the discrepancy-plus-search view.

### Experiment 1

Participants were kept busily engaged in an ongoing activity of rating the properties of the referents of a list of words. For the prospective memory task, participants were instructed that if they ever saw either one of two target words during the word-rating task, then they should press the 1 key on the keyboard. To reduce the discrepancy in the processing of the nontarget words in the word-rating task relative to the target words, in one condition we included the nontarget words in a word-list learning task administered at the outset of the experiment. These nontargets, having been studied in the experimental context (as had the prospective memory targets during the initial instructions), should stimulate a quality and coherence of processing that would be similar to that stimulated by the targets (cf. Whittlesea & Williams, 2001a). In another condition, the word-list learning task included none of the word-rating task nontargets. In this situation, the fluent, familiar processing of targets (because the targets were presented during the initial instructions) presumably would be discrepant with the standard of processing established by the nontargets, none of which was previously presented.

The discrepancy-plus-search view makes the novel prediction that prospective memory should be impaired in the first group (preexposure of nontargets) relative to the second group (no pre-exposure of nontargets). Note that the targets, the prospective memory response, the cover activity, and the nontargets in the cover activity are identical in the two groups. Thus, on the basis of work that has focused on variations in prospective memory as a function of properties of the targets (Brandimonte & Passolunghi, 1994; Einstein & McDaniel, 1990; McDaniel & Einstein, 1993; McDaniel et al., 1998), the demands of the ongoing activity (Einstein, Smith, McDaniel, & Shaw, 1997; Marsh, Hancock, & Hicks, 2002; Marsh & Hicks, 1998; McDaniel et al., 1998), and the emphasis on the prospective memory task (Kliegel et al., 2001, in press), no difference in prospective memory would be expected.

Another cue-focused view, the monitoring view (e.g., the Guynn, 2001, 2003, and Smith, 2003, frameworks rely at least in part on attentional monitoring), suggests that attentional resources are deployed throughout the cover activity to determine whether a particular marker (i.e., the target word) is present. As currently formulated, the monitoring view would not predict an effect of nontarget preexposure on prospective memory. One might argue that prior exposure of nontargets facilitates pattern recognition, thereby freeing attentional resources for monitoring (cf. Smith, 2003) and enhancing detection of the marker as a prospective memory cue. On this formulation, prospective memory should be better when the nontargets have been preexposed.

### Method

#### Design and participants. The design was a single-factor design with prior exposure of the nontargets (preexposed, nonexposed) as the between-subjects factor. The participants were 48 undergraduates enrolled in psychology courses at the University of New Mexico who participated either in partial fulfillment of a course requirement or for extra credit. There were 24 participants in each between-subjects condition.

#### Materials. The prospective memory target words were counterbalanced, such that half of the participants in each condition were given spaghetti and thread, and half were given eraser and needle. Participants were instructed to press the 1 key whenever they saw either target word.

The remaining 150 words were selected from the Paivio, Yuille, and Madigan (1968) corpus. The words were divided into three 50-word sets. Across participants, each of two sets was presented equally often as preexposed and nonexposed nontargets. The third 50-word set was used in the recognition task as lures (words that were not seen in the study list or again in any condition).

The stimuli for the word-rating cover task (50 nontargets, which were either preexposed or nonexposed, and 2 prospective memory targets presented once each) were presented on the computer screen with a rating scale ranging from 1 (not at all) to 5 (very) and a dimension on which to rate the word (concreteness, meaningfulness, pleasantness, or familiarity). The participants wrote their responses on numbered answer sheets (three sheets with 22 lines on each of the first two pages and 8 lines on the third page). The target events appeared as the 20th and 44th items in the word-rating task, so one line per page corresponded to a target event (with none on the last page). The stimuli for recognition study and test were presented on the computer screen, and participants wrote their answers on numbered answer sheets.

#### Procedure. The experiment lasted approximately 1 hr. Participants were told that they would rate words for different characteristics, but first they would study a list of words for a recognition test. For the study phase, 50 words were presented one at a time for 5 s each in the center of the computer screen. Participants saw either the nontarget words that would later appear in the word-rating task or 50 words that would not appear later. For the test phase, the 50 studied words and 50 lures, randomly intermixed, were presented one at a time in the center of the computer screen. Participants decided whether each word had been studied, wrote down
either y or n (yes or no) on the answer sheet, and pressed the space bar to go to the next word.

After the recognition test, participants were told that they would rate words for different characteristics and were given instructions and practice on the word-rating cover task. For this task, a word to be rated, one of four possible dimensions on which to rate the word (concreteness, meaningfulness, pleasantness, or familiarity), and a rating scale ranging from 1 (not at all) to 5 (very) appeared together on the computer screen for 7 s (on this scale, 3 indicated neutral). Participants wrote the first letter of the rating dimension (C, M, P, F) and their rating (1, 2, 3, 4, 5) on the answer sheet. Participants practiced this task for four trials (one trial for each dimension), with a different word on each trial.

After the practice trials, the prospective memory instructions were presented on the computer: If participants ever saw a target word in the word-rating task, then they should press the 1 key on the keyboard. After participants indicated that they understood the instructions, they were asked to repeat the instructions, and those who failed to do so accurately were asked to read and repeat the instructions again.

After the prospective memory instructions, as a distracter task participants were given 3 practice trials and 15 test trials of an operation span working memory task (Turner & Engle, 1989). After this task, participants were reminded of the instructions for the word-rating task and informed that they would perform this task next. They were not reminded of the prospective memory task. Following the 52 word-rating task trials, participants were given a retrospective memory test for the prospective memory target events and intended action. All participants were able to recall the target events and intended action.

Results and Discussion

For all analyses, the alpha level was set at .05. The magnitude of the significant and marginally significant effects is indicated by eta squared. A prospective memory response was considered correct if the participant pressed the 1 key on the keyboard. If the participant pressed the 1 key on the keyboard, participants were reminded of the instructions for the word-rating task and informed that they would perform this task next. They were not reminded of the prospective memory task. Following the 52 word-rating task trials, participants were given a retrospective memory test for the prospective memory target events and intended action. All participants were able to recall the target events and intended action.

We assumed that in the low-associative condition, the target word (e.g., spaghetti–needle) would not be sufficiently associated with the response word (e.g., thread–needle) to ordinarily prompt reflexive retrieval of the intended action. If the intended action were not reflexively retrieved, then successful prospective memory would reflect other cue-focused processes. Conversely, in the high-associative condition, the rapid and reflexive processes assumed to operate (cf. Moscovitch, 1994) might preempt cue-focused processes such as discrepancy attribution and search for the intended action. On the basis of these assumptions, we expected that if the reflexive-associative view has merit, then reflexively and automatic processes would be more evident in the high-associative condition, whereas in the low-associative condition, cue-focused processes would be more evident. To test these expectations, we incorporated the following manipulations.

To test the idea of reflexive, associative retrieval, we varied the attentional demands of the ongoing activity. In some conditions, the attentional demands were increased by adding a digit-monitoring task to the word-rating task (following Einstein et al.,

Experiment 2

We made several changes to the procedure of Experiment 1. Instead of pressing the 1 key, participants were instructed to write a particular response word if they ever saw a target word during the word-rating task (cf. Mantyla, 1991). This allowed manipulation of the associative relation between the target word and the response word. In the high-associative condition, the target word was associatively related to the response word (e.g., thread–needle, spaghetti–sauce). In the low-associative condition, the target words were re-paired with the response words such that there was no obvious associative relation (e.g., thread–sauce, spaghetti–needle). To avoid creating confusion, we presented no low-associative participant with re-pairings such that switching the responses would form high-associative pairings.

If reflexive-associative processes are involved in prospective memory, then such processes should be more prominent in the high-associative condition than in the low-associative condition. We assumed that in the low-associative condition, the target word (e.g., spaghetti) would not be sufficiently associated with the response word (e.g., needle) to ordinarily prompt reflexive retrieval of the intended action. If the intended action were not reflexively retrieved, then successful prospective memory would reflect other, cue-focused processes. Conversely, in the high-associative condition, the rapid and reflexive processes assumed to operate (cf. Moscovitch, 1994) might preempt cue-focused processes such as discrepancy attribution and search for the intended action. On the basis of these assumptions, we expected that if the reflexive-associative view has merit, then reflexively and automatic processes would be more evident in the high-associative condition, whereas in the low-associative condition, cue-focused processes would be more evident. To test these expectations, we incorporated the following manipulations.

To test the idea of reflexive, associative retrieval, we varied the attentional demands of the ongoing activity. In some conditions, the attentional demands were increased by adding a digit-monitoring task to the word-rating task (following Einstein et al.,

2 The associative manipulation does not strictly overlap with the model’s assumption that the prospective memory target event and the intended action can be directly associated. That is, in the high-association condition the word (sauce) associated with the target event (spaghetti) is not exactly the intended action (write sauce). We suggest that the high-association condition likely facilitates the close association of the intended action to the target event by its focus on the high associate (sauce).
A defining feature of the reflexive-associative view is that retrieval of the intended action requires few or no attentional resources (cf. Moscovitch, 1994; note though that the target event must be processed so that it is encoded into the cognitive system). Thus, this model makes the counterintuitive prediction that increased attentional demands should not impair prospective memory (cf. Einstein et al., 1997), at least when the target and action have a strong association.

As in Experiment 1, we manipulated nontarget preexposure, and to gain generality, we preexposed the nontargets after rather than before the prospective memory instructions (as in Experiment 1). On the basis of the reasoning developed above, the multiprocess view anticipates that the low-associative but not the high-associative condition should be impaired by increased attentional demands (cf. Einstein et al., 1997; Marsh & Hicks, 1998; McDaniel et al., 1998, Experiment 3) and by nontarget preexposure. Within the discrepancy-plus-search view, increased attentional demands could disrupt prospective memory by interfering with discrepancy analysis (the evaluation of either the quality of processing or the relation between the actual and expected quality of processing) or by precluding allocation of attention to items for which discrepancy is perceived (see Whittlesea & Williams, 2001a), thereby attenuating noticing of the target event (Marsh & Hicks, 1998). Divided attention could also interfere with the retrieval of the intended action after the target event is noticed (Einstein & McDaniel, 1996). Alternatively, if prospective memory is based entirely on cue-focused processes (Ellis, 1996; Marsh, Hancock, & Hicks, 2002; Marsh & Hicks, 1998; Smith, 2003), including the discrepancy-attribution processes implicated in Experiment 1, then both increased attentional demands and nontarget preexposure should impair both the high- and low-association conditions.

One final issue merits comment. Because attentional demands were varied within-subjects, we increased the total number of prospective memory trials for each participant to four to allow two trials per experimental condition. However, practice effects can occur across trials (see Maylor, 1998), which may alter the dynamics of the processes involved in the later prospective memory trials and possibly mask noteworthy effects. Our interest in processes that would be prominent in the first trial or two reflects many real-world prospective memory situations in which the target for a particular action needs to be responded to only once (e.g., giving a message to a colleague). Accordingly, our analyses included a focus on the first two prospective memory trials for every participant.

Method

Design. The design was a $2 \times 2 \times 2$ mixed factorial, with the association between the target and action words (high, low) and the preexposure of the nontarget words in the cover task (preexposed, nonexposed) varied between subjects, and the amount of attention available during the cover task (full, divided) varied within subjects. The order of the full versus divided attention conditions was counterbalanced across participants in each between-subjects condition (i.e., the participants received alternating 56-s periods of full vs. divided attention, half starting with full attention, and half starting with divided attention).

Participants. The participants were 63 undergraduates enrolled in psychology courses at the University of New Mexico who participated either in partial fulfillment of a course requirement or for extra credit. There were 16 participants in each between-subjects condition, except for the low-association group with nonexposed nontargets (15 participants).

Materials. The high-association target-action pairs were eraser–pencil, steeple–church, spaghetti–sauce, and thread–needle. Half of the participants in the high-association condition received eraser–pencil and steeple–church, and half received spaghetti–sauce and thread–needle. Each intended action word was the most frequent free associate to its target word in the University of South Florida word association norms (Nelson, McEvoy, & Schreiber, 1998). The low-association pairs were created by re-pairing the high-association pairs to create pairs without any preexisting association. Half of the participants in the low-association condition received eraser–needle and steeple–sauce, and half received spaghetti–church and thread–pencil.

Two hundred words were selected from the Paivio et al. (1968) corpus to serve as nontargets in the word-rating cover task. These 200 nontargets were divided into two 100-word sets. In the preexposed condition, one set was presented for recognition study and test and as nontargets in the word-rating cover task. In the nonexposed condition, one set was presented for recognition study and test and another set was presented as nontargets in the word-rating cover tasks. Across participants, each set served equally often as preexposed and nonexposed nontargets.

The stimuli for the word-rating cover task (two prospective memory targets presented twice each in the context of 100 preexposed or 100 nonexposed nontargets) were presented on the computer screen, with a rating scale ranging from 1 (not at all) to 5 (very) and a dimension on which to rate the word (concreteness, meaningfulness, pleasantness, or familiarity). Participants were asked to write the first letter of the rating dimension (C, M, P, F) and the rating (1, 2, 3, 4, 5) on numbered answer sheets (four pages with 26 lines per page). The target events appeared as the 20th, 44th, 76th, and 100th items in the word-rating cover task, and thus one line per page corresponded to a target event. The stimuli for recognition study and test were presented on the computer screen, and participants wrote their responses on numbered answer sheets.

Procedure. The experiment lasted approximately 1 hr. Participants were first given instructions, examples, and 56 s of practice on the digit-monitoring divided attention task. Digits were presented via an audio tape every 2 s for periods of 56 s, and participants pressed a button on a hand counter each time two odd digits occurred consecutively. The 56-s periods of digit presentation (divided attention condition) alternated with 56-s periods of no-digit presentation (full attention condition).

Participants were next given instructions, examples, and practice on the word-rating cover task. Then the prospective memory instructions were presented on the computer: If participants ever saw a target word in the word-rating task, then they should write down the intended action word on the answer sheet, and pressed the Enter key to go to the next word. After recognition study and test, participants were reminded of the instructions for the digit-monitoring task and the word-rating task and informed that they would perform these tasks next. They were not reminded of the prospective memory task. During the 104 word-rating cover task trials, the two targets appeared twice each in the context of the 100 nontargets, once each during a 56-s period when digits were not presented and once each during a 56-s period when digits were presented. After the
word-rating cover task, participants were given a retrospective memory test for the prospective memory target words and the intended action words.  

Results  
We first conducted a $2 \times 2 \times 2$ mixed ANOVA with data from all four prospective memory trials. Because we were interested in prospective memory processes in a single prospective memory task (rather than in a repeated prospective memory task; cf. Einstein, McDaniel, Smith, & Shaw, 1998), and because such effects were evident using two trials in Experiment 1, we also conducted a parallel $2 \times 2 \times 2$ mixed ANOVA on the first two prospective memory trials. The means for both analyses are displayed in Table 1.  

Considering all four trials, high association produced better prospective memory than did low association ($M = .88, SD = .17$; and $M = .74, SD = .31$, respectively), $F(1, 59) = 4.35$, $MSE = 0.12$, $\eta^2 = .07$. Consistent with a cue-focused approach, the attentional demands of the ongoing activity affected prospective memory, $F(1, 59) = 4.64$, $MSE = 0.06$, $\eta^2 = .07$, with demanding ongoing activity producing worse prospective memory than standard ongoing activity ($M = .76, SD = .35$ and $M = .86, SD = .28$, respectively). The interactions between association condition and attentional demands, $F(1, 59) = 2.11$, $MSE = 0.06$, and between association condition and nontarget preexposure, $F(1, 59) = 1.93$, $MSE = 0.12$, were not significant. Still, examination of Table 1 reveals that the negative effect of divided attention was generally limited to the low-association condition ($M = .82, SD = .30$ and $M = .66, SD = .42$, for standard and divided attention, respectively), $F(1, 59) = 6.40$, $MSE = 0.06$, $\eta^2 = .10$. In the high-association condition, there was little difference as a function of attentional demands ($M = .90, SD = .25$ for standard and $M = .86, SD = .23$, for divided attention; $F < 1$). And in the high-association condition, prospective memory was nominally better with preexposed nontargets ($M = .91, SD = .15$) than with nonexposed nontargets ($M = .84, SD = .18$), whereas in the low-association condition prospective memory was nominally worse with preexposed nontargets ($M = .68, SD = .27$) than with nonexposed nontargets ($M = .80, SD = .36$).  

The ANOVA for the first two trials also showed that prospective memory was better in the high-association than in the low-association condition, $F(1, 59) = 6.29$, $MSE = 0.19$, $\eta^2 = .10$. Most important, the effects of nontarget preexposure in the low-association condition were more clearly revealed. Association condition and nontarget preexposure significantly interacted, $F(1, 59) = 7.41$, $MSE = 0.19$, $\eta^2 = .11$, such that in the low-association condition, preexposure of nontargets ($M = .56, SD = .36$) reduced prospective memory relative to nonexposure ($M = .77, SD = .37$), whereas in the high-association condition the reverse occurred ($M = .97, SD = .12$ and $M = .75, SD = .32$, respectively). There were no other significant effects.  

Discussion  
In line with the multiprocess model, prospective memory in the low-association condition was consistent with the discrepancy-plus-search view, and performance in the high-association condition showed evidence of more reflexive-associative retrieval. In the low-association condition, prospective memory was impaired under high attentional demands (for the ANOVA with all trials) and when the nontargets were preexposed (especially in the ANOVA for the first two trials). Note that when the analysis was limited to the first two trials, the impairment in prospective memory under high attentional demands was identical to that when all trials were considered. However, the effect was not significant, because with only one observation per participant in each attentional condition, the error rate increased substantially (cf. $MSE = 0.14$ for one observation per participant with $MSE = 0.06$ for two observations per participant for the attentional effect).  

By contrast, prospective memory in the high-association condition appeared to be mediated by a reflexive-associative process. Prospective memory showed little negative impact of high attentional demands and no negative impact of preexposed nontargets. Yet, several patterns for the high-association condition are not as compelling with regard to this theoretical perspective. First, examination of Table 1 shows that high attentional demands seemed to impair prospective memory in the high-association condition with nonexposed nontargets. This nominal pattern contradicts the reflexive-associative view. Second, when only the first two trials were considered, nonexposed nontargets resulted in worse prospective memory than did preexposed nontargets. These patterns are puzzling, but were they to replicate, they would lend support to a possible variant of the monitoring view discussed earlier. Before further discussion, we report another experiment to determine whether these patterns are anomalous or represent significant and stable patterns. Experiment 3 therefore was conducted to replicate these manipulations in the high-association condition.  

Experiment 3  
This experiment focused on the influence of attentional demands and nontarget preexposure in the high-association condition. Extending Experiment 2, we also implemented a new procedure whereby participants could write down an X if they could not remember the intended action response word. If prospective mem-

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3 All but 2 participants correctly recalled the target words and intended action words. Removing these 2 participants from the analyses did not change the prospective memory patterns, other than to reduce the significance level of the association effect to just over .05 (rather than just under .05).
ory in this high-association condition is mediated on most trials by reflexive-associative retrieval of the intended action, then prospective memory should not be affected by the attentional demands of the ongoing activities or by preexposure of nontarget items. Further, participants should respond with an X on few or none of the trials.

Alternatively, if discrepancy-attribution processes mediate prospective memory on most trials even in the high-association condition, then nontarget preexposure should impair prospective memory. Also, sometimes participants might respond with an X on noticing the significance of the target event but failing to retrieve the intended action. On this view, X responses could become more prevalent under high attentional demand because fewer resources would be available to retrieve the exact response word (the assumption is that it is less demanding to remember an X than to retrieve the exact response word). Most critical, by many approaches to prospective memory, increased attentional demands should attenuate prospective memory (cf. Craik, 1986; Marsh & Hicks, 1998; Marsh, Hicks, & Watson, 2002; Maylor, 1996; Smith, 2003).

**Method**

**Design and participants.** The design was a 2 X 2 mixed factorial, with the attention available during the word-rating cover task (full, divided) varied within subjects, and the preexposure of the nontarget words in the word-rating cover task (preexposed, nonexposed) varied between subjects. The 32 participants were undergraduates enrolled in psychology courses at the University of New Mexico who participated for extra credit, with 16 assigned to each nontarget preexposure group. The order of the full versus divided attention periods during the cover task was counterbalanced within each group, as described in Experiment 2.

**Materials and procedure.** The target words and response words were the high-association pairs used in Experiment 2. The other stimuli were the same as in Experiment 2, and the preexposure manipulation for the nontarget words was implemented as in Experiment 2. The procedure was the same as described in Experiment 2, except that if participants could not remember the exact response word on presentation of the target word, then they should write down an X. On the retrospective memory test for the target words and response words, 4 participants recorded their responses in the incorrect blanks (i.e., the target word was recorded on the blank for the response word). However, because the pairings were correct, we assumed correct retrospective memory and did not replace these participants, all of whom performed correctly in the prospective memory task.

**Results**

We scored prospective memory to distinguish between responses with the designated response word and responses with an X. As expected, with the high-association target–action pairs there was only one X response (which yielded a proportion of .008 X responses in the experiment), and the only X response occurred in the full attention condition. Also, 1 participant did not completely write the intended action word on one trial. However, the first three letters were written, so the trial was scored as correct. Analyzing the data when the one X response was scored as incorrect produced an identical outcome, and accordingly, we report only the ANOVA for the data in which the X was scored as incorrect (Table 2 gives the means).

The 2 (nontarget preexposure) X 2 (attentional demands) mixed ANOVA confirmed that divided attention (M = .86, SD = .26) did not attenuate prospective memory (M = .86, SD = .26, for full attention; F < 1). Nontarget preexposure also did not affect prospective memory (F < 1). Further, there was no interaction between attentional demands and nontarget preexposure (F < 1). As in Experiment 2, we also examined performance on the first two trials, which also showed little variation in prospective memory as a function of divided attention and nontarget preexposure. An ANOVA confirmed there were no significant effects (all Fs < 1).

**Discussion**

The previous experiments support the idea that at least two processes play a role in prospective memory retrieval, with one process being more prominent for the low-association condition and another process being more prominent for the high-association condition. In the low-association condition (Experiments 1 and 2), a discrepancy-based process was implicated by the reduction in prospective memory with preexposed nontargets. Moreover, the significant negative effect of high attentional demands (Experiment 2) is consistent with the idea that the directed search stimulated by discrepancy, or the noticing/evaluation of discrepancy, or both, are controlled processes that are subject to disruption by divided attention (cf. Jacoby, 1991; Whittlesea & Williams, 2001a).

By contrast, the slight and nonsignificant modulation of prospective memory by attentional demands and nontarget preexposure in the high-association condition in this experiment (also in Experiment 2) supports the interpretation that participants in the high-association condition relied more on reflexive-associative retrieval. In line with this idea, prospective memory in the high-association condition in Experiment 3 was uniformly characterized by retrieval of the intended action (i.e., virtually no X responses).

**General Discussion**

As detailed in the discussions for the individual experiments, neither cue-focused approaches nor a reflexive-associative approach completely captures the patterns of performance. Instead, the results implicate multiple retrieval processes in prospective memory (McDaniel & Einstein, 2000) that include both cue-focused and reflexive-associative processes. Each class of processes appeared to emerge most prominently under particular conditions. Most telling were the different patterns for the high-association and the low-association conditions. For each condition, the patterns within and across experiments converged on an assumed theoretical process but diverged from the patterns of the other condition.

### Table 2

<table>
<thead>
<tr>
<th>Mean Proportion of Prospective Memory Responses in Experiment 3</th>
<th>Attentional demand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nontarget condition</td>
</tr>
<tr>
<td>Preexposed</td>
<td>.84 (.81)</td>
</tr>
<tr>
<td>Nonexposed</td>
<td>.88 (.88)</td>
</tr>
<tr>
<td>M</td>
<td>.86 (.84)</td>
</tr>
</tbody>
</table>

*Note.* Means in parentheses represent performance on the first two trials.
Reflexive-Associative Processes

Consider first the results when the target event and intended action were associated. Several results supported the idea that retrieval of the intended action was reflexive and was not highly dependent on cue-focused processes. First, prospective memory was uniformly characterized by retrieval of the intended action. On only 8% of the trials (1 participant on one trial) did participants remember they had to perform a prospective memory task but not remember the intended action (i.e., respond with an X in Experiment 3). In contrast, in unpublished data for the low-association pairs participants did not remember the intended action and responded with an X on 13.5% of the trials. Second, in Experiments 2 and 3 prospective memory was quite good under high attentional demands (86% in the divided attention condition averaged across the two experiments) and not attenuated relative to performance under standard attentional demands (87%). Third, preexposure of nontargets did not systematically impair prospective memory. Finally, one might expect that a reflexive, associative retrieval process would support better prospective memory than would a condition in which such a process was less likely. This expectation was borne out in Experiment 2.

It should be noted that we view prospective memory under these conditions as relatively automatic, because although retrieval is automatic, other components of prospective memory may be sensitive to the availability of limited attentional resources. Successful performance of an intended action requires processing the target event to the informational level identified as pertinent for the performance of an intended action (Marsh, Hicks, & Hancock, 2000; Maylor, 1998). However, the results did not change when these participants were divided by a secondary task, prospective memory was significantly impaired under divided attention (for the low-association condition, Experiment 2) is consistent with the view that monitoring is involved in noticing the prospective memory target event when cue-focused processes are operative. However, the negative effect of nontarget preexposure is not consistent with a straightforward monitoring view (Guynn, 2001, 2003; Smith, 2003), in which presumably the target event representation is maintained in the cognitive system to trigger the intended action when an environmental event matches that representation (cf. Kimberg & Farah, 1993). If anything, maintenance of this representation might be more likely when the processing of the nontargets is more fluent, as should be the case for preexposed nontargets (Scarborough, Cortese, & Scarborough, 1977). It remains possible, though, that an alternative formulation of the monitoring view might account for the current effect of nontarget preexposure.

As just mentioned, when attention to the target event was divided by a secondary task, prospective memory was significantly impaired for the low-association condition (Experiment 2). From the perspective of the reflexive-associative view, this impairment could suggest that the target event was not sufficiently processed to stimulate associative retrieval. However, the ongoing activity required the words to be processed to a semantic level, which theoretically is sufficient to activate reflexive-associative retrieval (Moscovitch, 1994). Consistent with this claim, divided attention did not produce impairment for the high-association condition. Therefore, the implication is that for the low-association condition, a cue-focused process such as discrepancy-plus-search was involved and was compromised by the increased attentional demands.

In closing, this research has illuminated the processes by which prospective memory retrieval is accomplished by the cognitive system in the absence of an external request to remember. Specifically, the findings suggest that both reflexive-associative pro-

4 In some cases, a reflexive-associative retrieval process might support retrieval of a more general intention (“I have to do something”) if the initial encoding included this general intention. In the present context, however, the instructions focused on the specific intended action (e.g., write sauce). Thus, most likely the memory representation consisted of the target event (spaghetti) and the specific intended action, instead of or in addition to a more general encoding (“I’ve got to do something when spaghetti appears”). It is also important to note that unlike a retrospective memory task in which an explicit request to remember likely alerts participants to a failure of associative retrieval (such that participants have a general feeling of knowing the specific encoding but being unable to report it), in prospective memory, the reflexive-associative mechanism either retrieves an associated intended action or nothing is delivered to awareness (cf. Moscovitch, 1994). These considerations converge on the interpretation that retrieval of the general intention to perform a prospective memory task instead of the precise intended action reflects a cue-focused process (at least in the present paradigm).
cesses and discrepancy-based noticing processes are exploited and that the prominence of these processes can be affected by features of the prospective memory task (such as high vs. low cue-action association) and by features of the context in which the prospective memory cue is embedded. Several general points are also noteworthy. First, one theoretical implication is that cognitive processes involved in prospective memory do not implicate a prospective memory system or process per se but are processes that support a variety of cognitive functions including prospective memory. Second, prospective memory need not reflect a high degree of self-agency, an assumption that has been attractive to theorists (e.g., Craik, 1986; Slallice & Burgess, 1991). More generally, the processes proposed herein are consistent with recent suggestions to avoid excessive reliance on homunculus-like constructs in cognitive theory (Kintsch, Healy, Hegarty, Pennington, & Salthouse, 1999). Third, we believe that the multiprocess framework—in particular that prospective memory may be supported by both discrepancy-attribution and reflexive-associative processes—is attractive from a rational, adaptive perspective. Similar to arguments that working memory must invoke multiple faculties because it is central to cognition (Cowan, 1999), we suggest that because prospective memory is intimately linked to the future orientation and planning that is central to human survival, the cognitive system relies on a number of memory and attentional mechanisms to support prospective memory (McDaniel & Einstein, 2000). Under carefully designed conditions, it may be possible to tease apart these mechanisms, as was done in the current project. Ordinarily, however, discrepancy-attribution processes (as well as other possible cue-focused mechanisms) and automatic-associative processes probably operate in concert, albeit somewhat independently, such that either process may support prospective memory at any given time. Relying on a single process might prove too fragile to support such an important memory activity.

References


