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Metacognitive awareness of event-based prospective memory ☆

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Abstract

This study examined people's ability to predict and postdict their performance on an event-based prospective memory task. Using nonfocal cues, one group of participants predicted their success at finding animal words and a different group predicted their ability to find words with a particular syllable in it. The authors also administered a self-report questionnaire on everyday prospective and retrospective memory failures. Based on the different strategies adopted by the two groups and correlations among the dependent variables, the authors concluded that people do have a basic awareness of their prospective memory abilities, but that this awareness is far from accurate. The importance of metamemory concerning one's prospective memory is discussed in terms of how it influences the strategies that people might choose for actually completing their various everyday intentions.
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In the course of everyday life, people often form intentions to perform an activity at a later date or time. Presumably, they do so because the current conditions are not amenable to completing the activity at the moment thereby necessitating intention formation. Thus, the same system used to record activities and occurrences that have been experienced in the past also subserves the ability to remember to fulfill intentions at some future point in time (Einstein & McDaniel, 1990). In the past decade or so, researchers interested in how people fulfill their intentions have labeled forward looking memories as *prospective* and experiences recorded about the past as *retrospective* (e.g., Kliegel, McDaniel, & Einstein, in press). In this sense, prospective and retrospective memories are both declarative representations that can be cued by external objects and people; or they can be cued internally through normal thought processes. For example, seeing a particular watch on a dresser skirt may cue one to think of the person who gave it to us as a gift (a retrospective memory) or cue one to think about the intention to replace its dead battery (a prospective memory). Whereas the field has been studying various aspects of retrospective memory for over a century, relatively little research has

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examined the conditions that subserve recalling prospective memories. When framed in the manner as we have done here, many of the principles of retrospective memory translate nicely to being true of prospective memory as well (see Marsh, Cook, & Hicks, 2006).

In the current study, we examined people's knowledge about their own prospective memory performance. Doing so may be an important endeavor because at the time people form an intention they must decide concomitantly just how much environmental support they are going to need to actually accomplish the task. For example, if one decides to purchase an item on the way home from work, perhaps the drive by the store will be sufficient to cue the intention for some people. Others may write themselves a note and stick it to the dashboard thereby increasing the probability of intention completion. The decision to use a daily planner or PDA is a strong comment on one's ability to negotiate daily affairs and engagements. In fact, Marsh, Hicks, and Landau (1998) reported that people who use such devices do so because they are compensating for worse memory and attention capabilities as measured by standard laboratory assessments (see also Marsh & Hicks, 1998). The fact that people use compensatory strategies of all kinds (e.g., writing notes on one's hand) may indicate that people have a calibrated metaknowledge about their own prospective memory. We have known for many years that people's feelings and beliefs about their own memory correlate positively with actual memory performance (e.g., Dixon, 1989). More specifically, memory self-efficacy is a particular dimension of metamemory that investigates one's feelings and affect about one's own memory ability (e.g., Hultsch, Hertzog, Dixon, & Davidson, 1988). We believe that such feelings are often the impetus for using one strategy vs. another to fulfill different kinds of intentions (e.g., McDonald-Miszczak, Gould, & Tychyinski, 1999).

Whereas predictive accuracy has been studied extensively in retrospective memory paradigms (e.g., feelings of knowing, Koriat, 1995; Koriat & Levy-Sadot, 2001), the parallel inquiry is virtually absent in the prospective memory literature. One study did ask younger vs. older adults to predict or postdict their ability to make eight phone calls over a 4-week period (Devolder, Brigham, & Pressley, 1990). Of course, the older adults were better at remembering to do so (Henry, Macleod, Phillips, & Crawford, 2004). However, the younger adults significantly overpredicted how successful they would be whereas the older adults did not. Both groups were equally successful at postdicting their performance at the end of the 4-week period.[1] Based on those findings, perhaps younger adults are basing their predicted prospective memory performance on their retrospective memory ability. In the study reported here, we asked participants to predict their ability to remember to perform a simple prospective memory task. Many participants would spontaneously preface their prediction to the experimenter with something like "I have a bad memory so..." or "My memory is good and I never write things down so..." which indicated to us that they may be using their general retrospective metamemory to predict their prospective memory performance. Of course, the two forms of memory may be correlated in which case such a strategy might be adaptive. However, there is no agreement as to whether retrospective memory and prospective memory are actually correlated in laboratory studies. Cherry and LeCompte (1999) argued that a correlation existed whereas Kidder et al. (1997) argued that it did not. In both of those studies the correlation was in neighborhood of .2 suggesting shared variance only in the 4% range. So, from that perspective, using one's retrospective metamemory to predict prospective memory might be maladaptive (for other evidence against a correlation see Einstein & McDaniel, 1990; McDaniel & Einstein, 1992).

Given the importance that metamemory about one's own prospective memory can play in strategy choices for trying to remember to fulfill intentions, we decided to investigate how accurate people were at predicting their own event-based prospective memory performance. In event-based tasks, an environmental cue reminds people to fulfill an intention. More generally, participants become engrossed in an ongoing task such as naming famous faces, reading a story, making various word judgments, etc. (e.g., Einstein et al., 2005; Ellis, Kvavilashvili, & Milne, 1999; Maylor, 1996, 1998; McDaniel, Guynn, Einstein, & Breneiser, 2004). Prior to beginning this activity, they are given an intention to respond in a special way to classes of items (e.g., faces with beards, instances of the category *fruit*) or specific sets of items (Abraham Lincoln's face or the word

[1] We are not aware of any other studies that examined both predictions and postdictions of performance. Kidder, Park, Hertzog, and Morrell (1997) did examine postdictions of younger and older adults performance and both age groups felt that they had responded to fewer cues than they actually did. By contrast, Knight, Harnett, and Titov (2005) examined predictions on a cue by cue basis and found that a group with traumatic brain injury overpredicted their event-based performance whereas control group slightly underpredicted their success.

apple). Although a variety of dependent variables are possible, often times the proportion of cues detected is used, and recently, the average latency to perform the ongoing task is often relevant to various theoretical questions being addressed.

In the current study, we preceded the ongoing activity (here a lexical decision task) with a question asking participants what percentage of the event-based cues they expected to find. We also asked at the conclusion of the ongoing task what percentage they felt that they had found (i.e., a postdiction of performance). The basic idea was simply to assess people's accuracy at predicting how good they will be in performing a prospective memory task. For the sake of completeness, we also administered the Prospective and Retrospective Memory Questionnaire (PRMQ; Smith, Della Sala, Logie, & Maylor, 2000) which yields two self-report scores about the frequency of both prospective and retrospective memory errors in everyday life (for normative data see Crawford, Smith, Maylor, Della Sala, & Logie, 2003). The design of the present study was essentially correlational in nature; but to place prospective memory performance in two different ranges of the response scale, we also administered different event-based intentions to different participants. One group was given an intention to respond to words denoting animals and the other was asked to find words containing the syllable *tor* such as in *dormitory* (Einstein et al., 2005). Both of these intentions use nonfocal cues because the cognitive demands of the ongoing task do not focus attention on the relevant features of the prospective memory cue (Einstein & McDaniel, 2005). However, based on Einstein et al.'s (2005) report, we expected worse prospective memory performance with the syllable intention as compared with the animal intention.

1. Methods

1.1. Participants

Undergraduate students from the University of Georgia volunteered in exchange for partial credit toward a research appreciation requirement. Each participant was tested individually in sessions that lasted approximately 30 min. One hundred participants were randomly assigned to the two between-subjects conditions, but through an assignment error we ended up testing 51 with an animal intention and 49 with a syllable intention.

1.2. Materials and procedure

The lexical decision ongoing task was identical to the procedure that we have used successfully on several different occasions (e.g., Hicks, Marsh, & Cook, 2005; Marsh, Hicks, Cook, Hansen, & Pallos, 2003). There were 210 trials, half of which contained a letter string denoting a valid English word, and the other half contained a pronounceable nonword created by substituting one or two letters in a valid word (e.g., *sree*). The 210 separate words were chosen from the Kučera and Francis (1967) norms. All of these stimuli were randomly assigned to a trial position within the experimental sequence for each participant tested. After this randomization, the software randomly took eight prospective memory cues and assigned them to trials 25, 50, 75, etc. through trial 200. The eight animal words were chosen from the Battig and Montague (1969) norms, and the syllable intention stimuli were chosen from the MRC database (Coltheart, 1981). Every effort was made to roughly equate the two different sets of cues on word frequency and imagability, but the syllable intention cues had a slightly greater syllabic length. Because we know of no published work that cites these variables as important to prospective memory processes, we deemed that these efforts would be adequate. Recall that the purpose here was just to observe event-based performance in two different ranges of performance.

Participants read instructions for the experiment from the computer monitor. Upon completion, the experimenter cleared the screen and verbally reiterated these in her own words. We asked people to respond (using the F and J keys) according to whether or not the letter string on a trial was a valid English word. They were further told that we were interested in their ability to remember to perform an activity in the future. They were asked to press the /-key after their ongoing task response if they found an animal (or syllable *tor* in a word). The software was written such that each trial began with a *waiting* message which the participants cleared with a space bar response to initiate a trial. Once initiated, a short warning tone and fixation point appeared for 250 ms, and these were replaced by the letter string that remained on the screen until a judgment was made.

Following the verbal instructions, the experimenter advanced the software which then asked participants to enter a number between 0 and 100 that represented what percentage of the cues they expected to find. After entering their prediction, they worked on a distractor task (three-digit multiplication problems) for 4 min so that the intention was not fully active when the lexical decision task was administered. After the 210th trial of the lexical decision task, a message appeared asking participants to estimate what percentage of cues they felt that they had detected. Finally, at the conclusion of the experiment, the experimenter started a new piece of software which administered a computerized version of the PRMQ to assess the frequency of everyday errors of prospective and retrospective memory.[2]

2. Results and discussion

Unless otherwise indicated with a p value, the probability of a Type I error does not exceed 5%. Any latency greater than 2.5 standard deviations from a participant's grand mean was trimmed. In keeping with our past practice, we did not count the eight late prospective responses as correct; and their addition would not change the reported outcomes in any appreciable way. Table 1 summarizes prospective and ongoing task performance. Event-based performance is reported as the average proportion of cues (out of eight) that were successfully detected. As expected from Einstein et al.'s (2005) results, event-based prospective memory was better when people were given the animal intention as compared with the syllable intention, $t(98) = 2.69$. Obviously, people given the syllable intention realized that it was going to be a difficult intention to fulfill because their average response latency to words in the ongoing activity was about 80 ms slower, $t(98) = 3.32$. Thus, despite compensating for the difficulty of the intention, people who held the syllable intention still detected fewer of those cues.

We analyzed the average predictions and the average postdictions in a 2 (intention: animal vs. syllable) $\times$ 2 (judgment: prediction vs. postdiction) mixed-model Analysis of Variance (ANOVA) with the first factor tested between-subjects and the second factor being tested within-subjects. The interaction was statistically significant, $F(1, 98) = 11.09$ (see Table 1). Both groups of participants predicted that they would only detect about 50% of the cues, thereby exhibiting underconfidence in their prospective memory abilities, $t(98) = 1.04$ ns. Note that this outcome does not replicate Devolder et al.'s (1990) finding with a naturalistic nonlaboratory prospective memory task but it does agree with Knight et al.'s (2005) laboratory-based findings. The underconfidence persisted to the postdictions, and participants in the syllable condition postdicted exactly what they predicted. By contrast, participants in the animal intention condition postdicted that they found more cues than did participants in the syllable condition, $t(98) = 3.70$. The reason for this difference is probably a combination of the very high prospective memory performance in the animal intention condition and the fact that the animals themselves may be more memorable as a category of items than words sharing the syllable *tor*. Thus, when making their postdictions people can remember the many animals they encountered more quickly and more easily and this raises their postdictions over those in the syllable condition.

Table 1
Prospective memory performance (as proportions), ongoing task latency (in MS), and metacognitive judgments (as percentages)

Condition	Prospective memory	Ongoing task latency	Prediction	Postdiction
Animal intention	.89	744	54	70
Syllable intention	.69	820	50	52

[2] There are two obvious infelicities to the present design that deserve the reader's attention. First, asking people to predict their prospective memory performance may elevate the importance of the prospective memory component of the experiment and thereby indicate our true interest in this task. Consequently, this facet of the design is unfortunate but we did not see any way around it. For this reason, we tested the two separate intentions to observe performance in two ranges of the response scale. Second, administering the PRMQ last was not optimal because participant's performance during the experiment may in some way influence their responses. However, had we administered it before, then any disguise would be destroyed that we had only a secondary interest in their prospective memory performance.

Table 2 contains the Pearson product-moment correlations among the variables collected in this study. There were three consistent correlations that were found when the correlations were calculated without regard to assigned condition or when each condition was considered separately. The first is that postdictions were highly positively correlated with prospective memory performance. That relationship makes sense insofar as people are using their memory for the number of times they responded to postdict how successful they were. Devolder et al. (1990) found the same effect as did Kidder et al. (1997) with younger adults. The second relationship is that predictions positively correlated with postdictions; and this relationship makes sense too because a given individual who is either underconfident or overconfident in his or her prospective memory performance will carry that same level of confidence through to the postdictions. Third and finally, the number of self-report retrospective memory errors was correlated with the number of self-report prospective memory errors on the PRMQ. So, people who tend to make retrospective memory errors also have trouble with prospective memory as well. The remaining correlations that will be discussed were all significant in the overall sample, but exhibited some nonsignificance when each intention condition was analyzed separately (probably due to the sample sizes tested). The reader should note that when one of these correlations is not significant for a particular intention condition, it is in the same direction and significant for the other intention condition.

One tantalizing relationship was that predictions correlated positively with overall prospective memory success. This outcome was statistically significant in the animal intention condition but not in the syllable condition. These results suggest that people do have metacognitive access to how good their prospective memory will be, at least with some intentions. The absence of a correlation in the syllable condition may be owing to the fact that people performed much better than their expectations and given how much more slowly they went through the ongoing task. In other words, perhaps their predictions did not incorporate the fact that they ended up using a compensatory strategy to be successful at finding words containing that syllable. Although the relationship is statistically marginal, overall latency in the ongoing task was correlated with cue detection in the syllable condition only. That marginal outcome is consistent with the fact that participants used a compensatory strategy (i.e., slowing) and they were justified in doing so because it aided in cue detection.

Table 2
Lower triangular correlation matrices for the dependent measures pooling over both conditions and for each condition separately

	Prospective	Prediction	Postdiction	Latency	PRMQ-P
Without regard to assigned condition					
Prediction	.23†				
Postdiction	.63‡	.53‡			
Latency	.02	−.03	−.03		
PRMQ-P	−.13	−.26‡	−.24†	.03	
PRMQ-R	−.16	−.32‡	−.32‡	−.02	.62‡
Animal intention condition only					
Prediction	.29†				
Postdiction	.70‡	.53‡			
Latency	−.08	−.01	.05		
PRMQ-P	−.14	−.33†	−.17	.20	
PRMQ-R	−.09	−.19	−.20	−.15	.53‡
Syllable intention condition only					
Prediction	.15				
Postdiction	.50‡	.54‡			
Latency	.25*	−.01	.13		
PRMQ-P	−.17	−.22	−.36†	−.05	
PRMQ-R	−.19	−.41‡	−.42‡	.02	.70‡

Note. Prospective, event-based prospective memory performance; Prediction, predicted success; Postdiction, estimate of the number of cues detected; Latency, average latency to words in the ongoing task; PRMQ-P, prospective memory subscale of the PRMQ; PRMQ-R, retrospective subscale of the PRMQ.

* $.10 > p > .05$.

‡ $p < .01$.

† $p < .05$.

In the overall sample, the number of everyday retrospective and prospective memory errors was negatively correlated with the predicted and postdicted success for prospective memory on the laboratory task. Of the four correlations expressing this relationship, three were statistically significant in the syllable condition and the remaining one was significant in the animal intention condition. Thus, what one knows about one's everyday errors may constitute information that is used in predicting and postdicting one's performance on a laboratory test of prospective memory. Those results combined with the positive relationship between predictions and actual prospective memory (in the animal condition) together suggest that people do have metacognitive awareness of their prospective memory abilities.

3. Further discussion and conclusions

The vast majority of the work to date on prospective memory has examined the characteristics of event-based tasks. The goal of this study was merely to assess whether people have access to information about how well they can perform a prospective memory task. In general, the answer to this question seems to be affirmative. People know how many everyday retrospective and prospective memory failures they have, they use this information when predicting and postdicting their performance, and with the animal intention anyway their predictions tend support how many cues they actually end up detecting. However, except for the intercorrelations between predictions and postdictions, none of these correlations is outstandingly large. So, from that perspective people may have some access to how they will perform on a prospective memory task, but they are from perfect in their assessments. In fact, most of our participants were very underconfident in their ability to perform the laboratory-based task, when in fact, their performance on the whole was much better than we expected from our prior studies. This underconfidence may stem from the fact that we often become aware of things that we forget to do. For example, over the years Einstein and McDaniel (1996) have asked many students the question "What was the last thing you remember forgetting?" Well over half of the people will respond with an intention thereby indicating that unfulfilled prospective memories loom large in retrospective memory.

Although people do have metacognitive access to both how well they will remember an intention (i.e., predictions) and how well they did detect cues (i.e., postdictions), their metacognitive abilities are not veridical. In each case in Table 1, predicted and postdicted performance is about 20% too low. As mentioned in the previous paragraph, people are probably more aware of their memory failures than their memorial successes. Being underconfident about fulfilling prospective memories is probably an adaptive quality insofar as it keeps unfulfilled intentions periodically refreshed. By contrast, the cost associated with retrieving the fact that an intention has been accomplished is very small as compared with not completing the intention at all. Thus, underconfidence in prospective memory may actually be positively correlated with ultimate success at completing intentions.

Like other facets of cognition, how much metamemorial awareness a given person has about his or her memory is likely to be an individual difference. People with a good awareness of their own prospective memory skills probably can choose the appropriate strategies for remembering their intentions whereas a person with low awareness may choose strategies that lead to intentions going unfulfilled more often. Of course, awareness is only one variable that affects what strategies people choose. The importance of the intention and what consequences for forgetting that can befall the individual are also likely to affect how people deal with remembering an intention. For example, printing an examination at home the night before it is to be given and leaving it on one's cluttered desk with 200 other sheets of paper is a very bad strategy for remembering to take it to school the following morning. However, because the consequences would be grave to arrive at the class without the examination, taping one's car keys to it will at least ensure that the examination makes it to the parking lot at school the following day. And if the consequences are very grave, as in the present example, people may develop backup strategies for ensuring the intention gets fulfilled such as taping one's keys to the exam and also sending a copy via electronic mail to one's secretary with a carbon copy to oneself. Our point is that our metamemory concerning our own prospective memory abilities can dramatically affect the ways in which we plan to fulfill various intentions.

From a theoretical standpoint a debate exists about how much preparatory attention needs to be devoted to our environment in order to detect event-based cues (e.g., Einstein et al., 2005; Smith & Bayen, 2004). In our

own work on this issue, we have preferred to argue that people decide to allocate a certain amount of attention to an entire task set (i.e., the constellation of performing the ongoing activity and the prospective memory task together). Variables such as stimulus independent thoughts, distractions, and interruptions can affect that attentional allocation policy. Above and beyond such changes in the overall allocation of attention, more local tradeoffs in attention between the ongoing task and the prospective memory task also take place. For example, the ongoing task can become locally easier or more difficult to perform thereby leaving varying amounts of attention to detect cues related to an intention (see Hicks et al., 2005; Marsh, Hicks, & Cook, 2005). Both sorts of tradeoffs probably occur, but we would argue that metacognitive awareness of one's own prospective memory abilities is most likely to affect the more global attentional allocation policy that one sets at the outset of the task set. For this reason, we believe that the participants assigned to the syllable intention proceeded much more slowly through the ongoing activity. They would not have done so if they had not realized it was a difficult cue to detect and that their prospective memory was not perfect. Having said this, a very important intention might protect the allocation of attention to prospective memory processes from the more local tradeoffs that occur naturally during an ongoing task. This issue has yet to be empirically tested.

We close by considering one final point that may be consequential to everyday prospective memory. In this laboratory-based assessment of prospective memory, the predictions and the postdictions were very highly positively correlated. As we mentioned earlier, this correlation could be driven by underconfident individuals remaining underconfident and overconfident individuals remaining overconfident. That same correlation could also be driven by the fact that metamemorial awareness of poor prospective memory is met with objective evidence of output monitoring failures (e.g., Einstein, McDaniel, Smith, & Shaw, 1998). Output monitoring failures occur when we believe that we have completed an intention, but we have not; and they also occur when we believe that a task has gone uncompleted, but we have already finished it. Such failures occur with mailing bills, taking vitamins, shampooing one's hair, feeding pets, and so forth. Often the environment will leave traces of both types of errors. For example, unpaid bills are met with late fees, already full pet dishes do not empty themselves, etc. Our point is that people who report poor prospective memory are reporting poor output monitoring. With everyday intentions a closer monitoring of the environment and performing a "double check" of the environment may be one way to improve everyday prospective memory instead of assuming that a task has or has not gone unfulfilled.

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