

Comparing Older and Younger Adults in an Event-Based Prospective Memory Paradigm Containing an Output Monitoring Component

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ABSTRACT

Two experiments with younger and older adults were conducted to investigate the output-monitoring component of event-based prospective memory. In the standard form of the task, participants must remember to press a key when a certain class of items is encountered. To evaluate output monitoring, event-based cues were repeated and participants were asked to press a different key if they could remember that an earlier response was made to a particular cue. Younger adults forgot fewer of their successful responses, but displayed a distinct bias to claim that they had responded earlier when actually they had forgotten to respond. By contrast, older adults displayed this bias much less frequently. Elaborated responding to cues had the effect of improving the performance of younger, but not older adults. The results are discussed in terms of natural repetitions and omission errors that might be made in everyday prospective memory tasks.

Loosely defined, prospective memory tasks are ones in which people establish the intention to perform some action in the future. Such intentions include planning to watch a special television program, promising to take a child to an athletic event, remembering to keep a dentist appointment, planning to write a book or research article, brushing one's teeth, telephoning a friend, and so forth. As this very short list makes clear, there are a variety of different prospective memory tasks. Consequently, the intentions that are subsumed under the umbrella term prospective memory have been divided

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into a variety of classification schemes concerning the tasks themselves, as well as the factors that are likely to affect their successful completion (for one excellent review see Ellis (1996)). Of these different types, event-based prospective memory is the topic of present concern (e.g., Einstein & McDaniel, 1990; McDaniel et al., 2004). In an event-based prospective memory task, an intention to perform some action is established in memory, and later, some aspect of the environment eventually triggers remembering to fulfill the intention. For example, hanging dry cleaning on the back door knob is usually an effective cue to remember that a trip to the dry cleaner was planned for that morning.

Whether event-based prospective memory is preserved with normal aging has been debated. In standard laboratory studies of event-based memory, participants process a series of stimuli, some of which are to be responded to in a manner different from the primary, ongoing task. For example, Einstein and McDaniel (1990) have used a short-term memory task (among others) in which triplets of words are to be recalled across discrete trials in the experimental sequence. Participants can be asked to press a key when specific items appear or when instances of categories appear (e.g., animals). As originally reported, little or no age-related declines on event-based prospective memory tasks were found (Einstein & McDaniel, 1990; Einstein et al. 1992; Einstein et al., 1995). Appealing to Craik's (1986) thesis that age-related declines should be found with tasks that are particularly demanding of self-initiated resources, one might conclude from these reports that event-based tasks do not require very much self-initiated memory retrieval for their successful completion (but see Henry et al., 2004). On the other hand, Maylor (1993, 1996, 1998) developed an alternative event-based task in which the primary, ongoing activity was identifying famous faces (i.e., naming them). The prospective task required remembering to circle the trial number on the response sheet if the face being identified possessed a particular feature (e.g., glasses, pipe, beard, etc.). In this form of the task, large and unambiguous age-related declines in event-based memory were found. Rightfully, Maylor (1998) has pointed out that her version of an event-based task requires task switching from the semantic cognitive process of face identification to some nonsemantic featural analysis of the stimuli (see also Marsh et al., 2000). By contrast, the event-based tasks used by Einstein, McDaniel, and their colleagues may be entirely semantic in nature such that the prospective memory and retrospective memory processes overlap highly. That overlap ostensibly provides greater support for older adults in this dual-task situation. Recently, McDaniel and Einstein (2000) have provided a task analysis and theory called the multiprocess view that specifies the conditions that may predict when age-related differences will and will not be found (also see McDaniel et al., 2004).

Against this backdrop, we wanted to examine whether age-related differences exist in people's memories about their previous event-based

prospective memory performance. To do so, we used a task that incorporated an output-monitoring component into an event-based task, which to our knowledge, has only been used in one study of a younger adult population (Marsh et al., 2002) and in another study of a schizophrenic population (Elvevag et al., 2003). In this paradigm, participants rate each word in a long list of words for how pleasant the underlying concept is. They are asked to remember to press a particular key before making the pleasantness rating whenever a word referring to an animal is encountered (e.g., the prospective cue *monkey*). The procedural twist from previous event-based studies was to repeat several of the animal words later in the rating task and ask participants to press a different key if they could remember making a prospective response earlier to that word (Marsh et al., 2002). In this fashion, one response key indicated a first successful encounter (called the *first* key) and the other key indicated having a memory of making an earlier response to that particular cue (called the *repeat* key). The task is slightly more complicated than standard event-based tasks, but the procedure is easy to explain and participants clearly understand what is being requested of them.

Theoretically, the paradigm was an adaptation of past work that was designed to examine output monitoring (e.g., Gardiner & Klee, 1976; Gardiner et al., 1977; Klee & Gardiner, 1976). That older work measured people's memory for what they had either free recalled or recognized previously. Our paradigm borrows heavily from this previous work because using a variant of this methodology allowed us to measure participant's memory for their earlier prospective memory performance. The primary difference between our approach and that used previously is that we do not ask directly for yes-no judgments about whether an item was recalled or recognized. Rather, participants must first identify the item as a prospective memory cue (independent of whether it was presented earlier), and given that prospective memory is successful, they must then use output monitoring to decide on whether to issue a first or repeat key response. To our knowledge only two articles have appeared that assessed age differences in output monitoring. Koriat et al. (1988) demonstrated that older adults have greater repetitions in free recall than in younger adults; and similarly, when asked directly older adults more often forget that they successfully recalled items before. Thus, that work suggests a basis for repetition errors in older adults based on retrospective forgetting. By contrast, in a prospective memory paradigm, Einstein et al. (1998) had older and younger adults repeatedly perform an action. The older adults more often erroneously reported that they had performed the action when they had not. But under divided attention, the older adults more often needlessly issued a repetition of already completed response. Aside from these studies on output monitoring and aging, more generally, older adults have worse memory for performing actions than do younger adults (for a review see Kausler (1994)), although this age difference may largely

be driven by very old age (Cregger & Rogers, 1998). Combined with the fact that older adults have more illusory memories (e.g., Dehon & Bredart, 2004; Gallo & Roediger, 2003), this output-monitoring component to prospective memory could detrimentally impact older adults more than younger adults.

In our paradigm, when a repeated item received the correct response upon its first encounter, the correct response upon its second encounter would be to press the repeat key. If the first key is pressed again a second time, then the degree to which participants forgot that they had responded previously can be measured. The incidence of this sort of error measures how frequently people forget that they had performed an activity. Therefore, it may be a viable index of their propensity to commit a repetition error in real-world prospective memory tasks. For example, this sort of error might indicate just how often a person might successfully remember to take medication, forget the particular instance in which it was successfully completed, and readminister another dose (thereby overmedicating oneself). By contrast, when an item is missed the first time, the correct response would be to press the first key when the repeated cue is encountered because no response was made to that item when it occurred originally. When the repeat key is pressed in this situation, we can infer that the participant remembers encountering the cue but has falsely recalled making a response the first time.¹ The incidence of this sort of misbelief may also be an indicator of real-world performance as well. This error would be analogous to having an intention to perform some activity and believing that it has already been fulfilled when it has not. Obviously, the consequences of a such a misbelief are likely to be an omission error, and using the previous example, could lead to undermedicating oneself.

In our previous work using this paradigm with younger adults we found some forgetting of previous, successful responses (15–20%) when the prospective cues were encountered a second time. By contrast, when cues were missed, younger adults erroneously believed that they had responded to them previously about 40–60% of the time depending on the tasks and conditions tested. Thus, we found some forgetting of accurate responding, but more surprisingly, a tremendously robust misbelief that they had faithfully performed a task successfully when they did not. The current experiments were conducted to assess whether age-related performance differences existed in people's memory for their past prospective memory performance. Because of age-related declines in retrospective memory (e.g., Craik, 1986;

¹ The instruction is stressed that the repeat key should only be used when they can remember pressing the first key to that specific item earlier in the task sequence. Because participants are asked to repeat this instruction back, it is not the case that they are confused about the task requirements, and therefore, this paradigm does measure true beliefs and misbeliefs about past performance (see Marsh et al., 2002, for more detailed treatment of this issue).

Light, 1991), we anticipated that older adults would not remember their earlier successful performance as often as their younger counterparts. The consequence would be that they would press the first key when they should have pressed the repeat key. However, if older adults have worse retrospective memory for the occurrence of words (and their responses), they may be less willing to claim they had responded successfully to an item that was missed earlier. In other words, the performance of older adults may be better than younger adults for cues that were originally missed the first time because older adults are unwilling to make the same claims asserted by younger adults that they had responded earlier when in fact they did not (cf. Smith, 1996). In a second experiment, the prospective response was made more memorable in order to determine if this would improve performance for either older or younger adults.

EXPERIMENT 1

The purpose of this experiment was to determine whether memory concerning past prospective memory performance differed in younger versus older adults. In our earlier work with younger adults, we concluded that there was some small forgetting of successful past performance (i.e., remembering that a key had been pressed), but we found an incredibly large propensity to remember (erroneously) that one had responded previously to a particular cue when no response had been issued. We predicted that older adults would have worse retrospective memory for their previous, correct responses (i.e., worse memory of successful past performance). We also predicted that this same retrospective memory deficit would manifest itself as an unwillingness to claim they had responded when they had not for cues that had been missed. In other words, declining retrospective memory has the potential to reduce an incredibly robust bias that is found in younger adults. Consequently, the memory deficit manifest in older adults could actually result in better performance for that group under these particular conditions. This experiment also allowed us to compare event-based prospective memory in younger versus older adults using different materials and procedures than were used in other laboratories, as well as provide the opportunity to replicate the results we found previously in younger adults.

Method

Participants

Thirty-five undergraduates ranging in age from 18–23 years old ($M = 19.2$, $SEM = 0.2$) volunteered in exchange for partial credit toward a course research requirement. Thirty-five community-dwelling older adults ranging in age from 60–74 years old ($M = 67.2$, $SEM = 3.6$) were compensated

with \$20 for their trip to the laboratory. Each participant was tested individually in sessions that lasted approximately 40 min. Demographic information was obtained concerning race, education, self-report of health and medication, and past or present medical conditions. In addition, the Shipley Vocabulary test (40 items total) and the digit-symbol substitution test were administered to both groups of participants. Racial composition was equivalent in both populations. The older adults had significantly more years of education (4.52) than did the younger adults (4.09) on a five-point check-off scale with four being some college and five being a college degree, $t(68) = 6.98$. Self-report of rated health was identical in both groups, $t(68) < 1.0$, $p > .20$, with both groups claiming “very good” health on average (younger: 4.16, older: 3.92). Thus, any differences in performance on the prospective memory task that favor younger adults are unlikely to be a consequence of health or educational background of the two groups of participants (see Cherry & LeCompte, 1999). On the Shipley Institute of Daily Living Vocabulary test (Shipley, 1986), the older adults scored higher ($M = 35.6$, $SEM = 2.8$) than did the younger adults ($M = 29.7$, $SEM = 2.9$), $t(68) = 8.45$. But, as expected, the older group did not perform as well on the digit-symbol substitution task ($M = 49.4$, $SEM = 9.3$) as the younger adults ($M = 60.5$, $SEM = 9.3$), $t(68) = 4.90$. Therefore, the ability data are comparable to those typically observed in age-comparative studies (e.g., Botwinick, 1977).

Materials

Three-hundred medium frequency words were taken from the Kučera and Francis (1967) normative compendium. These were randomized anew by the software for each participant tested and they constituted the words to be rated for pleasantness as the primary ongoing task. Twelve animal words were used as the stimuli for the prospective memory trials. For any given participant, eight words were randomly selected from this pool of 12 and were inserted every 25 trials on trials numbered, 22, 47, 72, 97, 122, and so forth through trial 297. Thus, there were 12 prospective memory trials in all. Four of these were repeated (for a total of eight trials) and four were not. Using a short-hand notation to denote repetitions and single occurrences of prospective cues, the animals were inserted on the prospective trials as follows: 1, 2, 3, 4, 1, 2, 5, 6, 7, 8, 3, 4. Thus, the first four cues (1–4) were repeated later in the sequence interspersed with new animals that were not repeated. Obviously, cues 1 and 2 were retested at a lag of 100 trials and cues 3 and 4 were retested at a lag of 200 trials. In our original study, we had hypothesized that performance might be a function of lag, but it was not (Marsh et al., 2002). We analyzed for it here, as well, and it was not significant; consequently, we do not make further mention of it. Obviously, the animal word replaced whatever word had been originally assigned to the

prospective trials, yielding 288 nonprospective trials in which 12 prospective trials were embedded.

Procedure

All participants initially received instructions on a computer monitor which the experimenter then verbally reiterated. The experiment was explained as a normative study in which participants would be rating stimuli for their pleasantness. Participants were asked to rate each word on a five-point scale with anchors at 1 (unpleasant) and 5 (very pleasant). They were encouraged to use the entire range of the response scale. The experimenter then explained that the numeric keys across the top, left-hand side of the keyboard should be used for this purpose and that the numeric keypad could not be used. The experimenter went on to explain that we were also interested in their ability to remember to perform an action in the future. When an animal was encountered during the pleasantness rating task, they were asked to press the “/” key before making their pleasantness rating. However, if they could remember making a response earlier to that same cue word, they were asked to press the “=” key to indicate that they had already responded earlier to that same word.

The instructions were explained twice in a slightly different manner each time, and the experimenter asked that these directions be repeated back. In this fashion, the experiment did not proceed until the experimenter was confident that participants knew what was expected of them. There was no appreciable delay between the instructions and the commencement of the rating task because the first prospective trial was 22 trials into the task, and the first repetition response did not occur until 122 trials into the sequence. The prospective response keys were chosen to be spatially distinct such that pleasantness ratings were entered on the left-hand side of the keyboard and the two prospective keys were both on the right-hand side, with both of these being distinctly located in terms of appearing at the bottom and top of the keyboard, respectively. As indicated earlier, we will refer to these as a *first* keypress or a *repeat* keypress. The demographic questionnaire, the Shipley, and the digit-symbol substitution were administered at the conclusion of the experimental session.

Before describing the results in detail, we address how prospective memory was scored in this experiment. Our instructions to participants indicated that they should respond to an animal by first making their prospective response and then entering their numeric pleasantness rating. In actual fact, the software recorded any key pressed. Therefore, if a participant accidentally pressed the first key out of habit and then pressed the repeat key, this would be recorded as having pressed the repeat key. However, if they made their pleasantness rating and then pressed the first or repeat key, this appeared as a prospective response on the subsequent trial. This occurred

only 2–3% of the time across tasks and conditions and the frequency did not covary with age group. Therefore, to place all responses on an equal footing, we did not score an inverted sequence of key presses as correct. Because this error was not very common, it does not matter to the overall results and interpretation whether we had accepted or rejected these trials as successful or unsuccessful prospective responses (and the latter was chosen). We also wish to dispense with any concern there was confusion about how to respond. There were no rogue responses where participants pressed a key to items that were not prospective memory cues except the late responses just addressed. There were three cases in this next experiment (i.e., keypresses) where an older adult responded to the initial appearance of a cue with a repeat key (this happened twice in the second experiment). Because these five people self-corrected their responding, these were treated as first key responses. Finally, in both experiments we asked participants at the end of the experiment when the “/” and “=” key responses should have been issued, and all participants were able to answer this question successfully.

Results and Discussion

Unless otherwise reported with an explicit probability value, all statistical tests are significant at the conventional level ($\alpha = .05$). We report performance on the nonrepeated cues first and then proceed to the data concerning performance for repeated cues. We do so first to assess whether we obtained any evidence for age-related differences in event-based prospective memory which are directly comparable to paradigms without an output monitoring component. For nonrepeated cues, the data have been analyzed in terms of the first four cues versus the second four. As specified by the shorthand notation in the method section, the first four cues would be the first occurrence of items 1, 2, 3, and 4. The second four cues would be the items 5, 6, 7, and 8 that were intermingled with the second occurrence of the repeated cues during the last 200 trials of the rating task. The data are summarized in the upper half of Table 1. As can be seen there, no overall age-related decline occurred with this particular instantiation of an event-based prospective memory task, $F(1, 68) < 1.0$, *ns*. Thus, these data appear to be consistent with Einstein et al.’s findings (1992, 1995) which under some conditions, no age-related decline will be observed on an event-based prospective memory task (cf. McDaniel et al., 2004). These results may have occurred because the ongoing task and the cues being detected were both semantic in nature (Marsh et al., 2000; Maylor, 1998). Of course, other studies have found age-related declines when the prospective and ongoing tasks overlapped (e.g., Einstein et al., 1997). However, that study had participants switching between different judgments on different trials which is known to place a higher cognitive load on participants and reduce event-based prospective memory performance (Marsh et al., 2002; also see Marsh & Hicks, 1998).

TABLE 1. Proportion of Trials on which a Prospective Response was Made for the Nonrepeated Cues in Experiments 1 and 2 with Standard Errors in Parentheses

	Population Tested	
	Younger	Older
Experiment 1		
First Half	.59 (.06)	.55 (.05)
Second Half	.66 (.06)	.69 (.05)
Average	.62 (.04)	.62 (.04)
Experiment 2		
First Half	.62 (.06)	.57 (.05)
Second Half	.64 (.05)	.53 (.05)
Average	.63 (.05)	.55 (.04)

However, both younger and older adults did show a practice effect in which performance was better on the second four cues than it was on the first four, $F(1, 68) = 4.26$. In our own work examining practice effects, we have found both a benefit in later responding as well as absolutely no effect at all across the task sequence (Marsh et al., 2002). Although practice effects occurred in this experiment to foreshadow, they did not occur in the next experiment. Perhaps there is some inconsistent benefit to repeatedly responding to cues in an event-based task, but we have never been able to isolate the critical variable(s) mediating why practice effects either do or do not occur. We acknowledge this issue is somewhat ancillary to the present concerns.

Before reporting performance on the repeated cues, we raise one issue concerning them. Not every younger or older adult necessarily contributed to every statistical analysis. Participants who miss all four occurrences of the first four trials obviously cannot contribute to conditionalized performance measures of having made a response in the first place. Likewise, if all four cues are responded to initially, no conditionalized score can be calculated for participants' memory for a missed cue. Therefore, the degrees of freedom are reduced slightly, which is why we collected large sample sizes in the first place. For the first set of conditionalized analyses, 4 younger and 5 older adults were excluded from the analyses, whereas in the second set, 9 younger and 5 older adults were excluded. Memory for one's past performance in this task is summarized in Table 2. In the upper half of the table, conditionalized performance on having originally made a correct response yields proportions that sum to unity for (a) correctly remembering that one pressed the first key before, by pressing the repeat key at the second occurrence, (b) forgetting that one responded earlier by pressing the first key a second time to the repetition, and (c) complete failures of prospective

TABLE 2. Proportion of Trials Sorted by the Response Made on the Repeated Cues Conditionalized on Original Performance in Experiment 1 (Standard Errors in Parentheses)

	Population Tested	
	Younger	Older
Made First Response		
Correct: pressed repeat	.77 (.06)	.54 (.08)
Incorrect: pressed first	.14 (.05)	.32 (.07)
Omit: no key press	.09 (.05)	.14 (.05)
Omitted First Response		
Correct: pressed first	.29 (.08)	.44 (.08)
Incorrect: pressed repeat	.46 (.08)	.22 (.06)
Omit: no key press	.25 (.07)	.34 (.07)

memory by omitting any response at all at the second occurrence. Because of the linear statistical dependence of responses a–c (i.e., summing to unity), we have analyzed responses (a) and (b) in a 2×2 model with the second factor being the variable of age. There was no overall effect of age, $F(1, 59) < 1.0$, *ns*, a significant effect of first versus repeat key use, $F(1, 59) = 22.35$, and a significant interaction between the two variables, $F(1, 59) = 4.60$.

As seen in Table 2, the statistical analyses support what is evident from the average proportion of responses. The lack of an overall age difference just meant that older and younger adults made about the same number of prospective responses to items they had identified earlier (i.e., no difference in the overt omissions to the repeated cues). Similarly, the majority of responses indicated that both younger and older adults do remember they had responded earlier as indicated by pressing the repeat key. The significant interaction emanates from the fact that older adults do simply forget more often that they had responded to a cue earlier and they press the first key a second time to these repeated cues. Thus, these data indicate that older adults may be more likely to forget that they had responded before and therefore be more likely to repeat an action in everyday tasks (cf. Koriat et al., 1988). The simple effects analyses demonstrated more correct repeat key presses in younger adults than in older adults, $t(59) = 2.14$, but the numerically greater incorrect first key presses made by older adults was only marginally significant by two-tailed test, $t(59) = 1.81$, $p = .07$. Recall that these results cannot be due to older adults pressing the first key out of habit and then changing their mind by pressing the repeat key because the software always recorded their final response.

When participants missed the first occurrence of a cue, they could correctly identify this by responding with the first key to the second occurrence, they could press the repeat key to indicate a false memory of having

responded earlier, or they could miss the cue again and make no prospective response at all.² The conditionalized data for repeated cues that were originally missed the first time are summarized in the bottom half of Table 2. These proportions also sum to unity. Analyzing the data in a similar fashion to the upper half of Table 2 yielded only a significant interaction between age and the particular key pressed, $F(1, 54) = 4.29$ (i.e., the two main effects were not statistically significant). As is evident from the pattern of mean proportions, the majority of younger adult's responses indicated that they actually believed they had responded earlier when in fact they did not (cf. Marsh et al., 2002). This outcome could only have occurred if the younger adults remembered encountering the cue before but forgot that they did not make a response earlier. In other words, they have a memory for having encountered the item, and also an erroneous memory that they had responded appropriately before. More than likely, the younger adults are inferring that if they had seen the cue they must have responded before (which they did not). By contrast, older adults have these erroneous memories much more infrequently than do the younger adults by simple effects analysis, $t(54) = 2.30$. Whether this occurs because they do not remember the item (i.e., worse retrospective memory) or because they are more cautious about the claims they are willing to make is not entirely clear from these data. However, the important result is that older adults significantly outperform the younger adults for the cues they missed before, by acting to press the first key much more often.

The current results are completely consistent with the greater repetition errors predicted to occur in older adults by Koriat et al.'s (1988) work. They are, however, slightly at variance with Einstein et al.'s (1998) report in which older adults more often claimed they had completed an activity that they did not. The difference is likely owing to procedural differences insofar as Einstein et al. asked participants to perform the identical activity 11 times. In that case, the action and whether it had been performed is likely to become decontextualized (Conway et al., 1997; Tulving, 1972). That is, concepts and actions that are repeatedly experienced will undergo a "remember" to "know" shift thereby indicating that use of memory is based more on familiarity rather than on recollection. Because familiarity processes are intact in older adults, they are likely to be basing their judgment on whether

² Of course, one infelicity to the current methodology is that when a first key is pressed in response to a repeated cue, we do not know if the item's earlier appearance was entirely forgotten or whether participants can identify their earlier failure to respond. Without additional keys to press that might confuse older adults we could devise no ideal method to avoid this interpretative issue. Therefore, the present results should be considered revealing insofar as they represent the first attempt to combine an output-monitoring component to a prospective memory paradigm with older adults, but other issues remain to be explored.

the action had been performed on familiarity which would account for the difference across studies.

Nevertheless, on the whole, the data from this experiment tell a consistent tale. Overall prospective memory performance for nonrepeated cues did not differ for younger versus older adults. That result actually worked very well in our favor because it meant that the amount of data being contributed to the conditionalized analyses for having made a response or having missed the first occurrence was equivalent across the younger and older populations. That result also demonstrates that under some circumstances, age-related declines in event-based prospective memory will not be observed (cf. McDaniel & Einstein, 2000). Moreover, had we not added the output monitoring component to our design, one might conclude that younger and older adults have identical prospective memory. However, as indicated by the output monitoring component of the task, younger and older adults differ in their retrospective memories about their past performance. Having made a response to a particular cue, younger adults generally remember their previous action, whereas older adults forget more often that they had correctly responded earlier. Although we believe that this represents an age-related decline in retrospective memory, in the present context, forgetting one made a prospective response earlier may lead to more repetition errors in such tasks as delivering messages or even taking medication in everyday life. (Later we will argue this result may represent more than a deficit in recollection.)

Having missed the cue the first time, younger adults believed that they did respond earlier (when they did not), which might lead this group to omit responses that would otherwise be appropriate to make. By contrast, the tendency in the older adults was to report that this was the first encounter and that they do not remember responding earlier, which of course, is true. Whether this occurs because older adults are more cautious or because they have no memory for the first missed occurrence is not captured by this paradigm. However, the greater propensity to forget successful responses suggests that at least part of the locus of this belief is an effect of forgetting. Therefore, one can conclude that younger adults generally report repetitions to repeated cues (whether erroneous or true) and older adults generally report first occurrences (whether erroneous or true). The net effect is that either the older or the younger group can be shown to have more accurate memories about their prospective performance depending on whether or not a successful response was made originally.

EXPERIMENT 2

The purpose of this second experiment was to make the prospective response slightly more complicated to improve memory for having successfully carried out the task. Older adults may be forgetting their earlier successful responses because

the prospective memory task is relatively simple (i.e., a single key press). In everyday life, fulfilling intentions is probably surrounded by much richer contexts in which the intended activity is embedded. For example, if one remembers to deliver a message to one's spouse after their return from running an errand, one might have a richer memory for the conversation surrounding fulfilling the intention. Our point is that older adults may have forgotten that they had pressed the key to a given cue in Experiment 1 because the response was largely devoid of any interaction with the environment. In Experiment 2, we replicated Experiment 1 in all of its essential details except one. In addition to pressing a key on the prospective trials, we asked participants to turn to the experimenter and say the cue word out loud. We hypothesized that making the response slightly more complicated would help both younger and older adults remember their previous, successful prospective response. However, because the younger adults do not forget their previous responses as often as the older adults, we thought that this manipulation would disproportionately increase the performance of older adults. In addition, we hypothesized that better memory for cues that were originally identified could be directly contrasted with those that had been missed, thereby increasing performance on the cues missed the first time.

Method

Participants

Thirty-five undergraduates ranging in age from 18–21 years old ($M = 18.8$, $SEM = 0.2$) who had not participated in Experiment 1 were recruited in the same manner as before. They were awarded course credit toward fulfilling a research requirement. Thirty-five community-dwelling older adults ranging in age from 60–73 years old ($M = 68.0$, $SEM = 0.7$) were compensated with an honorarium for their participation (\$20). Although there was no difference in racial composition of the two populations, the older adults had significantly more years of education (4.61) than the younger adults (4.11), $t(68) = 4.09$. As in Experiment 1, the younger adults rated their health as “very good” (4.23), but the older sample in this experiment rated their average health as somewhere in between “good” and “very good” (3.61), producing a difference in this demographic variable, $t(68) = 2.64$. However, both groups rated their health as comparable to others of their own age, $t(68) < 1.0$. As in Experiment 1, the older adults scored significantly higher on the Shipley vocabulary inventory ($M = 35.2$, $SEM = 3.5$) than did the younger adults ($M = 29.1$, $SEM = 2.7$), $t(68) = 8.07$, but performed worse than the younger group on the digit-symbol substitution test (older: $M = 41.6$, $SEM = 7.9$, younger: $M = 65.4$, $SEM = 11.4$), $t(68) = 9.96$.

Procedure

The procedure followed in this experiment was identical to Experiment 1. The only additional task entailed that prior to providing a pleasantness rating,

participants were asked to press the first or repeat key, turn toward the experimenter who was seated at a desk off to one side of the computer workstation, and speak the cue word aloud. They then continued with the tasks as they have been described.

Results and Discussion

There were no instances in which participants made a key press response and forgot to say the animal name aloud (or vice versa). Performance on the nonrepeated occurrences of items was analyzed for first and second halves of the experimental sequence in an identical manner reported for Experiment 1. As can be seen in the proportions summarized in the lower half of Table 1, neither main effect of age or first versus second half of the sequence was statistically significant, nor was the interaction between them, all three $F(1, 68)$'s < 1.51 , *ns*. In other words, in all respects the younger and older groups performed equivalently on this event-based prospective memory task. Unlike Experiment 1, there was no practice effect across the trial sequence. The important point is that although the older adults made nominally fewer prospective responses in this experiment, there was no statistical difference between the two populations. This null outcome is consistent with previous studies that have found no statistically significant age-related declines with some particular types of event-based prospective memory paradigms (Einstein et al., 1992, 1995). In addition, as with Experiment 1, had the output-monitoring component not been added, we would be concluding that younger and older adults have similar prospective memory performance.

For the first set of conditionalized analyses, 5 younger and 6 older adults were excluded from the analyses, whereas in the second set, 8 younger and 6 older adults were excluded. The conditionalized responses to repeated cues that were successfully responded to upon their first occurrence are summarized in the top half of Table 3 in an identical manner to Table 2. The 2 (younger vs. older) \times 2 (repeat vs. first keypress) analysis showed a main effect of age, $F(1, 60) = 6.19$, a main effect of key pressed, $F(1, 60) = 34.87$, and a significant interaction between the two variables, $F(1, 60) = 29.16$. As is evident from the data in Table 3, the more complex response helped younger adults to remember that they had successfully responded earlier, a finding conceptually replicating our earlier work using this paradigm (Marsh et al., 2002). The novel result as compared with Experiment 1 was that the older population did not benefit from this manipulation, and in fact, the manipulation appeared to have equated the proportion of correct responses (repeat key) to incorrect responses (first key) in the older adult sample (which was not true in Experiment 1). Therefore, the more complex and elaborated response had the effect of reducing performance in the older population. There are a number of ways to interpret this result, but it appears that increasing the memorability of making a prospective response has

TABLE 3. Proportion of Trials Sorted by the Response Made on the Repeated Cues Conditionalized on Original Performance in Experiment 2 (Standard Errors in Parentheses)

	Population Tested	
	Younger	Older
Made First Response		
Correct: pressed repeat	.90 (.03)	.43 (.07)
Incorrect: pressed first	.08 (.03)	.40 (.07)
Omit: no key press	.02 (.01)	.17 (.05)
Omitted First Response		
Correct: pressed first	.30 (.08)	.26 (.07)
Incorrect: pressed repeat	.44 (.09)	.35 (.08)
Omit: no key press	.26 (.08)	.39 (.08)

confused the older adults about their past performance. Theoretically, according to Hasher and Zacks's (1988) analysis, increasing the memorability of responding may have increased greater retrieval for specific cues such that older adults became confused about which cues they had responded to earlier and which they had not. This problem was perhaps exacerbated by the fact that all of the prospective memory cues were semantically related to one another, and therefore, highly confusable for older adults as to which items may have received a response and which did not. We will continue with this analysis shortly after reporting the data for the repeated cues that were missed upon their first appearance.

Performance by the younger adults on the items they had missed previously once again showed that the majority of their responses indicated that they believed erroneously that they had responded previously, when in fact, they had not (see the bottom half of Table 3). Therefore, our thesis was not borne out that a contrast effect between memories of more elaborated successful responses and more impoverished memories for items that had been missed would improve memories for the latter trials. For older adults, the statistical advantage of correctly responding with the first key to these items disappeared over what was observed in Experiment 1. In fact, there was no statistically significant main effect or interaction involving the younger versus older adults in this experiment, all three $F(1, 53)$'s < 1.41 , *ns*. Therefore, increasing the complexity and elaborating the prospective response helped younger adults and actually hurt the performance of older adults as compared to the results obtained in Experiment 1.

One way of conceptualizing this surprising finding is that older adults have a binding deficit that affects source monitoring as compared with younger adults (e.g., Henkel et al., 1998; Johnson et al., 1995; Spencer & Raz, 1995). The vocal and manual responses made in this experiment are

likely to have been recorded in memory for the older adults but they are not as tightly bound to individual cue items as they were for the younger adults. In other words, the older adults remember responding to certain animals with a vocal and manual keypress but they had trouble remembering to which particular animals those responses were made. With the entire set of cue items semantically related to one another, the overlap among items has appeared to produce extreme retrieval competition and increased their beliefs (relative to Experiment 1) that they had responded to missed cues when they actually had not. The important message to be taken from these data is that depending on tasks and conditions, the older adults in Experiment 1 performed worse to cues that they successfully processed and better to cues they had missed, whereas in this experiment a different pattern of results was obtained. In this experiment, the older adult's performance was worse for cues that they successfully identified earlier and it was no better for items that they had originally missed. We turn now to consider more generally what these beliefs about one's prospective memory performance might have to say about everyday activities in younger and older adults.

GENERAL DISCUSSION

Our motivation in conducting this study was to determine whether output monitoring in event-based prospective memory tasks varied with age. The simple answer to this query is that younger and older adults do have different memories about their past prospective memory performance. We assessed these differences by repeating items and asking participants to press a different key to indicate they remembered having already performed the action once before in the presence of a particular cue. We discovered that younger adults, in their favor, tended to remember their past successful actions. The negative aspect to their performance was that they also falsely remembered that they had responded to cues that did not evoke any prospective response during the first encounter. Together these two sets of beliefs would suggest that younger adults would tend not to repeat actions that have been performed, and likewise would be unlikely to fulfill intentions that had not been fulfilled yet. As a consequence, we would expect that younger adults might be surprised when environmental conditions demonstrate to them that an intention went unfulfilled. By contrast, older adults forget their past successful performances, but unlike the younger adults, they do not believe as often that an earlier encountered cue was processed appropriately. Thus, output monitoring of older adults might lead them to repeat fulfilled intentions that have already been performed.

Tempering these claims is the fact that output monitoring was measured only on four repeated cues. The remaining eight prospective trials simply measured overall event-based prospective memory (as they have been analyzed

here). In neither experiment was there an overall difference in prospective memory between the younger and the older adults. As a consequence, these data suggest that under some conditions, event-based retrieval is no more demanding for older adults than it is for younger adults (cf. McDaniel & Einstein, 2000). By contrast, the two populations differed substantially in this study in their memory for their past performance. The data reported here suggest very strongly that younger and older adults performance is likely to be very different on important qualitative dimensions even when no overall differences in the rate of cue detection are found. The younger adults in this study were not simply overconfident because they do forget some of their past successes, and the older adults were not simply underconfident because they will erroneously report that they had responded earlier when they did not. By adding an output-monitoring component to the prospective task we were able to gain some indication of whether responses would be repeated or withheld had this been a more naturalistic everyday task. Because older adults tended to forget previous responses that they made, they were less susceptible to the strong bias exhibited by younger adults to believe they had responded to the first occurrence when in fact they had not. On balance, this tendency to forget might lead to greater repetition errors, but it nevertheless protects the older adults from the opposite kind of error, namely, omission errors.

Increasing the memorability of the response helped younger adults in Experiment 2, but did not help the older adults. In fact, compared to Experiment 1, performance was arguably worse for the older adults. We believe that increasing the memorability of the responses may have created some strong retrieval competition because under those circumstances the older adults can remember making some responses but probably become confused as to which items received responses and which did not. The semantic similarity of the cues to one another probably exacerbated this problem. After all, strong contextual support will generally help retrieval in older adults (e.g., Light & Singh, 1987). However, better memory for cues that were responded to does not necessarily help in discriminating one cue from another on the basis of whether it received a response earlier (as we had hypothesized before conducting Experiment 2). That output-monitoring judgment requires a form of what has been called a target-monitoring judgment (Brown et al., 1997). In target monitoring, one must determine whether a response has been emitted to one source versus another, just as in prospective memory one must determine if an intention has been completed before in order to avoid either a repetition or an omission error. In our own work on target monitoring, we have found that performance (emitting a response to different sources) is generally better than source monitoring (receiving a response from different sources) (Marsh & Hicks, 2002).

However, the cognitive processes used to bind memory traces together in target monitoring would be the same as those used in source monitoring.

Unfortunately, the binding process is less complete in older adults than it is in younger adults (Henkel et al., 1998; Johnson et al., 1995). In terms of the current findings, older adults do not simply have worse retrospective memory for the past occurrence of items. Rather, they are also likely to have trouble in remembering what they have emitted in the prospective memory paradigm that emanates from some difficulty binding any associated action (key press or vocal response) to a particular target event (e.g., *monkey*). Thus, an encoding deficit in older adults is also likely to be part of the reason they display different memory for their past prospective memory performance. The same is true in “purer” measures of output monitoring that require younger and older adults to free recall lists of words and later judge from all of the studied items which they had previously recalled and which they had not (Koriat). Older adults tend not to identify all of the words they had correctly recalled suggesting that items do not become bound to the free recall act in the same way as they do for younger adults (i.e., an encoding difference). Our point here is simply that there is probably something more going on here than simple forgetting of whether or not an item occurred previously. The results reported here are likely to be influenced by either forgetting an association between one’s action (or lack thereof) and the item itself, or they are the result of never having formed the association in the first place.

The same is true in studies of aging and self-performed tasks (SPTs). Self-performed tasks are simple actions that participants perform such as *spin the top*. Kausler and Hakami (1983) found that with less engaging actions older adults had worse memory for SPTs than did younger adults. With more engaging activities the age-related decline disappeared. We can hardly call pressing a key in response to noticing an animal word an overly engaging response. What is probably happening both with the prospective memory task and with the SPTs is that older adults are not very effectively associating their actions with the cues that will be needed later when their memory is tested. In our task, pressing a key is not as keenly associated with *monkey* just as *top* is not as keenly associated with *spin* in the SPT literature. In everyday prospective memory tasks, we rarely think to ourselves that we need to associate the person with the message we are delivering when an intention is successfully fulfilled. However, the data and theory put forth here suggest that older adults would benefit from trying to develop such associations. According to this analysis of performance, the great confusion experienced by older adults in Experiment 2 may be the consequence of an elaborated prospective response that heightens item memory but does not increase the association between the item and successful performance of the task. Perhaps a better manipulation would have been to have participants devise a novel sentence in order to promote such associations.

The results from Experiment 2 may raise some caution about older adults improving their performance using implementation intentions (e.g., Gollwitzer, 1999). Implementation intentions are goals that are planned

more elaborately at the time of encoding. For example, if one wishes to deviate on the trip home from work to purchase eggs, imaging the route deviation has been shown to increase intention fulfillment. In fact, Chasteen et al. (2001) demonstrated that older adults benefit from forming such implementations in an event-based prospective memory paradigm. Although such a manipulation might increase cue detection, the current results suggest that such a manipulation may make it more difficult for older adults to later distinguish between related actions they have taken to fulfill their intentions because they become confused about the specifics of any one intention.

Although part of this analysis is somewhat speculative at this point, the important idea is that older adults may not simply suffer from poorer episodic retrieval: they may also suffer from a binding deficit at encoding in which targets and actions do not become firmly solidified or otherwise bound together in memory. For this reason, as was observed in Experiment 2, confusions about past performance and what responses were emitted to which cues would lead to greater repetitions and omissions in everyday prospective tasks. The basic methodology used here can be modified, albeit in a slightly more complicated way, to separate the effect of item memory for a cue's previous encounter and the memory (if any) for an action performed in its presence or as a response to it. The present study highlights the fact that one's memory for their past performance will entirely determine their behavior to cues that have been encountered in the past. Studying issues of output monitoring and target monitoring as they are related to event-based tasks and other forms of prospective memory is likely to be a fruitful avenue of inquiry because these issues can determine why people make or withhold a prospective response, and consequently, define why omission and repetition errors occur.

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