# Remembering to Perform Actions in the Future: Can Intentions Pop Into Mind?

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## Introduction

Prospective memory is memory for activities to be performed in the future. Examples include remembering to turn off your cell phone during a lecture, remembering to give your friend Patty a message, and remembering to actually attach an attachment to an email message. It is often contrasted with retrospective memory, which is the type of memory that psychologists typically study. Retrospective memory is memory for past events, such as memory of the plot of a movie that you saw two weeks ago, memory for the content of a lecture that you heard last month, and memory for what you had for breakfast this morning.

If you think about it even minimally, our lives are full of prospective memory demands. For example, when I get up in the morning, I need to remember to take my vitamins, to make my lunch, to pack my book bag with the things that I will need at school, and to stuff my gym bag with the items that I will need later in the day. Then, I need to remember to put all those items in my car and later to bring them to my office. During the day, I need to remember to go to class (thankfully I have never forgotten that), make announcements in class (unfortunately I have forgotten those on many occasions), and to attend various appointments and committee meetings throughout the day (regretfully, I have forgotten some of those too). And, at the end of the day, I may need to remember to meet my wife at an agreed upon time and location (I'm still married).

In an attempt to document the prevalence of prospective memory in everyday life, I ask my students on the first day of class to write down the last thing they remember forgetting. I then classify their memory failures as either retrospective or prospective memory failures. So if someone wrote that she was at a party recently and temporarily forgot a person's name, I would classify that as a retrospective memory failure. By contrast, if someone wrote that he forgot to return a book to the library, I would classify that as a prospective memory failure. Regardless of whether I conduct this exercise with college-age students or older adults, it is always the case that the majority of the failures are prospective memory failures.

It is also the case that many of our embarrassing memory failures involve prospective memory. You can probably think of an embarrassing occasion on which you forgot to perform an intended action. My most embarrassing failure was forgetting my first department meeting as chair of the department. Although I was highly prepared for this meeting, a student called me down to the lab about 15 minutes before the department meeting began, and I got completely absorbed in solving the immediate problems there. It goes without saying that that failure of memory created an inauspicious start to my new leadership position!

Prospective memory failures can also have serious consequences. As of 2008, more than 50 percent of Americans take prescription medications on a regular basis. And as you might imagine, older adults take more medication than any other age group. Because it is not unusual for older adults to take three, four, or five medications regularly, forgetting to take one's medication can contribute to poor health. Indeed, for older adults, this kind of forgetting can threaten independent living.

Despite the prevalence and importance of prospective memory for everyday life, there has been relatively little research in the field. As you can see in Figure 1, there was virtually no research prior to 1990—in stark contrast to the hundreds of thousands of studies that had been conducted on retrospective memory. There is steadily increasing interest in prospective memory, however, and empirical and theoretical papers on this topic are now regularly appearing in our best journals.

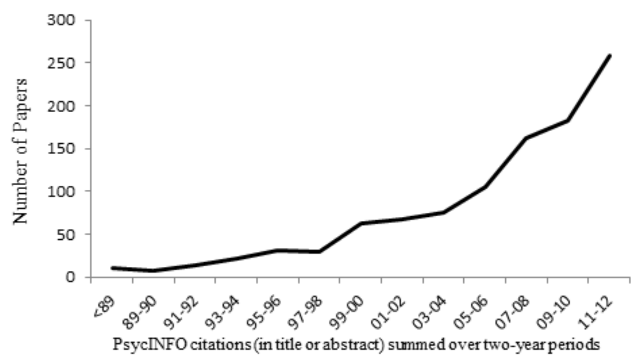


Figure 1. The growth of research on prospective memory (adapted from Marsh, Cook, & Hicks, 2006).

To give you a concrete idea of how we study prospective memory in the laboratory, I will describe a typical paradigm. As can be seen in Figure 2, we first engage participants in what we call an *ongoing* task. For example, we might tell them that our central interest is in having them rate words for the ease with which they can be imaged. So, for this task, participants might be presented with words one at a time in the center of a computer screen and then be directed to rate each word on a 5-point scale, where 1 indicates *very difficult to image* (e.g., *truth*) and 5 indicates *very easy to image* (e.g., *chair*). Once participants understand this task and have had some practice with it, we tell them that we have an additional interest in their ability to remember to perform an action in the future and, specifically, that if they ever see a particular word (e.g., the word *rake*) in the context of the imagery-rating task, they should press a designated key. We then introduce a delay, during which the participants are asked to perform several other activities. After this delay, we reintroduce the ongoing imagery-rating task, and we do not remind them of the prospective memory task. The target word *rake* might occur three or four times among 400 or so imagery-rating trials, and our measure of prospective remembering is the proportion of times out of four that participants remember to press the designated key when the target word *rake* occurs. To us, this is analogous to being busily engaged in the demands of life and yet having to remember to give your friend Patty a message when you see her.

1. Present participants with instructions and practice trials for an ongoing task (e.g., imagery rating).
2. Present participants with the prospective memory instructions (e.g., "Press the *Q* key whenever you see the word *rake* in the context of the ongoing task").
3. A delay is introduced during which participants perform other activities (e.g., participants might perform other memory tasks and/or fill out demographics forms)
4. Reintroduce the ongoing task (imagery rating) without reminding participants of the prospective memory task.
5. The prospective memory target (*rake*) occurs several times in the ongoing task, and prospective memory performance is measured by the proportion of times participants remember to press the designated key when the target occurs.

Figure 2. A typical paradigm for studying prospective

**Theories of Prospective Memory Retrieval**

An important question is, what is different about prospective memory? In the typical retrospective-memory task, participants might be presented with a list of words to learn and then at some point the experimenter puts the participants in what we call a retrieval mode—that is, the experimenter asks them to start remembering the list of words that was presented earlier (Tulving, 1983). The experimenter might present participants with some cues to help them remember, but the critical feature is that the experimenter asks them to start remembering. As can be seen in the typical prospective-memory paradigm described in Figure 2, a central difference is that in testing prospective memory the experimenter does not put participants in a retrieval mode when the target word occurs. Thus, when the word *rake* occurs in the context of the imagery-rating task, no one reminds them to check their memory for what they were supposed to do when the word *rake* occurs. Instead, somehow, participants have to switch from analyzing how easy it is to image words to seeing the word *rake* as a cue for an action. So a central question in the prospective-memory literature is how does the cognitive system accomplish remembering when people are not specifically trying to remember at the time?

There are currently two major theories that address this question. One theory is that we remember to perform the intended action through monitoring processes (Smith, 2003). The idea here is that when we form an intention, we initiate monitoring processes, which can sometimes feel like active and conscious monitoring and sometimes can occur unconsciously. Regardless of whether monitoring is conscious or not, the important assumptions in this theory are that monitoring always draws on a limited capacity of working memory resources and that monitoring is always *necessary* for prospective memory retrieval. Thus, if our monitoring lapses, we will forget.

My good friend and long-time colleague Mark McDaniel and I have proposed a very different theory, which we call the multiprocess theory (McDaniel & Einstein, 2000; 2007). Because remembering to perform actions in the future is central to our lives, we believe that it is adaptive to have a flexible system that uses a variety of mechanisms to accomplish prospective remembering. We believe that if we relied exclusively on monitoring, then prospective memory retrieval would be too fragile. In particular, we believe that there are also spontaneous retrieval processes. By spontaneous retrieval processes, we mean that the occurrence of an appropriate cue can cause an intention to pop in to mind, even when we are not monitoring (i.e., when no resources are devoted to looking for or monitoring for the target).

Although we have developed a couple of theories about exactly how spontaneous retrieval can occur, one theory is that during planning, people form an association between the target cue (e.g., the target word *rake*) and the intended action (e.g., pressing the *Q* key). This association is stored in long-term memory and later, when the target cue is encountered, we believe that there is an associative system (very much like the hippocampal system described by Moscovitch, 1994; see McDaniel & Einstein, 2011) that delivers the intended action to consciousness. The idea is that if someone has formed a good encoding of that association and if that person fully processes the cue at retrieval, the intention (*press the Q key*) should pop into awareness when the individual later processes the target word *rake*.

**A Test of the Theories**

The key difference between the monitoring and multiprocess theories is that the multiprocess theory assumes the existence of spontaneous retrieval processes, and a goal of our research has been to test for the existence of these kinds of retrieval processes. So how can we scientifically test whether a thought pops into awareness when a target word occurs? One might assume that you could use neuroimaging techniques to investigate this issue, but current neuroimaging methods require numerous trials and are unable to detect an occasional thought popping into mind. Being a cognitive psychologist, I am interested in studying mental processes scientifically, and the way that we do that is to infer them from behavior. So in order to measure whether or not a thought can pop into awareness, we have to creatively design experimental conditions that enable us to make this inference.

Although we have developed several methods for inferring spontaneous retrieval processes, the most ingenious method was inspired by one of my undergraduate research students, Ruthann Thomas, who recently finished a PhD at the University of Toronto and then a post-doctoral position at Washington University in St. Louis. She is now a professor at Hendrix College in Arkansas. Her idea was to start the experiment with the typical first two steps of a prospective memory paradigm (see Figure 2) but then introduce a twist in the procedure. That is, she involved participants in an ongoing task, which was the image-rating task used in the example described earlier, and had them practice this task until they thoroughly understood it. Next, Ruthann gave participants prospective-memory instructions. Specifically, she told them that we had a secondary interest in their ability to remember to perform an action in the future, and that they should press the designated *Q* key whenever they saw the word *rake* during the image-rating task.

After being convinced that participants understood the instructions, she departed from the typical prospective-memory paradigm by purposely asking participants to suspend their intention to remember during an intervening *speed* task. The *speed* task was in actuality what we call a lexical-decision task. For this task, participants are presented with strings of letters in the middle of the computer screen and simply are asked to determine whether the letters form a word or not. Thus, if they see the letters *abtel* they would press the *no* key, whereas if they see the letters *table*, they would press the *yes* key. A critical feature of this task is that she told participants that our sole interest during this task was in their ability to perform this *speed* task as quickly and accurately as possible and to ignore all other intentions while they were performing it. Nonetheless, she presented the word *rake* during this speed task, as well as a control word that was matched on all dimensions with the word *rake*.

As you might imagine, performance on this speed task is nearly perfect, and the interest is in the speed of responding. We believe that this experimental design provides a good test of the theories because participants should not have been monitoring during the speed task (and indeed, we have evidence that they were not monitoring). Thus, according to monitoring theory, whenever the target word *rake* occurred, it should have gone by unnoticed. That is, it should have been processed like any other word and had very rapid response times. According to the multiprocess theory, however, presenting the word *rake* to participants in the context of the speed task, even though participants were not monitoring, should cause the prospective memory to pop into awareness, and this should slow down participants' speed of pressing the *yes* key to indicate that it is a word. Thus, according to the multiprocess theory, there should be slowing in response to the target word relative to matched control items. This is exactly what happened as participants were about 50 milliseconds slower to respond that *rake* was a word (relative to the matched control word). Our interpretation of these results is that the target word *rake* was "loaded" in some sense so that whenever it occurred, it caused the intended action to be spontaneously retrieved and slowed down participants' speed of deciding that it was a word (Einstein, McDaniel, Thomas, Mayfield, Shank, Morrisette, &Breneiser, 2005; see also Scullin, Einstein, & McDaniel, 2009). Thus, the pattern of results suggests the existence of spontaneous retrieval processes and supports the multiprocess theory.

**Does Aging Affect Spontaneous Retrieval?**

In our most recent research, we wondered whether normal aging compromises spontaneous retrieval processes. One of the most common complaints of older adults is memory difficulties (Einstein & McDaniel, 2004), and laboratory research clearly shows that normal aging compromises performance on many retrospective memory tasks (McDaniel, Einstein, & Jacoby, 2008). An intriguing pattern in the research, however, is that aging tends to have greater effects on cognitively demanding retrieval tasks (like trying to remember the details of a move that you saw a month ago) and smaller or no effects on more automatic retrieval processes (perhaps like spontaneous retrieval). To examine the possibility that spontaneous retrieval is spared with normal aging, we tested your adults (college students at Furman University who were 17 to 23 years old) and healthy older adults (recruited from the Greenville community and between 61 and 84 years of age) in a suspended intention paradigm like the one described above. Our interest was in whether the target word *rake*, when it appeared in the speed task, would go by unnoticed and be processed just as quickly as the control word or would lead to slowing (as it does in young adults). As you can see in Figure 3, the exciting finding is that older adults showed just as much slowing to target words as young adults; thus, spontaneous retrieval seems to be spared with normal aging. In a new paper with five Furman students as coauthors (Mullet, Scullin, Hess, Scullin, Arnold, & Einstein, 2013), we replicated this finding as well as found additional evidence that spontaneous retrieval is preserved in normal aging.

**Improving Your Prospective Memory**

I will close by describing a strategy that has been shown to be effective in improving prospective memory. The strategy is based on the research and theorizing of Peter Gollwitzer (Gollwitzer, 1999), who is very interested in how to get people to follow through on their intentions. He believes that although people often form very strong intentions, they tend to form very general intentions, such as "I will take my medication." Because he believes that the "the road to hell is paved with general intentions," he argues that people need to go beyond forming general intentions and instead create implementation intentions. These take the form of "when situation x arises, I will perform y." Thus, instead of saying "I will take my medication," one should form the implementation intention "at breakfast in the morning, I will take my medication." The idea here is that it is important to

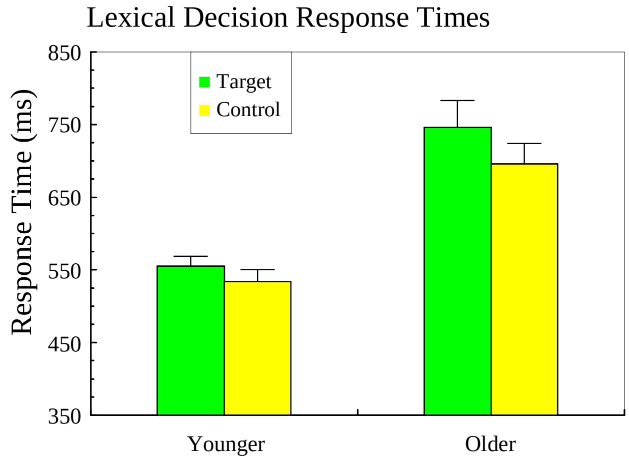


Figure 3. Lexical decision response times (in milliseconds) to target- and matched-control items for young and older adults (from Mullet, Scullin, Hess, Scullin, Arnold, & Einstein, 2013).

connect the intended action to a triggering cue. And, to the extent that you have formed a good encoding of this association, it is very likely that when having breakfast in the morning, the thought about taking your medication will pop into mind. Gollwitzer believes that forming implementation intentions allows us to switch from using monitoring to relying on spontaneous retrieval processes. The evidence is compelling that implementation intentions help people of all ages remember to perform intended actions, and I encourage you to conceptualize your prospective memory tasks in the form of implementation intentions.

## Conclusion

In closing, I want to thank the South Carolina Academy of Sciences and the South Carolina Research Authority for the Governor's Excellence in Scientific Research Award at a Predominantly Undergraduate Institution and for the opportunity to present you with an overview of my research on prospective memory. I also want to thank the many undergraduate students who have contributed so creatively to my understanding of prospective memory and who have enriched my life.

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