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Location-based prospective memory

Andrea E O'Rear and Gabriel A Radvansky

Abstract

This study explores location-based prospective memory. People often have to remember to do things when in a particular location, such as buying tissues the next time they are in the supermarket. For event cognition theory, location is important for structuring events. However, because event cognition has not been used to examine prospective memory, the question remains of how multiple events will influence prospective memory performance. In our experiments, people delivered messages from store to store in a virtual shopping mall as an ongoing task. The prospective tasks were to do certain activities in certain stores. For Experiment 1, each trial involved one prospective memory task to be done in a single location at one of three delays. The virtual environment and location cues were effective for prospective memory, and performance was unaffected by delay. For Experiment 2, each trial involved two prospective memory tasks, given in either one or two instruction locations, and to be done in either one or two store locations. There was improved performance when people received instructions from two locations and did both tasks in one location relative to other combinations. This demonstrates that location-based event structure influences how well people perform on prospective memory tasks.

Keywords

Prospective memory; event cognition; event structure; virtual environment; location

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Prospective memory is memory for the future. It is involved when people want to remember to do something later when they will likely be doing something else. For example, people might need to remember to put gasoline in the car the next time they go to the grocery store. Traditionally, researchers have referred to prospective memory tasks as being one of two types: time-based and event-based (Einstein & McDaniel, 1990; but see Kvavilashvili & Ellis, 1996 regarding activity-based tasks). Time-based tasks are to be carried out after either a specified time interval or at a specific time on the clock, for example, asking an experimenter for a newspaper after 20 min has passed (Groot, Wilson, Evans, & Watson, 2002) or taking one's medication at 9:00 p.m. (e.g., Rose, Rendell, McDaniel, Aberle, & Kliegel, 2010). In comparison, event-based tasks are to be carried out when a salient entity appears in the environment, for example, pressing a button on a computer keyboard if the word "rake" appears during a list-learning task (Einstein & McDaniel, 1990). The aim of this study was to explore the effectiveness of prospective memory when the retrieval cue is a spatial framework in which a person is located.

Event cognition

Although the label *event-based tasks* has been used for a type of prospective memory for decades, there has never been a firm definition of just what constitutes an event. Event cognition theory can provide some insight. It suggests that people form mental representations of real or imagined events, called *event models* (Johnson-Laird, 1983; Radvansky & Zacks, 2014; Van Dijk & Kintsch, 1983; Zwaan & Radvansky, 1998). While events are unfolding, people monitor multiple dimensions when processing these event models. Five commonly discussed dimensions are space, time, entity, causality, and intentionality (Zwaan & Radvansky, 1998). When there is a change in any one of these dimensions (e.g., the protagonist in a story leaves his house and walks outside), people need to update their event models. Event structure can be

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University of Notre Dame, Notre Dame, IN, USA

Corresponding author:
Andrea E O'Rear, Department of Psychology, University of Notre Dame, Notre Dame, IN 46556, USA.
Email: akalchik@nd.edu

conceptualised in terms of the roles played by the various event components. Radvansky and R. Zacks (1997) and Radvansky and J. Zacks (2014) suggested that each event model is structured around a *spatial-temporal framework*. This is the spatial location containing the event and the temporal duration of the event. Within each event are *entities*, which are the objects or people involved. Associated with each entity may be a number of *properties* or *characteristics*, including physical, emotional, and mental states, such as goals. Within the spatial-temporal framework, there may be *structural relations* that capture how the entities are related to one another and to the framework. These can include spatial, functional, kinship, social, ownership relations, and so on. Finally, because multiple events may be grouped into sequences or clusters, events may be joined by *linking relations*, such as temporal or causal relations among events.

Returning to the prospective memory literature, from this theoretical view most previous studies of event-based prospective memory have used individual stimuli as event cues, such as seeing a word on a screen (e.g., Einstein & McDaniel, 1990; Scullin, McDaniel, & Shelton, 2013) or hearing a recording of a dog bark (Knight, Nicholls, & Titov, 2008). For event cognition theory, these are only a component of events, namely, they are *entities* within an event. Therefore, to gain a deeper understanding of how event structure may influence prospective memory, we assessed a different event component: the *spatial framework*.

Locations as event frameworks

Spatial location can serve as the bounding framework for an event. Because of this, changes in location often result in event model updating, with new locations serving as the bases for new events (Glenberg, Meyer, & Lindem, 1987; Morrow, Bower, & Greenspan, 1989; Morrow, Greenspan, & Bower, 1987). For instance, Radvansky and colleagues (Pettijohn & Radvansky, 2015, 2016; Radvansky & Copeland, 2006; Radvansky, Krawietz, & Tamplin, 2011; Radvansky, Pettijohn, & Kim, 2015; Radvansky, Tamplin, & Krawietz, 2010) have found that when people move from room to room in a virtual environment, there is forgetting of information as a person walks through a doorway, going from one spatial framework to another.

Another line of work shows that location can be used to segregate information into different event models (e.g., Radvansky, 1999, 2005). Retrieval interference is observed when common entities are spread across multiple location-based event models but not when they are integrated into a common event model (Radvansky & Zacks, 1991). There is also evidence that learning information across multiple locations can improve memory. Specifically, Pettijohn, Thompson, Tamplin, Krawietz, and Radvansky (2016; see also Smith, 1982; Smith & Rothkopf, 1984) found that if people learned a list of words in one room, memory was worse than if they learned half of the list in one room and half in another. The location-based event structure helped organise the information in memory, improving performance. A similar result occurs for word lists presented in one versus two computer windows, as well as for information in narratives containing event shifts (see also Radvansky, 2012).

Thus, overall, changes in spatial location can influence retrospective memory. This influence of spatial location has yet to be thoroughly explored for prospective memory. We do this here by exploring what we refer to as *location-based prospective memory*.

Location cues in the prospective memory literature

Several event-based prospective memory studies have used cues that, at least on the surface, appear to be location based. However, upon closer examination, only one of them fits our definition (i.e., people are cued to do a prospective memory task by being in a location-based framework). Sellen, Louie, Harris, and Wilkins (1997) examined factors that lead people to think of their future intentions in an event-based and a time-based prospective memory task. Their event-based task was for employees in a workplace to press a button on a wearable badge every time they entered the building's common area. Thus, this can be viewed as a location-based memory task. The time-based task was to press the button at specified times throughout the day. The result was that people were better at the event-based than the time-based task, and they thought of the event-based task most often when walking into the common area location. In other words, location can be an effective prospective memory cue. That said, it is important to note that this study was observational, not experimental, and did not directly manipulate event structure as this study does. Moreover, no one has followed up on this finding.

Other studies have involved having people navigate and do prospective memory tasks in a virtual city or town (e.g., Gonneaud et al., 2012; Kalpouzos, Eriksson, Sjolie, Molin, & Nyberg, 2010; Knight et al., 2008; Trawley, Stephens, Rendell, & Groeger, 2017). For example, Kalpouzos et al. (2010) created a virtual representation of the participants' own town (Umeå, Sweden). They used a joystick to travel along different routes and did four or five event-based prospective memory tasks per route (e.g., throw a candy wrapper in the trashcan). Participants had to walk up to cues when they saw them (e.g., the trashcan; the phone booth), but they did not enter new locations. Thus, the prospective memory cues were more like traditional event-based (i.e., entity) than location-based cues.

Gonneaud et al. (2012) also created a virtual city. Participants had to "drive" to the train station, remembering to do nine prospective memory tasks along the way (e.g., buy stamp booklet at the post office). Although the event-based cues were locations (e.g., the post office), people did not actually enter them. Just seeing the location marker served as the cue. Trawley et al. (2017) used a similar method in a study of the influence of different prospective memory tasks on performance during a simulated driving task. In the event-based group, people were asked to flash their headlights and state the prospective memory task when they drove past each of nine cue locations, such as McDonald's.

In another study, Knight et al. (2008) linked together 1,200 photos of a real street that participants could scroll through using a touchscreen (similar to Google Street View). For the ongoing tasks, people went to 10 different stores and either bought or asked about an item. Two of the three prospective memory tasks had a simple stimulus as a cue (i.e., if people saw a person carrying a box or heard a dog barking, they needed to tell the experimenter the name of the store in front of themselves), but the third did involve actually entering different locations. Specifically, whenever people saw a store selling food, they were to walk into the store and ask if they had a food licence. This is more of an event-based task because people were not already in the store but were triggered by seeing it from outside, like many event-based prospective memory tasks. Seeing the store name (e.g., Subway) is what cued people to do the task, not being in the location itself.

Logie and his colleagues have done multiple studies using a virtual environment (Law, Trawley, Brown, Stephens, & Logie, 2013; Trawley, Law, Brown, Niven, & Logie, 2014; Trawley, Law, & Logie, 2011). Trawley et al. (2011) looked at whether planning ability and working memory capacity affected how well people did on a Virtual Errands Test, in which people were given a list of errands to complete in different locations throughout a four-floor building. Although people did have to remember to do tasks in particular locations, this study varied from traditional prospective memory studies in that there was no ongoing task with an embedded prospective memory task. Instead, each errand was a prospective memory task, and completing the errand list was the only activity.

Trawley et al. (2014) used an updated version of the Virtual Errands Test in which they manipulated cue salience. The completion of the errand list was the ongoing task, and the prospective memory task was to push a button beneath any wall painting that participants saw in the virtual environment. Because the paintings were the cues, the experiment was a test of traditional event-based prospective memory. Like the Virtual Errands Test, the ongoing task in the present experiments was for people to go from store to store, delivering messages in a shopping mall. The prospective memory instructions told people that, if they happened to be *in* a particular store, they were to do an additional task. In that way, the participants' presence in a location is what cued the prospective memory task.

Finally, Smith, Hunt, and Murray (2017) recently published a study that bears a superficial resemblance to our work. Smith et al. had students view a series of images depicting a walk across their home campus. Prior to this, people received four prospective memory tasks to be done at each of four pre-specified locations. Thus, people were moving through an environment with a need to do different tasks at different locations. However, there are number of important differences. First, although our participants controlled their movement, Smith et al. forced students to take a directed path through the use of photographs. Second, Smith et al. emphasised participants' performance on the secondary ongoing task of counting people in the images and on the regulation of working memory contents, which does not concern us here. Third, they had four prospective memory tasks, whereas in our study selections were made from a menu of 25 possible tasks, thus rendering chance performance much lower. Moreover, their prospective tasks were semantically/thematically/functionally related to the cues (e.g., take money out when you get to the ATM), whereas we randomly assigned these on each trial. Finally, our prospective memory cues were always the occupation of a spatial location, whereas theirs were sometimes locations and sometimes an object or entity within the event (e.g., an ATM) consistent with most event-based prospective memory studies.

There are also a number of theoretical differences. First, the focus of their Experiments 1-3 is not on prospective memory, per se, but the intrusion of prospective memory processing on the secondary task. Thus, this is a dual task situation in which the addition of a second task impedes performance. This is a well-known finding. What may be novel is that the prospective task was not held in an active state until the unfolding path approached a place where that task was to be done. This is analogous to the reactivation of character goal information during narrative comprehension (e.g., Lutz & Radvansky, 1997; Suh & Trabasso, 1993). In their Experiment 4, people watched the path sequence images, twice through. The first time, people simply viewed the sequence. The second time, people did an event segmentation task (e.g., Kurby & Zacks, 2008; Zacks, Speer, & Reynolds, 2009). They found that people were likely to mark event boundaries at spatial region shifts, replicating a well-known finding. These data were never directly related to prospective memory performance, and there is no way to determine how close the event boundaries were to the points at which prospective memory responses were expected. They did report a slowdown in secondary task processing speed at the event boundaries in Experiments 1-3, consistent with studies showing changes in reading time, brain activity, eye movements, and pupil dilation at event boundaries (e.g., Eisenberg & Zacks, 2016; Speer, Zacks, & Reynolds, 2007; Zacks, Speer, Swallow, & Maley, 2010). It is unknown whether this is due to increased processing effort to update an event model or to the surprise in a shift in the flow of events (Pettijohn & Radvansky, 2016). That is, these could just be causal breaks from the participants' perspective.

The present experiments

Because this is an initial study of location-based prospective memory, there are many aspects that need to be explored. To this end, our two experiments, which took place in a virtual shopping mall, assessed three factors that may play a role in location-based prospective memory. These were (1) the effectiveness of location as a prospective memory cue, (2) the delay between receiving a prospective memory cue and the need to execute it, and (3) the influence of event structure during a multiple-response prospective memory task, including both different prospective memory instruction events and different prospective memory target locations. We discuss the influence of the first two factors here but hold off on discussion of the third until the introduction to Experiment 2.

The hypothesis for the first factor is straightforward: because location is widely used by people as a way to structure memories, it is expected that location will serve as an effective prospective memory cue. Thus, we expect people to perform well in the task, in general, and that when errors are made, they are more likely to be cases in which a person is in the correct location and chooses the wrong action than cases in which a person is in the wrong location but chooses the correct action.

The second factor was delay. There has been some prior assessment of retention delay with time-based and event-based prospective memory studies. However, the findings have been mixed. Some studies have found that greater delays impair prospective memory (e.g., Martin, Brown, & Hicks, 2011; McBride, Beckner, & Abney, 2011), whereas others have found either no effect (e.g., McBride et al., 2011; Stone, Dismukes, & Remington, 2010) or that increasing delays actually improves prospective memory performance (e.g., Hicks, Marsh, & Russell, 2000; Martin et al., 2011). Martin et al. (2011) suggested that the pattern of results is influenced by when the delay occurs. A delay may occur (1) after the prospective memory instructions are given but before the ongoing task begins or (2) after the ongoing task begins but before the first prospective memory cue appears. Martin et al. suggested that non-focal prospective memory was impaired when there was a long delay of the second type, but it was improved when the delay was the first type (see also Hicks et al., 2000). They suggested that people with a longer filler task had time to rehearse the prospective memory task, whereas those with a longer delay following the start of the ongoing task were more likely to get distracted and rehearse the prospective memory task less often. Moreover, McBride et al. (2011) found that non-focal prospective memory, but not focal prospective memory, was impaired when they manipulated the length of delay within the ongoing task before the prospective memory cue. They suggested that people begin the experiment by monitoring for the prospective memory cue but stop or reduce monitoring as time goes on. Because people are more likely to need to monitor to do the non-focal task (Einstein et al., 2005), this decrease in monitoring may lead to the lower non-focal prospective memory performance at longer delays. Focal prospective memory, however, would not be impaired by a decline in monitoring because monitoring is not needed for successful performance. Thus, the placement of a delay, along with the task's focality, impacts whether prospective memory is improved or impaired.

To assess delay in this study, the number of stores that people were sent to prior to the prospective memory cue location was varied to create short, medium, and long delays. Two possible outcomes are noted. First, it is possible that longer delays could impair prospective memory performance because longer delays involved entering multiple stores and changing locations leads people to update their event models and forget information from older models (e.g., Radvansky & Copeland, 2006). If so, then multiple changes of event models could make the prospective memory tasks less accessible. Alternatively, it is also possible that the delay may have no effect on performance because the current task was focal and the delay took place after the ongoing task began (McBride et al., 2011). If so, interference and distractions would be minimised.

Experiment 1

The aim of Experiment 1 was to be an initial exploration of location-based prospective memory using a virtual mall environment. The general influence of instruction-target delay was also assessed.

Method

Participants. In total, 37 students (19 females, aged 18-22 years, M=19.4, SD=1.2) were recruited from the University of Notre Dame's Department of Psychology participant pool for partial course credit. These people all had normal or corrected to normal vision. All procedures were in compliance with the university's Institutional Review Board. Due to the nature of the computer program used in the experiment, people who were prone to motion sickness were strongly discouraged from participating. Despite this, 12 people were not able to finish the experiment because they felt ill and were therefore replaced. Five additional people were also replaced, three for not following directions and two due to technical difficulties.

Materials. A virtual shopping mall with 18 stores was created using the Valve Hammer Editor (Valve Software, 2003). An overview map is shown in Figure 1. The virtual

Figure 1. Overview map of virtual shopping mall.

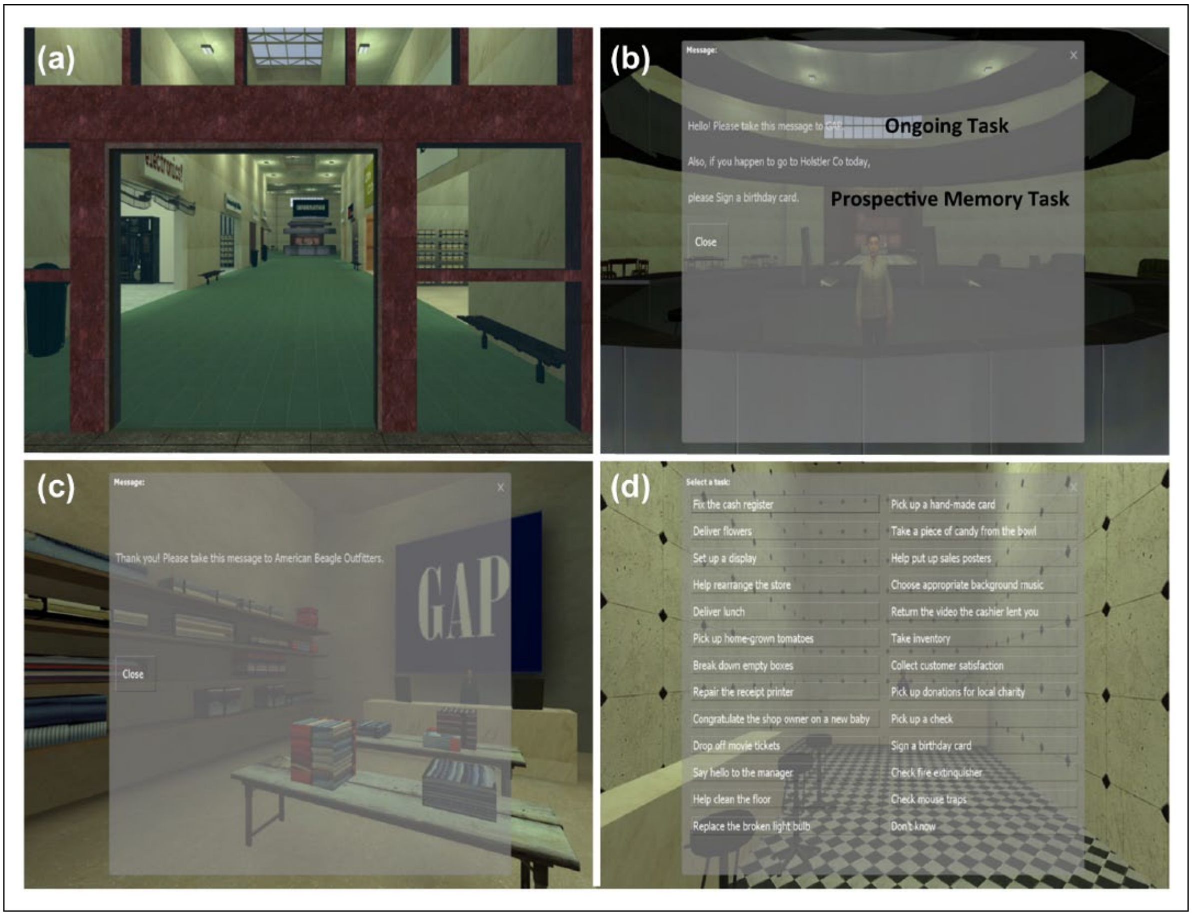
environment was displayed to participants on a 46″ touchscreen monitor (Samsung model 460TSN2), and participants used a joystick to navigate through the mall using a first-person perspective.

When making a prospective memory response, participants selected a choice from a list of 25 options (e.g., help put up sales posters) when they believed they had a task to perform. A 26th option, "Don't know," was also included for people to select if they knew they had to do something but could not remember what. The full list of options is listed in Appendix 1.

Procedure. Upon entering the laboratory, each person was given a brief description of the study and provided informed consent. Next, the experimenter read the instructions, explaining that they would be walking around the mall, delivering messages from store to store. This was the ongoing task. Screen shots of the virtual situations described in this section can be seen in Figure 2. Once participants entered the mall, they were told to start by walking to the Information Desk (Figure 2a). There, they were given the prospective memory task as well as which store they needed to go to first (Figure 2b). This was presented via a dialog box. As an example, it could say, "Please take this message to Radio Shock. Also, if you happen to go to Reed's Reads today, please help put up sales posters." Thus, the first message was where they were to go next, and the second was the prospective memory task for that trial. When participants entered any store to deliver a message, a dialog box appeared that said "Thank you!" and instructed them which store to go to next (Figure 2c). Thus, participants were sent from store to store; they did not have a specific list ahead of time. If people entered a store that was not part of their prescribed path, they received a message saying, for example, "Aren't you supposed to go to Reed's Reads?"[1]

When people thought that they were in a target location, they pushed a button on the top of the joystick to bring up the list of all possible prospective memory tasks (Figure 2d). Participants then chose the task they believed they were supposed to do (or the "Don't know" option) by tapping their finger on the screen.

Each experimental session had 24 trials of varying lengths. Eight trials were "short," with participants



Hello! Please take this message to GAP.

Also, if you happen to go to Holstler Co today,

please Sign a birthday card.

Thank you! Please take this message to American Beagle Outfitters.

Figure 2. Screen shots from the program. (a) View when entering the mall. (b) Instructions from Information Desk (ongoing and prospective memory task labels added). (c) Telling person where to go next. (d) List of prospective memory task options.

visiting 3-4 stores, eight were "medium" (6-8 stores), and eight were "long" (9-11 stores). For two trials of each length (six total), participants were never sent to the target store during the ongoing task. These were "catch trials" to prevent participants from expecting a prospective memory task cue in every trial, although they received prospective memory instructions in every trial. The different trial types were randomised for each person. There were also zero, one, or two stores, randomly chosen, for the participant to go to as part of the ongoing task after going to the prospective memory target location. The inclusion of these stores, along with the changing delay lengths, prevented people from anticipating when the prospective memory task should occur. At the end of each trial sequence, people were instructed to return to the Information Desk.

Results

Scoring protocol. Each of the participants' responses could fall into one of five categories: (1) Correct, (2) Location Only, (3) Task Only, (4) Incorrect, and (5) No Response. *Correct* responses were those in which people did the correct prospective memory task in the correct location. *Location Only* responses occurred when people got the correct location but selected the wrong task. *Task Only* responses were when people did the correct task but in the wrong location. *Incorrect* responses were when people got both the location and the task incorrect. Finally, *No Responses* were cases in which no prospective memory task was done on the trial.

It was possible for a person to produce multiple responses on a given trial. For example, if a person made two responses on one trial that fell into the categories of *Location Only* and *Correct*, then both of these response types would be scored as having occurred on that trial. Responses were converted to proportions of response types out of six. As described above, there were six trials each for short, medium, and long trials that contained prospective memory tasks, as well as six catch trials. That means that a person could have up to six responses of any given type (e.g., *Correct*) for all three delays and for catch trials. The mean proportions of responses for each response type in each delay length are presented in Figure 3.

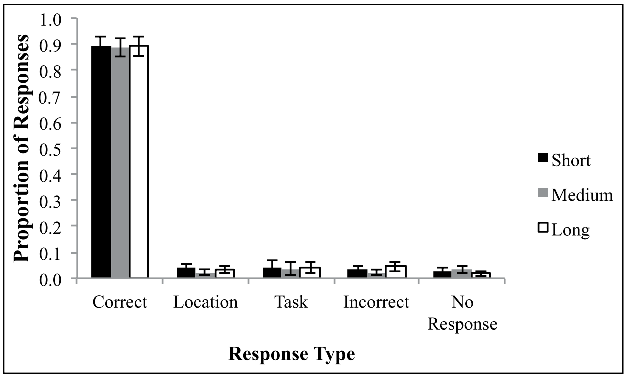


Figure 3. Mean proportions of responses by response type and length of delay in Experiment 1.
Error bars represent standard error of the mean.

Catch trials were only scored as *Correct* ($M = .829$) or *Incorrect* ($M = .171$) because no response was to be made on those trials, so no responses could be partially correct. There was no influence of delay on catch trials, $F(2, 72) = 1.80$, $MSE = .19$, $p = .17$, $\eta_p^2 = .05$. Because catch trials were included in the experiment only to prevent anticipation of prospective memory tasks and to ensure people were paying attention (the means indicate that they were), those trials are not included in any further analyses.

Analyses. As shown in Figure 3, there was no major influence of delay. Moreover, the majority of the responses were correct, suggesting that location was an effective prospective memory cue. Partly because of this, and partly for clarity, two primary analyses were conducted. The first assessed just the effect of delay on the Correct responses, and the second included the four remaining error response types.

For the Correct responses, a 3-way (Delay: short, medium, and long) repeated measures analysis of variance (ANOVA) was done. No significant effect of Delay was observed, $F < 1$.

For the error responses, a 4 (error type: location, task, incorrect, no response) × 3 (delay) repeated measures ANOVA was done. This analysis revealed no main effects of Error Type or Delay, and the interaction was not significant, all Fs < 1.

Discussion

In Experiment 1, people gave correct responses quite often, with performance close to ceiling.[2] Thus, people understood the task and did well, suggesting that location is an effective prospective memory cue. In addition, a location-based prospective memory task using a virtual environment can be used to assess prospective memory. It is interesting that there were no differences among the different error response types. Because the task was straightforward and simple, having only one prospective memory task per trial, it is possible that the challenge was not great enough for there to be any differentiable effects among the different error types. Experiment 2 used a more complex task that allowed for subtler effects to be observed.

Finally, there was no effect of length of delay in this study. This is consistent with McBride et al.'s (2011) idea that a delay after the start of the ongoing task and before the first prospective memory cue will not have an influence if the prospective memory task is focal. It also suggests that any interference experienced from changing locations during the ongoing task did not substantially increase any memory cost as the delay lengths increased.

Experiment 2

The aim of Experiment 2 was to examine the influence of event structure on prospective memory. To this end, we varied the number of instruction and target location events. Put simply, Experiment 2 had a 2 × 2 design, shown in Figure 4. In all four conditions, people were given two prospective memory tasks. One factor was whether the two prospective memory instructions were given in the same place (one event) or in two different places (two events). The second was whether the two prospective memory tasks needed to be done in the same target location (one event) or in two different locations (two events). The conditions are labelled in terms of the number of instruction locations and target locations, respectively: 1 Instruction–1 Target, 1 Instruction–2 Target, 2 Instruction–1 Target, and 2 Instruction–2 Target. For example, 1 Instruction–2 Target means that there were a single instruction event and two retrieval events.

Event cognition theory predictions

Predictions for the above design will be interpreted based on insights from event cognition theory and the number of event models needed to do the task. First, according to this view, events are represented by separate event models that refer to encountered or described events (Radvansky & Zacks, 2014). For the encoding events in this experiment, the event models created are straightforward, one for the each of the instruction locations. Thus, there will be one event model for a person's understanding when both instructions are given as part of the same event, but two event models when they are given as part of two events. Please see Figure 5 as a guide to understanding this view.

What is of primary importance for prospective memory is the ability to respond to the cue at the appropriate time, which, in this case, is when a person is in the correct cue location. In other words, how easily does the memory for what to do come to mind at the place? Because the location where a person will need to remember to do an action is an

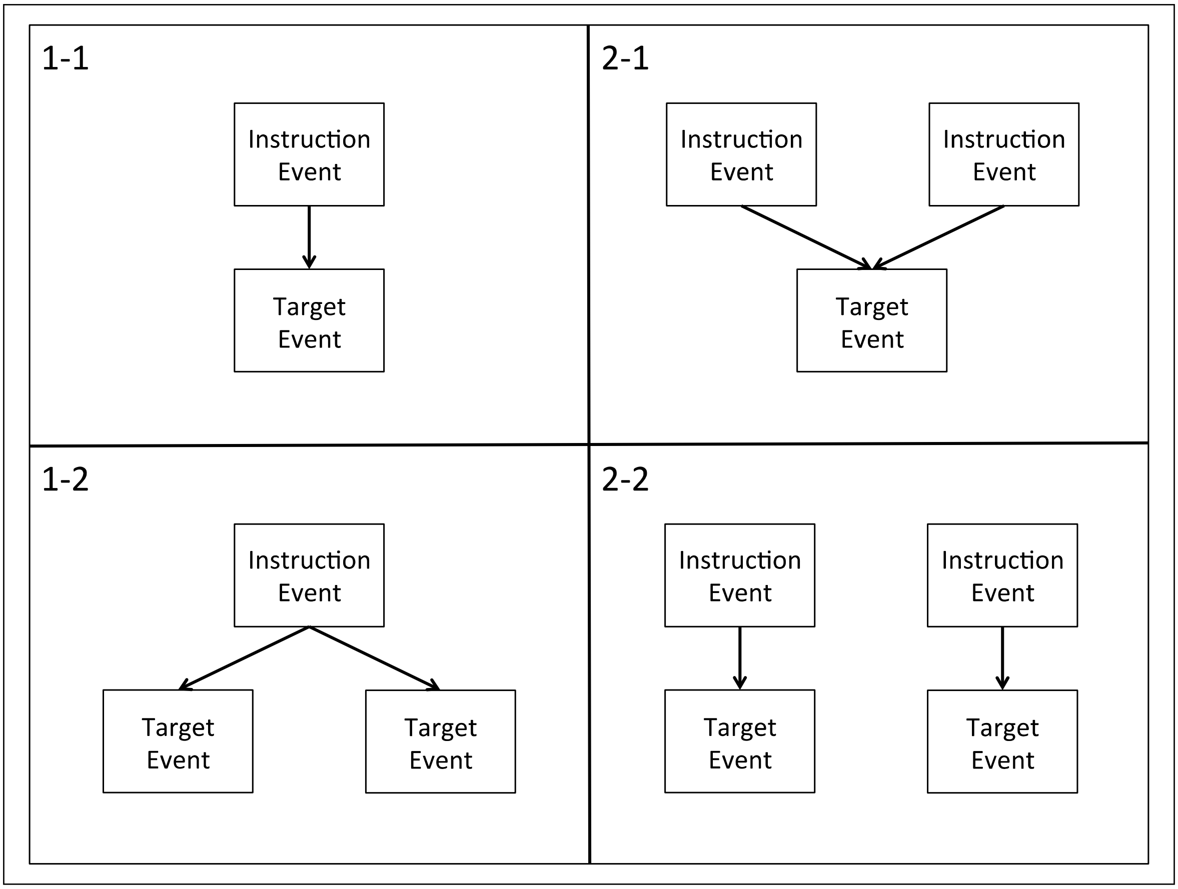


Figure 4. Diagram of the instruction and target event configurations used in Experiment 2.

event, at the time of encoding, people will likely form an event model of a possible future event in which they would do that activity.

Using the design outlined in Figure 5, we can make some predictions about the strength of those possible world event models. First, for the 1 Instruction–1 Target condition, there is only a single event model, and it is encoded once. Second, for the 1 Instruction–2 Target condition, there are two event models, one for each location, and they are each encoded once. Thus, the memory strength of those two models would be similar to the case in the 1 Instruction–1 Target condition. Third, similarly, for the 2 Instruction–2 Target condition, there are two event models created, one for each cue location, and these are only encoded once, although in this case at different times. So, again, the strength of the memory trace would be assumed to be similar as in the 1 Instruction–1 Target and 1 Instruction–2 Target conditions. Finally, and importantly, for the 2 Instruction–1 Target condition there are two encoding events, one at each instruction location, but they both involve a single future event. Thus, the event model for that location is encoded twice, giving it greater strength in memory. As such, the event model view prediction is that prospective memory will be better in the 2 Instruction–1 Target condition than the other three conditions, which will be similar.

Method

Participants. For each condition in this experiment (1 Instruction–1 Target, 1 Instruction–2 Target, 2 Instruction–1 Target, and 2 Instruction–2 Target), 48 students (192 total, 105 females, aged 17-36 years, $M = 19.6$, $SD = 2.1$) with normal or corrected to normal vision were recruited from the University of Notre Dame's Department of Psychology participant pool and given partial course credit. All procedures were in compliance with the university's Institutional Review Board.

Again, people who were prone to motion sickness were discouraged from participating. However, several people had to be replaced due to motion sickness: 15 in 1 Instruction–1 Target, 8 in 1 Instruction–2 Target, 12 in 2 Instruction–1 Target, and 6 in 2 Instruction–2 Target. In addition, several people were also replaced due to technical issues (5 in 1 Instruction–1 Target, 1 in 1 Instruction–2 Target) or not following directions (3 each in 1 Instruction–1 Target, 1 Instruction–2 Target, and 2 Instruction–2 Target). Finally, 5 people were trimmed

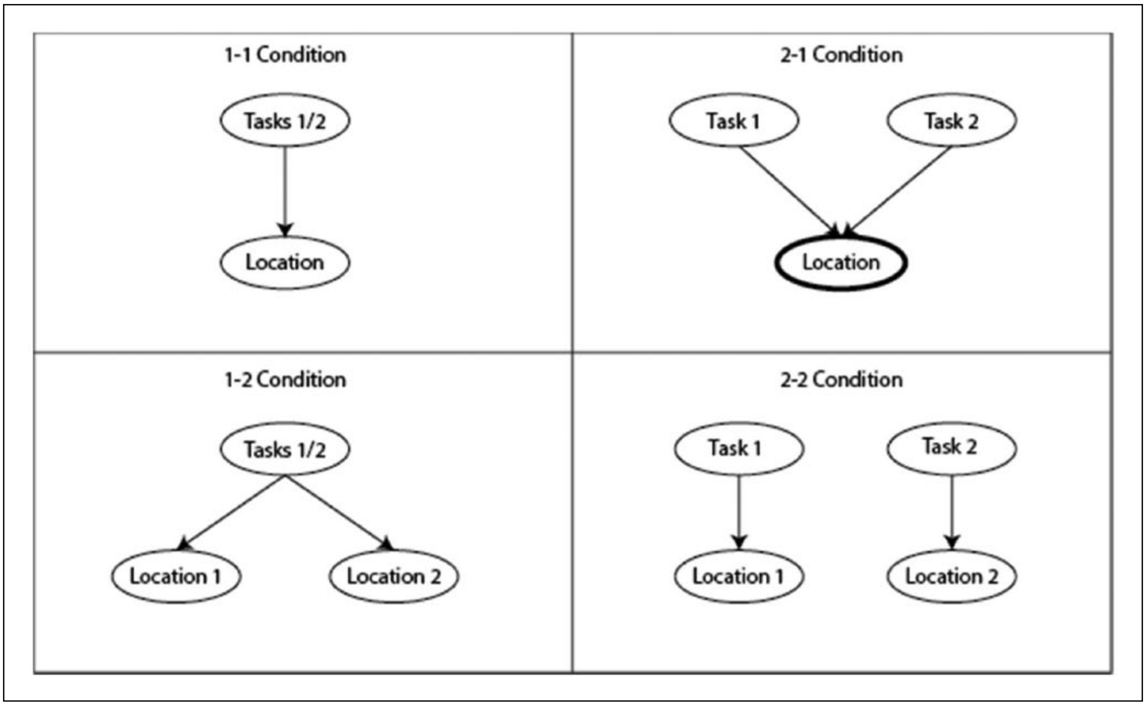


Figure 5. Prediction of an event cognition account.
The arrows represent patterns of planning, and the dark oval represents greater storage strength.

and replaced for having Correct scores that were 3 or more standard deviations below the mean of their respective conditions (1 in 1 Instruction–1 Target, 1 in 1 Instruction–2 Target, 2 in 2 Instruction–1 Target, and 1 in 2 Instruction–2 Target).

Materials and procedure. The prospective memory tasks were the same as in Experiment 1. The general procedure and number of trials were also the same. However, participants were given two prospective memory tasks per trial, and we varied the number of instruction and target locations among the four conditions. Also, people in the current study used a mouse to choose prospective memory tasks from the list. Finally, while the Information Desk was the start location where people received instructions, for the 2 Instruction–1 Target and 2 Instruction–2 Target conditions, participants also went to the Mall Manager to get a second prospective memory task instruction. More detailed descriptions of each condition are provided next.

For the 1 Instruction–1 Target condition, people received the two prospective memory tasks at one location, and they were both to be done in the same target location. As an example, the instructions could be, "Please take this message to Radio Shock. Also, if you happen to go to Reed's Reads today, please help put up sales posters and take inventory." Thus, two prospective memory tasks were given on each trial in the same location, and both tasks were to be done in the same location.

In the 1 Instruction–2 Target condition, people received both prospective memory tasks in one location, as in the 1 Instruction–1 Target condition, and each prospective memory task was to be done in a different target location. For example, the instruction could be, "Please take this message to Radio Shock. Also, if you happen to go to Reed's Reads today, please help put up sales posters, and if you happen to go to MKay Jewelers, please take inventory."

In the 2 Instruction–1 Target condition, people were given the two prospective memory instructions in different locations, and both prospective memory tasks were to be done in the same target location. As before, people were told to start by walking up to the Information Desk, but only one prospective memory task was given. For example, the instruction might be, "Please take this message to the Mall Manager. Also, if you happen to go to Reed's Reads today, please help put up sales posters." Participants then walked to the Mall Manager for the second prospective memory task, where the instruction might be, "If you happen to go to Reed's Reads, please take inventory. Please take this message to Radio Shock."

Finally, in the 2 Instruction–2 Target condition, there were two different instruction locations, as in the 2 Instruction–1 Target condition, and each prospective memory task needed to be done in different target locations, as in the 1 Instruction–2 Target condition.

Results

Scoring protocol. Two primary analyses were done in a similar way as was done for Experiment 1. One assessed correct responses, and the other assessed errors. Responses

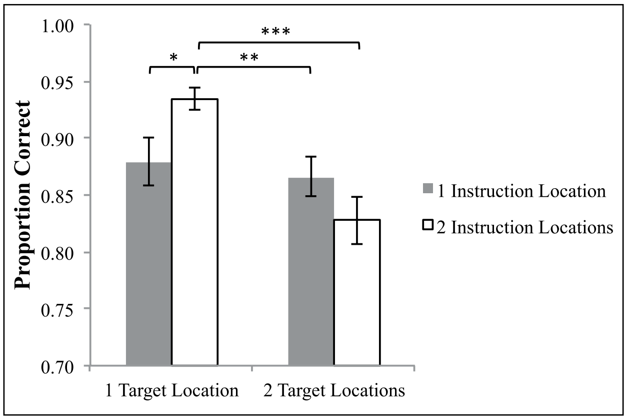


Figure 6. Mean proportions of correct responses by instruction and target locations in Experiment 2.
Error bars represent standard error of the mean.
$*p < .05$, $**p < .01$, $***p < .001$.

were scored like Experiment 1, with two changes. First, because there were two prospective memory tasks per trial, response proportions were calculated out of 12 instead of 6, with the exception of Location Only responses in conditions 1 Instruction–1 Target and 2 Instruction–1 Target. These were still calculated out of 6 because there was only one target location in those versions. Second, having two prospective memory tasks per trial necessitated an additional step for the No Response category. In Experiment 1, either a response was made or not. Here, a response could be made for zero, one, or two of the prospective memory tasks. Therefore, any missing response was counted as a No Response.

Again, as in Experiment 1, catch trials were only scored as *Correct* (*M*s = .913, .941, .951, and .954 for 1 Instruction–1 Target, 1 Instruction–2 Target, 2 Instruction–1 Target, and 2 Instruction–2 Target, respectively) or *Incorrect*. Because the Correct means were high, this indicates that people were largely attending to the task. Furthermore, there is no difference among these means, $F(3, 188) = 1.09$, $MSE = .02$, $p = .35$, $\eta_p^2 = .02$. Therefore, these trials are not considered further.

Correct responses. The Correct response data are shown in Figure 6. These data were submitted to a 2 (Instruction Location: 1 or 2) × 2 (Target Location: 1 or 2) between-participants ANOVA. There was a main effect of Target Location, $F(1, 188) = 11.61$, $MSE = .02$, $p = .001$, $\eta_p^2 = .001$, but not Instruction Location, $F < 1$, and there was a significant Instruction Location × Target Location interaction, $F(1, 188) = 7.03$, $MSE = .02$, $p = .009$, $\eta_p^2 = .04$.

To understand this interaction, planned comparisons were made among all four conditions. These revealed that the interaction was driven by performance in the 2 Instruction–1 Target condition (2 instruction locations, 1 target location) being more accurate than in the others: 1 Instruction–1 Target versus 2 Instruction–1 Target, $F(1, 94) = 5.83$, $MSE = .01$, $p = .02$, $\eta_p^2 = .03$; 1 Instruction–2 Target versus 2 Instruction–1 Target, $F(1, 94) = 12.96$, $MSE = .009$, $p = .001$, $\eta_p^2 = .12$; and 2 Instruction–2 Target versus 2 Instruction–1 Target, $F(1, 94) = 21.35$, $MSE = .01$, $p < .001$, $\eta_p^2 = .18$. Overall, having two instruction locations and one prospective memory target location led to more accurate prospective memory performance. This is consistent with the event cognition view. In addition, performance in the 2 Instruction–2 Target condition was marginally worse than in the 1 Instruction–1 Target condition, $F(1, 94) = 3.00$, $MSE = .02$, $p = .09$, $\eta_p^2 = .03$. Finally, performance in the 2 Instruction–2 Target condition was nominally, but not significantly, worse than the 1 Instruction–2 Target condition ($p = .16$). The comparison of the 1 Instruction–1 Target and 1 Instruction–2 Target conditions was not significant, $F < 1$. This smaller and minor effect of worse performance in the 2 Instruction–2 Target condition may reflect more generalised interference, perhaps with the need for a person to be dealing with four event models on each trial. That said, the effects are small and not significant.

Error rates. The error rate data are shown in Table 1. These data were submitted to a 2 (Instruction Location) × 2 (Target Location) × 4 (Error Type) mixed ANOVA with Instruction Location and Target Location as the between-participants variables and Error Type as the repeated measures variable. There was a main effect of Error Type, $F(3, 564) = 25.39$, $MSE = .003$, $p < .001$, $\eta_p^2 = .12$, which was qualified by significant Error Type × Instruction Location, $F(3, 564) = 4.13$, $MSE = .003$, $p = .007$, $\eta_p^2 = .02$, and Error Type × Target Location interactions, $F(3, 564) = 9.06$, $MSE = .003$, $p < .001$, $\eta_p^2 = .05$.

Looking at the error rate data, we see that the Location Only ($M = .066$) and No Response ($M = .061$) error rates were greater than the Task Only ($M = .028$) and Incorrect ($M = .025$) error rates. At first, there does not appear to be a clear pattern when the error rate data are considered as a whole. Therefore, to make sense of this, we broke them down by response error type.

First, the No Response errors, shown in Figure 7, are errors of omission, whereas the other three are all errors of commission. A separate analysis of these data was done, using an Instruction Location × Target Location between-participants ANOVA. Although the main effect of Instruction Location was not significant, $F < 1$, there was a significant main effect of Target Location, $F(1, 188) = 11.85$, $MSE = .01$, $p = .001$, $\eta_p^2 = .06$, and a marginally significant interaction, $F(1, 188) = 3.02$, $MSE = .01$, $p = .08$, $\eta_p^2 = .02$. Breaking the interaction down reveals that there was an effect of Instruction Location when there was one prospective memory target location, $F(1, 94) = 5.52$, $MSE = .004$, $p = .02$, $\eta_p^2 = .06$, with fewer omission errors being made when there were two instruction locations.

Table 1. Mean proportions of error responses by instruction and target locations in Experiment 2.

	1 Instruction Location	2 Instruction Locations
Room only		
1 Target Location	.063 (.013)	.078 (.011)
2 Target Locations	.049 (.006)	.074 (.010)
Task only		
1 Target location	.045 (.011)	.012 (.004)
2 Target Locations	.030 (.006)	.025 (.006)
Incorrect		
1 Target Location	.028 (.009)	.041 (.011)
2 Target Locations	.014 (.007)	.017 (.005)
No response		
1 Target Location	.057 (.011)	.026 (.006)
2 Target Locations	.076 (.013)	.086 (.013)

Standard error in parentheses.

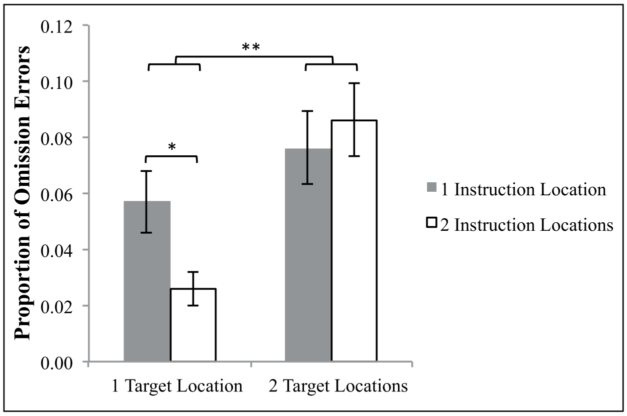


Figure 7. Mean proportions of omission errors by instruction and target locations in Experiment 2.
Error bars represent standard error of the mean.
*$p < .05$, **$p < .01$.

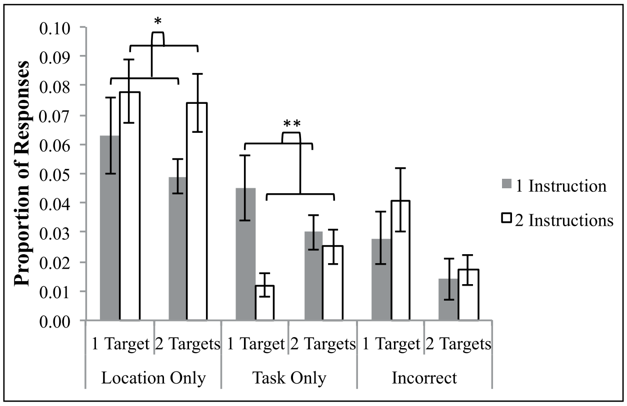


Figure 8. Mean proportion of commission errors by error type, instruction locations, and target locations in Experiment 2.
Error bars represent standard error of the mean.
*$p = .05$, **$p < .05$.

There was no effect of Instruction Location when there were two prospective memory target locations, $F < 1$. This reflects the pattern of performance for the Correct data, in that the 2 Instruction–1 Target condition had the highest accuracy and the lowest omission error rate.

Next, the error rates for the errors of commission are shown in Figure 8. These data were submitted to a 2 (Instruction Location) × 2 (Target Location) × 3 (Error Type, excluding No Response) ANOVA. There was a main effect of Error Type, $F(2, 376) = 34.03$, $MSE = .003$, $p < .001$, $\eta_p^2 = .15$, as well as a significant Error Type × Instruction Location interaction, $F(2, 376) = 6.22$, $MSE = .003$, $p = .002$, $\eta_p^2 = .03$. The main effect reflects the fact that people made Location Only commission errors ($M = .066$) more often than Task Only[3] ($M = .028$) or Incorrect ($M = .025$) errors. Breaking down the Error Type × Instruction Location interaction reveals that there was an effect of Instruction Location for the Task Only errors, $F(1, 190) = 6.68$, $MSE = .002$, $p = .01$, $\eta_p^2 = .03$, with fewer errors made when there were two instruction locations, and a marginally significant effect for the Location Only errors, $F(1, 190) = 3.81$, $MSE = .005$, $p = .052$, $\eta_p^2 = .02$, with fewer errors made when there was one instruction location. There was no effect for Incorrect responses, $F < 1$, indicating that the number of instruction locations did not impact this type of error.

Discussion

Because the results were broken down by correct and error responses, they are discussed here in the same way.

Correct responses. The data from the Correct responses provided the strongest evidence for how people use event models and how those models impact how well people remember the tasks that they need to do. As predicted by event cognition theory, people performed best in the 2 Instruction–1 Target condition, when they received instructions from two locations and performed the prospective memory tasks in one common location. This configuration allows people to create one event model for their goal while also providing the opportunity to encode that event model twice as each instruction is given. As a result, the event model is strengthened.

Performance among the other three conditions was similar to each other and lower than in the 2 Instruction–1 Target condition. In the 1 Instruction–1 Target condition, there is also just one event model for the prospective memory goal, but because the instructions both come from one location, people only establish that event model one time. The event model is not strengthened, which is why performance was lower than in the 2 Instruction–1 Target condition. Next is the 1 Instruction–2 Target condition, in which people make two event models for their goals based on instructions from one location. In this circumstance, there is no additional strengthening of either event model. Finally, the 2 Instruction–2 Target condition leads to two event models, each paired with its own set of instructions, thus resulting in four event models total. No cue model received increased strengthening. Moreover, the management of so many event models may have had a small impact on performance.

Error rates. As a reminder, the error response analyses were separated into errors of omission and commission. Therefore, the discussion of the error rates is broken down in the same way.

Errors of omission. Analysis of the omission errors, or the No Response data, revealed the same pattern of results as was seen with the Correct data. That is, the main effect of Target Location revealed more errors when there were two prospective memory target locations, and there were fewer errors in the 2 Instruction–1 Target condition, which had two instruction locations and one prospective memory task location. Because the pattern of data parallels that for the Correct data, the idea that the event structure used in the 2 Instruction–1 Target condition improves prospective memory performance is strengthened. People have better memory, potentially because when two encoding events converge on one target event model, they are less likely to forget to do the prospective memory tasks.

Errors of commission. The commission errors are the Location Only, Task Only, and Incorrect responses. Several interesting results were found. First, the main effect of Error Type indicated that people made Location Only responses more often than the other two types of commission errors. In other words, when people made a commission error, they were most likely to remember to do something when they were in the correct cue location as compared with somewhere else. This supports the idea that location serves as a good prospective memory cue to do *something*.

Beyond this, there was also a significant interaction of Error Type with Instruction Location. The Incorrect responses were unaffected, but there were fewer Task Only responses and more Location Only responses when there were two instruction locations than when there was one. These findings also align with the Correct and the omission error data. Specifically, this suggests that for the 2 Instruction–1 Target condition, memory was better for the location of the prospective memory tasks, while simultaneously making people less likely to respond with the prospective memory tasks if they were not sure of the location. In most cases, people remembered both, but location remains the strongest cue. Therefore, the most likely commission error was to remember just the location when there were two opportunities to plan for the same target event.

General discussion

The present set of experiments is the first direct assessment of location-based prospective memory, and they provided evidence that location is an effective prospective memory cue. Overall performance on the prospective memory tasks was high. Moreover, although there was no difference in the pattern of errors in Experiment 1, in Experiment 2, which had a greater prospective memory demand on participants, people were more likely to remember just the location and forget the activity than the reverse when they made an error. Thus, the spatial location was a prospective memory cue, even if a person could not remember what was to be done. In addition, Experiment 2 revealed that performance improved when people received instructions from two locations to do two prospective memory tasks in one common event location. Because this one condition improved performance, it is clear that event structure plays a role in prospective memory. In other words, when trying to remember to perform tasks in the future, people are able to make better use of that particular configuration of events than others.

Prospective memory research has made great progress over the past several decades, but this connection between prospective memory and event structure has been largely missing. It is well known that event structure impacts retrospective memory, and it is also known that there is a retrospective component to prospective memory (i.e., people need to remember what the task was to successfully perform it; e.g., Einstein, Holland, McDaniel, & Guynn, 1992). However, the types of event cues used in previous studies of event-based prospective memory were primarily entities involved in the ongoing events rather than the spatial-temporal framework. By exploring location-based prospective memory, this study has shown that by using event cognition theory, the exploration of prospective memory can be extended to new areas. Prospective memory outside the laboratory certainly can involve event-based or time-based entities, but it also often involves one's presence in spatial locations.

Moreover, the present results contribute to the Event Horizon Model (Radvansky, 2012) that aims to provide a unified explanation for why shifts in event models (i.e., event boundaries) can help or hinder memory in different situations. Specifically, the findings from these experiments provide a new instance in which memory is enhanced. The Event Horizon Model suggests that the presence of event boundaries can enhance memory through a chunking of information (e.g., Pettijohn et al., 2016). The current findings extend this idea: breaking the prospective memory task instructions into two encoding events improved memory but only when both prospective memory tasks were to be performed as part of the same location-based event.

We suggest the finding that people were more accurate in the 2 Instruction–1 Target condition than the other three conditions, which were more similar to one another, speaks to the prospective nature of these tasks, and may draw on the *episodic future thinking* (EFT) literature. EFT (Atance & O'Neill, 2001) is when a person imagines experiencing a particular scenario, or episode, at some time in the future. For example, if Steve has to remember to buy light bulbs the next time he is at the hardware store, he may imagine the act of picking up bulbs during his next visit. EFT is used to plan actions that will occur in a short time frame. In a diary study, D'Argembeau, Renaud, and Van der Linden (2011) found that 63% of EFT reported for things occurring in the near future (defined as the same day, week, or month) had to do with action planning. In other words, people use EFT to make it easier to successfully remember and perform tasks that they need to do later. In addition, Brewer and Marsh (2010) demonstrated that familiarity with the context of the ongoing task improved people's performance on a prospective memory task because it allowed them to better encode their future plan. Finally, there is some evidence that prospective memory and EFT draw on similar cognitive processes (Terrett et al., 2016). In the current experiments, it is reasonable to assume that the majority of participants were familiar with the context of a shopping mall and, therefore, would be able to plan ahead while encoding the prospective memory tasks.

More specifically, for the present study, it is possible that people use EFT to plan for the execution of the prospective memory tasks when they get the task instructions at the start of each trial (although we have no data that speak directly to this issue). The benefit seen in the 2 Instruction–1 Target condition may occur because people have two events (i.e., when they encode each set of instructions) to engage in EFT to plan for a single, common event (i.e., to do the prospective memory tasks in a common location). Processing the same target event twice strengthens the likelihood that the prospective memory tasks will be successfully remembered.

What about the other three conditions? Like the 2 Instruction–1 Target condition, the 1 Instruction–1 Target condition had one target event for both prospective memory tasks. However, both task instructions were provided together from the same source as part of a single event. Thus, people only had one opportunity at encoding to plan for the target event, and so prospective memory was not boosted. The 2 Instruction–2 Target condition also shared an element with 2 Instruction–1 Target, which was having two instruction-encoding events. Although the number of planning opportunities was the same, they referred to two separate prospective memory target events. Therefore, neither of the target events received the benefit of engaging in EFT twice for a common event. Finally, the 1 Instruction–2 Target condition was the reverse of the 2 Instruction–1 Target condition, with one instruction event and two target events. People had just one opportunity to plan for two separate target events.

In addition to the lack of benefits, the small, but nonsignificantly, worse performance in the 2 Instruction–2 Target condition may reflect some small role of retrieval interference as there are more event models needed in this condition than the others.

Comparison of Experiments 1 and 2

To further verify that the improvement seen in the 2 Instruction–1 Target condition was an improvement, the Correct response data from each condition in Experiment 2 were compared with the Correct data from Experiment 1. Experiment 1 can be considered a baseline in this situation as there was only one prospective memory task and no manipulation of instruction and target events. Single factor ANOVAs showed that there was no difference between Experiment 1 and the 1 Instruction–1 Target condition, $F < 1$, nor between Experiment 1 and the 1 Instruction–2 Target condition, $F(1, 253) = 1.36$, $MSE = .03$, $p = .24$, $\eta_p^2 = .005$. Performance in the 2 Instruction–1 Target condition was significantly higher than Experiment 1, $F(1, 253) = 4.59$, $MSE = .02$, $p = .03$, $\eta_p^2 = .02$. This is consistent with the idea that the benefit of the 2 Instruction-1 Target condition seen in Experiment 2 was actually an improvement in prospective memory performance and not simply worse performance in the other conditions. Finally, performance in the 2 Instruction–2 Target condition was significantly lower than Experiment 1, $F(1, 253) = 6.95$, $MSE = .04$, $p < .01$, $\eta_p^2 = .03$. This supports the earlier suggestion that there may be some performance deficit in the 2 Instruction–2 Target condition.

Alternative explanations

In this section, we consider two alternative accounts of our data that build on standard word list memory accounts. The first of these alternative explanations is that the superior performance that occurs for the 2 Instruction–1 Target condition is a result of a spacing effect (e.g., Glenberg & Lehmann, 1980). Specifically, in that condition, prospective memory task information is encountered twice at points that are spaced apart. Although this account has some appeal on the surface, a close look suggests that it is implausible. First, the spacing effect reflects superior memory of some types of repeated practice (spaced) over others (massed). This comes from a more general finding that repeated practice is better than a single encounter (e.g., Ebbinghaus, 1885). However, there is no general repeated practice benefit for Experiment 2. Second, the spacing effect generally refers to the number of items between repetitions of a given item, often called lag. However, there are no intervening memory items in this case. Third, the spaced practice effect generally is applied to content information that is repeated. That is not the case here. In all conditions, there were two different pieces of content, namely the target actions. What is repeated is the cue. We are unaware of any research showing that a benefit is gained by repeating a cue. If anything the paired-associate learning literature shows that repeating a cue with different items results in worse rather than improved performance (e.g., Postman, Stark, & Fraser, 1968).

A second alternative explanation is that the benefit observed in the 2 Instruction–1 Target condition is due to retrieval practice (e.g., Roediger & Karpicke, 2006). According to this view, when people go to the second instruction location, this would remind them of the prior instruction location. This reminding would then serve as retrieval practice for the target location, thereby boosting performance. There are several problems with this account. First, again, this explanation does not take into account the fact that two different target actions are being committed to memory; thus, this is not complete retrieval practice. Second, one could argue that retrieving the target action for the first instruction would interfere with the memory for the second target action for that location as a form of proactive interference (e.g., Postman et al., 1968.). This clearly did not occur. Third, there is no evidence that people are actually retrieving a memory of learning the first target action when they get the second target action at a different location. They may be, and they may not be. Finally, if a retrieval practice process were operating, then one would expect that a similar boost would have been observed for the 2 Instruction–2 Target condition. However, if anything, the data are trending in the opposite direction. Thus, a retrieval practice account does not seem a likely alternative explanation of our data.

Future directions

Having established that locations can serve as effective prospective memory cues and that event structure can improve prospective memory performance in some cases, we can now outline some avenues for future research. First, it needs to be established whether location-based prospective memory performance is similar to or distinctive from event-based and time-based prospective memory. To this end, we are currently exploring performance in a setting in which people experience the same events, but the prospective cue is a location, an event (i.e., seeing a particular entity), or a certain time.

Second, we suggested that when people were given the future, prospective memory task, they may have imagined the event in the future when they would need to do that task. Although this seems a plausible course of events, we actually have no evidence for this. To support this argument for the cognitive processes that people are engaging in, a direct assessment or manipulation of what is happening at encoding is needed.

Third, it would be of interest to explore what would happen when the location in which a person gets a prospective instruction is the same in which the task will be done.[4] For example, a person may be leaving the grocery store when they realise that they forgot to buy a jar of cumin. Rather than turning around and getting it, the person may store a future intention to buy it when they come to the store next time. Thus, the learning and the cue locations are the same. According to an event cognition perspective, this should be easier because the encoding event would so closely match the cuing event.

Finally, if our event cognition account is accurate, this pattern of data should not be limited to prospective memory. Instead, it should generalise to a range of memory tasks. For example, this account predicts that if people learn about a topic, it should show better retrospective memory if a single topic is learned across multiple events (2 Instruction–1 Target) than if that single topic is learned as part of one event (1 Instruction–1 Target), multiple topics are learned about in a single event (1 Instruction–2 Target), or multiple topics are each learned about in separate events (2 Instruction–2 Target). Although there is some evidence to support some of this (e.g., Pettijohn et al., 2016), all of these comparisons have not been present in a single study. We are currently exploring this, as well.

Conclusion

The present experiments bridge the gap between prospective memory and event cognition by examining the effects of location-based prospective memory cues. People frequently need to remember to do things in particular locations, so it is important to understand what circumstances will help or hinder the ability to successfully remember. The 2 × 2 design of this study (i.e., prospective memory instructions from one or two locations, prospective memory tasks executed in one or two target locations) addressed this issue by demonstrating that having two instruction-encoding locations and one prospective memory target location enhanced prospective memory abilities, whereas the other three combinations were not significantly different from each other. By incorporating important elements of event cognition, these results, along with the future directions, will progress and expand the field of prospective memory.

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Notes

1. The reminders did not appear to influence performance. Correcting for times people got stuck at the Info Desk and/or Manager, participants went to the wrong location 0.36 times per trial in Experiment 1 and approximately 0.5 times per trial in Experiment 2 (slight variations per condition), which is quite low. Many of these errors were quite likely mistakes caused by accidentally backing into stores when trying to navigate. The hidden triggers were placed right on the threshold of each store, making them easy to activate. Regarding the lower proportion in Experiment 1, because some of the errors are likely due to actual forgetting of the next location, we find it reasonable that people with only 1 prospective memory task to remember would make fewer mistakes than those with 2 tasks to remember. We thank an anonymous reviewer for suggesting this possibility.
2. Although many studies of prospective memory collectively have accuracy levels ranging from 20%-80% (e.g., Ball, Knight, Dewitt, & Brewer, 2013; Brooks, Rose, Potter, Jayawardena, & Morling, 2004; Einstein, Holland, McDaniel, & Guynn, 1992; Einstein & McDaniel, 1990; Knight, Nicholls, & Titov, 2008), there are also multiple studies reporting performance at or near ceiling (e.g., Ball et al., 2013; Groot, Wilson, Evans, & Watson, 2002; Kalpouzos, Eriksson, Sjolie, Molin, & Nyberg, 2010; McBride, Beckner, & Abney, 2011). This often reflects difficulty level. The present Experiment 1 allowed an assessment of task effectiveness prior to introducing difficulty. If accuracy was not high with this easier task version, that would have indicated either a hidden difficulty or an unreliable measure.
3. It may be of interest to note that, in both of the conditions that had two Target locations (1 Instruction–2 Target and 2 Instruction–2 Target), roughly 60% of the Task Only responses were actually "mix-ups." By this we mean that the task assigned to the first target store was done in the second, and/or the task assigned to the second store was done in the first.
4. We would like to thank an anonymous reviewer for suggesting this possibility.

ORCID iD

Andrea E O'Rear https://orcid.org/0000-0003-3936-7451

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Appendix 1

List of prospective memory task options

Fix the cash register
Deliver flowers
Set up a display
Help rearrange the store
Deliver lunch
Pick up home-grown tomatoes
Break down empty boxes
Repair the receipt printer
Congratulate shop owner on a new baby
Drop off movie tickets
Say hello to the manager
Help clean the floor
Replace the broken light bulb
Pick up a hand-made card
Take a piece of candy from the bowl
Help put up sales posters
Choose appropriate background music
Return the video the cashier lent you
Take inventory
Collect customer satisfaction
Pick up donations for local charity
Pick up a check
Sign a birthday card
Check fire extinguisher
Check mouse traps
Don't know