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Breaks and Task Switches in Prospective Memory

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SUMMARY

Based on research showing that easing task demands improves prospective memory, we examined the effects of breaks and task switches on prospective memory. The first experiment suggested that people tend not to take advantage of breaks to improve prospective memory unless specifically instructed to do so. The next two experiments showed that both breaks and task switches interfered with prospective memory. The results indicate that work settings with frequent breaks and task switches may be especially susceptible to prospective memory failure. Copyright © 2006 John Wiley & Sons, Ltd.

If we think about it even minimally, it is clear that our everyday lives are replete with prospective memory demands such as remembering to take vitamins, to give messages to various people, and to carry out errands. Prospective memory is also critical to many work settings. Loukopoulos, Dismukes, and Barshi (2001) have described the enormous number of prospective memory demands that occur in cockpit situations. Although many of these are scripted, they are still subject to failure under highly demanding situations, when routines are disrupted, and when there are interruptions. Prospective memory failures in these work settings can be catastrophic. For example, following a series of interruptions, an airline crew in 1987 forgot to set the flaps to the take-off position. In this particular case the warning circuit failed and the plane crashed, killing all but one person (Holbrook & Dismukes, 2005). Recently Gawande, Studdert, Orav, Brennan, and Zinner (2003) estimated that the typical large hospital has about one case a year of physicians leaving instruments or sponges in patients after surgery. Despite the best intention to remove these items, the demanding circumstances of surgery occasionally lead to these kinds of human error.

Existing research has revealed a number of factors associated with demanding work settings that affect prospective remembering. For example, interruptions that engage subjects in a new task for as little as 15 seconds have been shown to interfere with

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prospective memory (Einstein, McDaniel, Williford, Pagan, & Dismukes, 2003; see also Dodhia & Dismukes, 2005). McDaniel, Einstein, Graham, and Rall (2004) showed that presenting a small blue dot on the corner of a computer screen as a reminder of the prospective memory intention enabled participants to overcome the negative effects of such interruptions. A central finding in the prospective memory literature is that prospective memory suffers when the demands of the ongoing task are increased or when attention is divided with a task that engages central executive resources (Marsh & Hicks, 1998). Based on Marsh and Hicks' (1998) research, the central interest in this research was to examine whether breaks in the ongoing task can improve prospective memory. One possibility is that breaks release people from the high demands of their ongoing task and free up resources to review and refresh their intended actions (see also Kvavilashvili, 1987). From an applied prospective, if this were the case then it would suggest that intentionally creating breaks in demanding work routines would be helpful in maximizing prospective memory performance. On the other hand, the presence of breaks may have no effect on prospective memory. When given breaks, people may truly take breaks and not use them to reactivate intentions. We may be 'lazy' in the sense of not optimally using our free time to benefit the task at hand. Still another possibility is that breaks may interfere with prospective remembering. Breaks may, for example, function like interruptions and disengage individuals from the task demands (Einstein et al., 2003; McDaniel et al., 2004), and thus could possibly lower prospective memory.

To begin to test these possibilities, in the first experiment we examined whether people use breaks effectively to improve prospective memory. Participants were given the ongoing task of rating words and the prospective memory task of pressing a designated key whenever any of four target events occurred. They were given breaks during the ongoing task, and we varied whether or not they received a reminder about the prospective memory task during the break. We also varied the position of the target event following the break. Specifically, the target occurred in the 5th or the 20th position following a break. Our thought here was that if people refresh their intentions during the break, then the effects of this rehearsal might be more prominent immediately. Such a finding would be in line with Loftus' (1971) results demonstrating higher prospective memory after shorter retention intervals (although see Hicks, Marsh, & Russell, 2000, for different results).

EXPERIMENT 1

Method

Participants and design

Eighty-three San Jose State University students from the psychology research pool were tested individually in this experiment. Participants were randomly assigned to one of four experimental conditions produced by the factorial combination of the reminder variable (reminder, no reminder) and the position of prospective memory targets (5th or 20th position in each block).

Materials

The stimulus set consisted of 196 words taken from Thorndike and Lorge (1944). Each word was assigned to one of four ongoing task sets. The categorization task required participants to view drawings of objects and to rate on a five-point Likert-type scale how well they fit into a given descriptive category. For the pleasantness-rating task, participants rated the pleasantness of adjectives and nouns on a five-point Likert-type scale. The synonym selection task required participants to select a synonym of a designated word from five alternatives. The similarity task required that participants rate the similarity of two words on a five-point scale.

Four additional words were included as prospective memory target words (*song*, *sale*, *volume*, and *tall*). These targets were matched to the other words on word frequency. All trials and instructions were presented on a desktop IBM-compatible computer.

Procedure

Participants were first informed that they would perform a series of judgment tasks. The participants were then told that, in addition to the judgment tasks, they should press the period key on the keyboard if any one of four target words appeared during the judgment tasks. The four target items were displayed, and the participants were given 1 minute to memorize them. Participants were then asked to recall all four items. The rare participant who had trouble recalling the items was given additional time to study the set and was again asked to recall all four target items.

Next, participants were given a brief description of each of the experimental tasks (i.e., category judgments, similarity ratings, pleasantness ratings, and synonym selection) and a practice trial for each task. Once participants indicated that they understood the tasks and the instructions, the subject-paced experimental trials were presented. All 48 trials for each experimental task were presented in a single block. The order of the task blocks was counterbalanced across participants such that each task type occurred in each serial position with equivalent frequency. Each block of trials was preceded by an 8-second break interval. In the reminder condition, the reminder, 'Remember what to do if you see a target word' appeared on the monitor during the break. We chose this wording because previous research suggested that the most efficient prospective memory reminders cue both the target event and the prospective action (Guynn, McDaniel, & Einstein, 1998). For the no reminder condition the 8-second break was unfilled and the monitor was blank. The entire session in this and the other experiments lasted about 30 minutes.

Results and discussion

The mean proportion of correct prospective memory responses (out of four trials) for each experimental condition is provided in Table 1. A 2×2 between subjects (reminder by target position) analysis of variance (ANOVA) indicated that providing prospective memory reminders during a break produced significantly more prospective memory responses than a break alone, $F(1, 81) = 4.81$, $MSE = 0.11$, $p < 0.05$. Neither the prospective memory target's placement in the experimental sequence (early or late) nor the

Table 1. Experiment 1: Mean correct prospective memory responses (and standard deviations)

Target position	Break only	*N*	Break with reminders	*N*
Early	0.54 (0.44)	24	0.76 (0.19)	20
Late	0.65 (0.31)	20	0.74 (0.27)	19
Mean	0.60		0.75	

Note: Standard deviations in parentheses. *N*, number of participants.

interaction was significant (F's < 1). The finding that the position of the target relative to the break did not affect prospective memory is consistent with that of Einstein, Holland, McDaniel, and Guynn (1992) but runs counter to that of Loftus (1971), who found poorer prospective memory over longer delays. It is interesting to note that Loftus' effect was less pronounced in a cued condition in which the intended action was associated with a particular cue (as was the case in the present research). Without cuing, perhaps people are more dependent on strategically maintaining the intention in mind and it may be that long delays are more likely to interfere with this maintenance (cf., Einstein, McDaniel, Thomas, Mayfield, Shank, Morrisette, & Breneiser, 2005). The results also indicate that appropriate reminders (cf. Guynn et al., 1998) during a break improved prospective memory relative to an unfilled break. This result suggests that participants were not reminding themselves on their own about the prospective memory task during the break. Thus, it appears that people do not use breaks optimally and take advantage of freed resources in the middle of a prospective memory task, unless given a reminder.

At this point it is not entirely clear what participants were doing during unfilled breaks. They may have been refreshing their intentions but perhaps doing so less optimally than when given a reminder. The results are difficult to interpret because we did not include a control condition that did not receive a break. Thus, the purpose of the next experiment was to directly compare prospective memory performance in a condition that received no break with a condition that received a break without a reminder. We also varied whether or not there were task switches. In Experiment 1, whenever there was a break there was also a task switch, and it is important to disentangle the effects of breaks from those of task switches. In the next experiment, participants either performed the same task throughout the experiment or switched to a new task at each break. Given that we often switch tasks in demanding work settings, there is applied value to examining the effects of task switches. In terms of functional effects of task switches, we may review our intentions whenever we change tasks (which should improve prospective remembering), or the task switch may in some way disrupt the maintenance of the intention (which should lead to a decrement in prospective memory performance).

EXPERIMENT 2

Method

Participants and design

Sixty-four students at the University of New Mexico volunteered for the study in return for credit toward their psychology courses. Sixteen participants were assigned to each of the four conditions resulting from the factorial combination of the break (presence or absence of a 10 seconds break period between blocks of stimuli) and the task-switch (same or different ongoing task) variables. All participants were tested individually.

Materials

Four sets of stimuli were constructed for the four ongoing tasks. One set of 240 words from Thorndike and Lorge (1944) was used for the pleasantness-rating task. These same items were used for the anagram task, wherein 240 word pairs of anagrams and correctly spelled targets were generated. Half of the anagrams were true anagrams, and the other half false (i.e., their component letters could not be rearranged into the target word). The similarity-judgment task required a second set of 240 words to complement the original corpus. In this case, the companion stimuli were either semantically related or not to the original word. The synonym task consisted of the core set of 240 stimulus items and four comparison words for each item, one of which was a true synonym.

Procedure

In the no-switch groups participants received one ongoing task for the entire experiment (240 trials). The particular task these participants were assigned was counterbalanced across participants. Pleasantness rating required participants to rate the pleasantness of a word from '1' to '5' using the computer's numeric keypad. The anagram task required participants to make a true/false judgment on whether a comparison word was an anagram of a target comparison word, with the numeric key '1' indicating true and the numeric key '2' indicating false. In the synonym task two words were presented, and the participant judged if they had the same meaning. The similarity task required participants to determine which of four comparison words was most similar to the target with a response from '1' to '4' on the numeric keypad.

In the switch groups, participants received 60 trials of each ongoing task, with the order of tasks counterbalanced across participants. Participants were told that they would be performing tasks presented by the computer and that the instructions for each task would appear at the top of each display. They were then informed of the prospective memory component of the experiment, which was introduced as a secondary interest. When any of a set of four words (*ignore*, *hope*, *simple*, *health*) appeared during the course of the experiment, they were to press the period key on the computer keyboard. The participants were then asked to repeat these instructions and words back to the experimenter. Those rare participants who failed to recall all four targets were represented with the items and again asked to recall them.

The trials were experimenter-paced, with each trial lasting for 5 seconds. In the break condition, after each set of 40 trials, the message 'Take a brief rest break' appeared for 10 seconds. The message did not inform participants about whether or not they were switching to a new task.

At the conclusion of the experimental tasks the participants were queried on their recognition of prospective memory targets. They were presented a list of 20 items, four of which were the prospective memory targets.

Results and discussion

The mean proportion of correct prospective memory responses (out of four) are displayed in Table 2 as a function of the switch and break conditions. A 2×2 (switch by break) between-subjects ANOVA revealed that breaks lowered prospective memory performance, $F(1, 60) = 5.20$, $MSE = 0.01$, $p < 0.05$. Also, task switches marginally lowered prospective memory performance, $F(1, 60) = 3.41$, $p < 0.10$. There was no significant interaction ($F < 1$).

To insure that prospective memory failures were not due to retrospective forgetting of the particular prospective memory target, prospective memory performance was conditionalized on successful target recognition in the recognition post-test (see Table 2). A 2×2 between-subjects ANOVA confirmed that breaks produced significantly lower prospective memory performance than did no breaks, $F(1, 60) = 4.15$, $MSE = 0.08$,

Table 2. Experiment 2: Means and standard deviations of prospective memory performance

Break	Task switch	Unconditionalized	Conditionalized on correct target recognition
Absent	No Switch	0.59 (0.25)	0.62 (0.25)
	Switch	0.42 (0.25)	0.46 (0.24)
Present	No Switch	0.39 (0.36)	0.45 (0.40)
	Switch	0.30 (0.26)	0.32 (0.27)

Note: Standard deviations in parentheses.

$p < 0.05$, and task switches produced significantly lower performance than did no task switches, $F(1, 60) = 3.87$, $p = 0.05$.There was no significant interaction ($F < 1$).

Based on the idea that prospective memory is a resource demanding process that can be disrupted by absorbing ongoing activities (Guynn, 2003; Marsh & Hicks, 1998), one might have expected better prospective memory in conditions where participants were given breaks in the ongoing activity, and thus an opportunity to self-remind. Counterintuitively, the results were exactly the opposite. Thus, the purpose of the next experiment was to determine whether or not these results could be replicated. In the next experiment, the materials and procedure closely resembled those of the previous experiment except that we tested new participants at a different university using a different experimenter and using different prospective memory target events.

Also, only participants who demonstrated accurate memory (on the post-test) for the prospective memory targets were included.

EXPERIMENT 3

Method

Participants and procedure

Participants were 87 San Jose State University students recruited from the Department of Psychology research participant pool. The materials and procedure were identical to those used in Experiment 2 with the exception that the prospective memory targets were *tall*, *song*, *volume*, and *sale*.

Results

The proportion of prospective memory responses as a function of condition is shown in Table 3. A 2×2 (switch by breaks) between-subjects ANOVA again showed that breaks

Table 3. Experiment 3: Means and standard deviations of proportion of prospective memory responses

Task switch	Break	*N*	No break	*N*
No switch	0.76 (0.27)	23	0.84 (0.25)	22
Switch	0.60 (0.31)	20	0.76 (0.27)	22
Mean	0.68		0.80	

Note: Standard deviations in parentheses. *N*, number of participants.

and task switches reduced prospective memory performance, $F(1, 83) = 4.21$, $MSE = 0.07$, $p < 0.05$ and $F(1, 83) = 4.17$, $p < 0.05$, respectively. There was no evidence of an interaction ($F < 1$).

GENERAL DISCUSSION

The results revealed that both breaks and task switches interfered with prospective memory. As such, they suggest that work settings with frequent task switches and breaks might be especially sensitive to prospective memory failures. Although this research focused on applied questions rather than underlying theoretical processes, we offer some possible explanations of these findings.

First, the results are inconsistent with an opportunist strategic view of prospective memory retrieval. One view of prospective memory retrieval is that it occurs through a capacity consuming process of monitoring the environment for the target event (Smith, 2003). From this perspective, one might expect people to seize every opportunity to reflect on one's prospective memory demands. If so, then (a) breaks should have improved prospective remembering and (b) reminders should not have helped because presumably participants were already thinking about the prospective memory tasks during the breaks. Clearly this was not the case.

The negative effects of task switches may have been due to a reduction in available contextual cues associated with the prospective memory intention. Nowinski and Dismukes (2005) showed that prospective memory retrieval was higher when the target cue occurred in an ongoing task context that matched the context in which the prospective memory intention was given. As applied to our findings, perhaps as participants started thinking about the prospective memory task in the beginning of the experiment there was some binding that occurred with the ongoing task, so that maintaining that ongoing task, relative to switching, led to higher prospective memory performance.

The negative effects of breaks may have been due to people suspending the old task demands (cf. Einstein et al., 2003), including those associated with the prospective memory task whenever they encountered a break. Participants may truly take a break when given a break. If so, when they resume an ongoing task it may be difficult to reactivate all of the task elements. The prospective memory intention may be especially difficult to reactivate because the external demands associated with the ongoing task mainly cue the ongoing task and not the prospective memory task. In addition, breaks could alter the individual's internal context, thereby reducing the availability of contextual cues previously associated with the prospective memory intention (see similar explanations for retrospective memory recency effects; Glenberg, Bradley, Kraus, & Renzaglia, 1983).

In conclusion, including breaks, which a priori would seem to provide opportunities to review the task requirements, can actually interfere with prospective memory performance. In light of other research showing that propitiously scheduled breaks can improve prospective remembering (Dodhia & Dismukes, 2005) and research showing that participants are more likely to strategically monitor when the importance of the prospective memory task is greatly emphasized (Einstein et al., 2005), the conditions under which breaks either improve or interfere with prospective remembering merit further examination.

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