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Effects of the Length of Retention Intervals and Metacognition of Prospective Memory Ability on Event-based Prospective Memory Performance

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This study examined the effects of the length of retention intervals and metacognition on event-based prospective memory performance. Sixty-one undergraduate students completed the Prospective and Retrospective Memory Questionnaire (PRMQ) to estimate their metacognition for prospective memory. Participants in the high and low PRMQ conditions were randomly assigned to three retention interval groups—short (2.5 min), middle (15 min), and long (30 min). They were given instructions for the cover and prospective memory tasks, and then conducted the cover task with the prospective memory task after the appropriate retention interval. The participants in the low PRMQ and long interval condition performed a more accurate prospective memory task than did the participants in the short interval condition.

Key words: prospective memory, metacognition, retention interval

Introduction

Memories of future plans or actions are required in many areas of human life and play an important role in the smooth flow of everyday living; this also applies to the memory of past experiences. Remembering to attend to a future event is called prospective memory, whereby people remember to carry out certain actions in the future without any prompting, such as explicit instructions to recall (Ceci & Bronfenbrenner, 1985; Meacham & Leiman, 1982). Successful prospective remembering involves not only the recall of the content of the task but also its retrieval at the appropriate moment to carry out the required action (Ellis & Kvavilashvili, 2000).

Many researchers suggest that prospective memory performance decreases over long retention intervals because a strong link exists between prospective memory performance and the length of retention (Loftus, 1971; Meacham & Leiman, 1982). However, some studies have found no relationship between prospective memory performance and the length of retention intervals (Einstein, Holland, McDaniel, & Guynn, 1992; Guynn, McDaniel, & Einstein, 1998).

Hicks, Marsh, and Russell (2000) suggested that prospective memory improved with increasing retention intervals. In their study, participants read the instructions for a cover task, which included a pleasantness rating task or syllable count task, on a computer screen. After

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reading the instructions, which were then reiterated, the participants were verbally informed about the prospective memory task by the experimenter. After the prospective instructions, the participants were randomly assigned to either a short (2.5 min) or a long (15 min) retention interval condition. The participants then engaged in the cover task and prospective memory task. Prospective memory performance was superior in the long retention group than in the short retention group.

This discrepancy in the relationship between prospective memory performance and the length of the retention interval appears to arise from the metacognition for the prospective memory task. In general, memory ability declines with age (e.g., Guynn et al., 1998). However, no age difference was observed in prospective memory performance even in older adults who complained about their prospective memory abilities decreasing due to age (Dobbs & Rule, 1987). Sellen, Louie, Harris, and Wilkins (1997) suggested that people may mentally consider unfulfilled intentions during a retention interval. Thus, people who are sensitive to their prospective memory performance would be predicted to activate metacognition for their prospective memory task. This would reduce their chances of failure of prospective memory. In addition, a decrease in cognitive function during aging was confirmed to have little negative effect on the prospective memory task in an experimental situation (Henry et al., 2004). The effects of metacognitive activation of prospective memory tasks would therefore be predicted to apply not only to older adults but also to relatively younger ones.

The prospective memory task is divided into the time-based task and the event-based task. The time-based task requires the participant to perform a specified behavior at a particular time, whereas the behavior for an event-based task is performed when a certain external event occurs (Einstein & McDaniel, 1990; Einstein, McDaniel, Richardson, Guynn, & Cunfer, 1995; Henry et al., 2004). Einstein & McDaniel (1996) confirmed that a time-based prospective memory task revealed an age-related reduction in prospective memory ability, whereas detecting an age-related reduction in this ability was more difficult with an event-based prospective memory task. This predicts that, compared to time-based tasks, event-based tasks will be more strongly influenced by the metacognition of prospective memory performance. In the present study, we examine the effects of the length of retention interval and self-reported prospective memory ability on event-based prospective memory performance.

Method

Participants and Design

Sixty-one undergraduate students (20 males and 41 females; mean age = 20.5; *SD* = 1.87) participated in the experiment. The participants were first asked to rate their own prospective memory ability using the Prospective and Retrospective Memory Questionnaire (PRMQ; Smith, Della Sala, Logie, & Maylor, 2000) before starting the experiment. The PRMQ is a set of questions about minor memory errors that everyone makes from time to time and is designed to provide a self-reported measure of prospective and retrospective memory slips in everyday life. The participants were asked to rate how often each type of memory failure occurred on a 5-point scale (1 = never, 5 = very often).

The participants were assigned to high and low meta-prospective memory groups based on their PRMQ scores. The participants from each group were then randomly assigned to three retention interval groups—short (2.5 min), middle (15 min), and long (30 min). The mean scores of the PRMQ items in each condition were as follows — short interval group (low: M = 3.5 (SD = 0.62), high: M = 2.3 (SD = 0.35)); middle interval group (low: M = 3.3 (SD = 0.41), high: M = 2.3 (SD = 0.29)); long interval group (low: M = 3.3 (SD = 0.23), high: M = 2.4 (SD = 0.27)). A 2 (meta-prospective memory: high or low) × 3 (retention interval: short, middle, or long) analysis of variance (ANOVA) was conducted on the mean score of the PRMQ items. A significant main effect was observed for meta-prospective memory (F (1, 58) = 112.48, $p < .01$) but no significant main effect was seen for retention interval (F (1, 58) = 0.35, *n.s.*). No significant interactions were evident. This affirmed that the participants were assigned appropriately to each condition.

In total, 19 participants participated in the experiment in the short retention interval condition (8 low and 11 high meta-prospective memory), 21 participants participated in the experiment in the middle retention interval condition (10 low and 11 high meta-prospective memory), and 21 participants participated in the long retention interval condition (10 low and 11 high meta-prospective memory).

Materials

The experiment used four event-based prospective memory targets that occurred in a series of 104 in the cover task. Four of the event-based words represented animal names (e.g., cat) and were randomly presented on trials numbered 25, 50, 75, and 100. Animal words were also presented on the trials numbered 101, 102, 103, and 104, in order to confirm participants' retention of their prospective memory task. Ninety-six words were presented during the cover task. In this task, participants were asked to assign either a pleasantness rating on a 5-point Likert scale (1 = very unpleasant, 5 = very pleasant) or to perform a syllable counting task by pressing a key on the computer keyboard. The cover task and prospective memory targets were presented in Kanji characters.

Procedure

In this study, both the instructions and experiment were carried out using a computer. The exception was the instructions for the prospective memory task, which were given verbally by the experimenter. Participants were first told that the purpose of the experiment was a study of the relationship between impression judgments and cognitive processing of Kanji characters. They read the instructions for the cover tasks and the experimenter then reiterated these instructions and verbally informed the participants of the prospective memory task. The participants were then asked to press the "/" key when an animal's name appeared in the cover task.

After the prospective task instructions, participants were asked to solve cryptographic tasks in each retention interval condition (2.5, 15, or 30 min). The experimenter timed the interval with a handheld stopwatch.

After each retention interval, participants performed the cover task. No mention was made of the prospective task instructions at this time. During each trial, a warning tone and fixation point (+) appeared for 500 ms. The word "Syllables?" or "Pleasantness?" then replaced the fixation point on the screen and remained there for 500 ms. The two queries were randomly presented in the trial sequence. After the query, a stimulus word replaced the queries. The stimulus word remained on the screen until the participant responded with a number from 1 to 5. Participants pressed the "/" key when the stimulus was an animal word. The computer recorded the number of participants who pressed the key and the response time (the time elapsed between appearance of the stimulus and the key press).

Results

Operation check

Twelve participants remembered the cover task and prospective memory task procedures during the retention interval program. Therefore, these participants were rejected from the following analysis because the retention interval was controlled by the length of the interference task. Thus, each condition was assigned to the following participants in the low meta-prospective memory condition: 8 participants in short retention (2 male, 6 female), 9 participants in middle retention (1 male, 8 female), and 6 participants in long retention (2 male, 4 female). In the high meta-prospective memory condition, 10 participants were assigned to the short retention condition (5 male, 5 female), 8 participants to the middle retention condition (1 male, 7 female), and 8 participants were assigned to the long retention condition (4 male, 4 female).

A paired t-test comparing the results in the mean pleasantness rating of positive ($M = 4.08$, $SD = 0.20$) and negative words ($M = 2.04$, $SD = 0.25$) in the cover task revealed a significant difference (t (48) = 21.05, $p < .01$). Additionally, participants correctly pushed the button 84% of the time for the syllable counting task. Thus, all the participants were confirmed to be concentrating on their cover tasks. A paired t-test comparing the results of the mean correct prospective memory performance of the first four ($M = 2.35$, $SD = 1.69$) and last four tasks ($M = 2.67$, $SD = 1.60$) showed a significant difference (t (48) = 2.22, $p < .05$), which suggested that the participants clearly understood our instructions for the experiment.

Correlations among the scores on the PRMQ items

First, we analyzed the relationship between each PRMQ item, including the prospective short-term self-cued, prospective short-term environmentally-cued, prospective long-term self-cued, and prospective long-term environmentally cued items (Table 1). Significant medium-degree positive correlations were found among the four prospective memory items.

Table 1 Correlations between the scores on the PRMQ items

	1	2	3
1. Short delay & Time-based PM	-		
2. Short delay & Event-based PM	0.46**	-	
3. Long delay & Time-based PM	0.51**	0.64**	-
4. Long delay & Event-based PM	0.25*	0.52**	0.57**

Note. PRMQ=Prospective and Retrospective Memory Questionnaire.
*$p<.05$, **$p<.01$

Performance on the prospective memory task

A 2 (meta-prospective memory) × 3 (retention interval) ANOVA was conducted on the mean score of the performance on the prospective memory task to probe the effects of meta-prospective memory and retention interval on the performance of the prospective memory task (Figure 1). No significant main effects were found for meta-prospective memory (F (1, 43) = 0.97, *n.s.*) and the retention interval (F (2, 43) = 1.46, *n.s.*). However, a trend was observed in terms of meta-prospective memory × retention interval interaction (F (2, 43) = 2.65, $p < .10$) revealing that, in the short retention interval, the participants in the low meta-prospective memory condition performed better on prospective memory tasks than did the participants in the high meta-prospective memory condition ($p < .10$). In the low meta-prospective memory condition, long retention intervals resulted in better performance on the prospective memory tasks than did the short and middle retention interval conditions ($p < .05$).

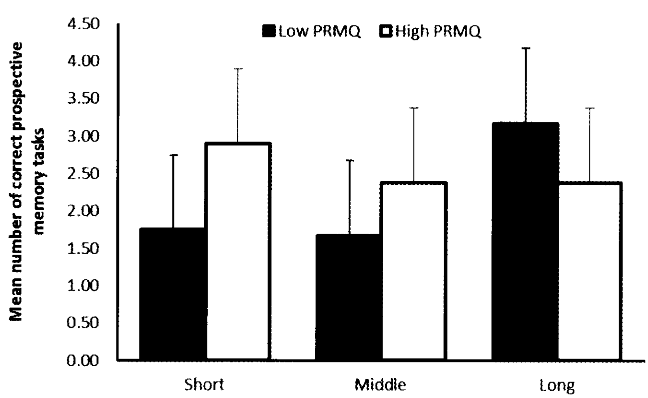

Figure 1. Mean number of correct prospective memory tasks in each retention interval. The error bar indicates standard deviation.

Response time of the prospective memory task

A 2 (meta-prospective memory) × 3 (retention interval) ANOVA was conducted on the mean duration (seconds) of the response time of the prospective memory task to check for effects of meta-prospective memory and retention interval on the response time of the prospective memory task (Figure 2). A significant main effect was seen for meta-prospective memory (F (1, 43) = 4.56, p < .05), revealing that participants in the low meta-prospective memory condition pushed the "/" key more slowly than did the participants in the high meta-prospective memory condition.

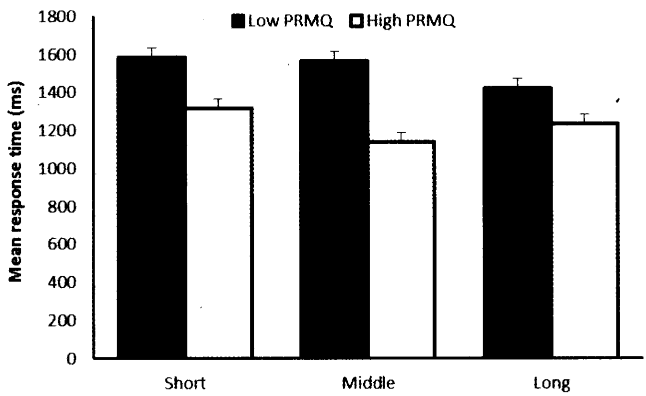

Figure 2. Mean response time for each retention interval. The error bar indicates standard deviation.

Discussion

In this study, we investigated the effects of retention interval and meta-prospective memory on the failure of event-based prospective memory. For the correlations between the scores on the PRMQ items, ratings of the participants' event-based prospective memory ability was related to their time-based prospective memory ability. Participants who gave a low rating to their event-based prospective memory abilities also gave a low rating to their time-based prospective memory ability. Likewise, a relationship was noted between the short-term and long-term prospective memory abilities. This suggested that metacognition of prospective memory does not independently constitute each sub-characteristic, such as length or cue, but these characteristics were influenced by a common factor.

In the performance of the prospective memory task, the participants underestimated their prospective memory abilities in the short delay interval condition decreased their performance on the prospective memory task as compared to the high estimation by the participants of their abilities. However, a longer retention interval resulted in a more accurate performance on the prospective memory task in the underestimated condition. Hicks et al. (2000) showed that prospective memory was improved by increasing retention intervals and the findings from the present study were essentially in agreement with those of Hicks et al. (2000). This suggested that prospective memory performance was established by the length of retention intervals, and also by metacognition of prospective memory mediated between the length of retention intervals and prospective memory performance.

Analysis of the relationship between the response time of the prospective memory task and the metacognition of prospective memory indicated that the participants in the underestimated meta-prospective memory ability condition increased their response time on their tasks. This result confirmed the previous findings that sensitivity for the task was increased by metacognition of prospective memory ability (Maylor, 1996).

Some issues remain to be resolved in future research. The first concerns the authenticity of the results. In the present study, participants performed our experiment in the laboratory. However, prospective memory performance has been suggested to differ in a laboratory situation compared to the natural context (Rendell & Thomson, 1999). Therefore, we need to investigate whether the metacognition of prospective memory served as a mediator between the length of retention intervals and prospective memory performance.

The second issue pertains to motivation for the task. Previous research showed that the motivation for the task was influenced by the task content (Dobbs & Reeves, 1996) and participant personality (Cutter & Graf, 2007). Prospective memory performance is affected by task motivation. In the present study, we could not control the participant's task motivation. These issues should be investigated in future studies aimed at decreasing the failure of prospective memory in everyday life.

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