The Influence of Target Event Frequency on Prospective Memory

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Abstract

Successful performance of a delayed intention task relies on recognition that a target event provides a signal for the retrieval and realization of the intention. We conducted repeated-instance event-based dual-task experiments in which the same action should be performed regardless of what particular target event occurs during an ongoing activity. We report two experiments that investigated important dimensions of this task design, and explored their influence on prospective remembering. The results suggested that the variations in the frequencies of target event influenced overall performance: relatively high frequency of target event improved prospective remembering. Performance was lower when target events were embedded in more difficult ongoing tasks. There was improvement of reaction time over presentations during ongoing tasks when remembering was compared for the first and final set of target events. As a result, it was suggested that the weight on the prospective memory task improved the performance of prospective memory task.

There are two nominally different memory activities; one is memory about past termed retrospective memory and another is memory for the future termed prospective memory. One of the characteristics of humans in comparison with other animals is the extent to which we live for the future. Many of our actions are best understood as goal directed, and the goals are often far in the future. Much of our lives are more or less directed to the distant future, or at least we are working toward sub-goals as part of a greater aim. Prospective memory plays a central part in a central aspect of our lives. Our own lives and the lives of others are organized around seeking and reaching goals, and prospective memory plays an integral part (Morris, 1992).

During our everyday lives, we often form an intention that we cannot realize immediately. We may be asked to attend a meeting tomorrow or decide to visit a friend after work (Ellis & Milne, 1996). In contrast to most retrospective memory tasks, there are no external agents that prompt the execution of planned actions. Instead, the rememberer has to identify the target event among other events at the time of retrieval. The target event is the item which in its subsequent appearance is the signal to perform a particular action. For example, remembering to leave a

message for a colleague requires that the person is recognized not only as a colleague or a friend but also as a reminder of the planned action (Mäntylä, 1993). Similarly, on a time-based prospective memory task (Einstein & McDaniel, 1990), one must remember that ten o'clock represents time for a coffee break and that a pill should be taken.

The type of error that occurs may depend in part on the characteristics of a particular intention. Some intentions can be realized immediately after their information, and others must be retained and recalled at a timely moment in the future (Kvavilashvili & Ellis, 1996). Both types of intentions are vulnerable to errors that can arise during the performance of their respective actions. A delayed intention is exposed to two kinds of sources of error: failure to correctly retain the intention over a period of delay and/or failure to recall it at an appropriate moment (Mizuno, 1998a; Ellis, Kvavilashvili, & Milne, 1999).

The paradigm where opportunities for realizing the intention are repeated is termed repeated-instance event-based prospective memory task; that is, intentions that should be recalled whenever a particular target event occurs in an ongoing activity. In a young adult population, these designs can induce very high levels of performance, often close to ceiling (Einstein & McDaniel, 1990; Mizuno, 1998b), and there is some indication of potential practice effects in a repeated-instant design (Ellis et al., 1999). The occurrence of either one of these effects may be influenced by the nature of the ongoing, concurrent activity within which a designated target event occurs. It is necessary, therefore, to consider whether any variations in performance that accompany changes in the frequency of repeated-instance events are consistent across the different degrees of difficulty of an ongoing task.

The experiments reported here were designated to address these important questions on repeated-instance event-based intentions and thereby examine some basic characteristics of experimental tasks.

1) What are the effects of varying the number of occasions on which a target event occurs in repeated instance event-based design? Is performance generally enhanced by a relatively high number of opportunities for recall?
2) Are the above effects influenced by the different degrees of difficulty of an ongoing task?
3) Does the repeated-instance design induce changes in performance over time, leading to a practice effect?
4) Is performance improved by emphasizing the relative importance of prospective memory task?

The ongoing task in Experiment 1 and Experiment 2 was to answer whether or

not the sum of calculation is correct. A prospective memory task was embedded in the ongoing task. Subjects were requested to carry out a particular action instead of the one required by the ongoing task. They were requested to press a response key when a certain target number which was told at the beginning trial of each list occurs.

EXPERIMENT 1

This experiment explored the effects on prospective memory task performance, entailing the presentation of the same target event on a relatively high and low number of occasions during one of two degrees of difficulty of an ongoing task of calculation. One is relatively easy and another is relatively difficult.

We would expect to observe a relative improvement in performance in high, as compared with low target event frequency condition. High target event frequency should be more likely to produce a practice effect since the likelihood of recognizing a target event would be higher for later, compared with earlier, presentations. Each of these effects may depend upon the characteristics and demands of the ongoing activity in which the target events are embedded.

The ongoing activities employed in this study are calculations of division which have two degrees of difficulty. We might expect target event recognition, and prospective memory task performance to be generally higher when target events are embedded in a relatively easy ongoing task compared with a relatively difficult ongoing task.

Method

Design and subjects

The experiment used a 3*2 between-subjects design. The first factor was target event frequency (low, middle, high), while the second factor was the degree of difficulty of the ongoing task (difficult vs. easy). Five people were assigned to each of the six experimental conditions.

The subjects were undergraduate students, undertaking a variety of degree courses, who participated in the study and received either course credit or a small payment in return. Their ages ranged from 18 to 36 years.

Materials and procedure

The ongoing task is a calculation of division, and they press the "1" key on the

computer keyboard when the sum given for each expression is correct and press the "0" key when it is incorrect. In difficult ongoing tasks, a number of three figures is divided by a number of two figures. In easy ongoing tasks, a number of two figures is divided by a number of one figure.

The prospective memory task was embedded in the calculation procedure. The prospective memory task is to respond to a particular target number which occurs at the beginning trial of each list. The target number is different in each list. They are instructed to press the "p" key whenever they encounter the target number in each expression. When an expression of division appears on the screen one by one, the subjects press the keys 1, 0 or P on the keyboard.

The number of targets presented in each list varied from two to six. The target number appears twice among thirty expressions of division in low frequency conditions. A target number appears four times in middle frequency condition. The target number appears six times in high frequency condition. The subject were not informed of the number of occasions on which they might expect to encounter the target number. One list consists of thirty trials, and one session consists of eight lists. The presentation of target number and the ongoing task of calculation was controlled by a program designed to run on an Apple Macintosh computer. Each was tested individually in an experimental session that took about 40 minutes to complete.

At the outset, the subjects were informed that most of the experimental tasks would require pressing a key on the computer, but a few tasks required the use of paper. For these tasks requiring paper, the subjects were asked to write their name at the top of every sheet of paper. After the experiment, they were handed a sheet of paper containing questions on prospective memory task they had just completed. The subjects were asked to rate (on a 5-point scale, with 1 indicating not at all, 2 indicating scarcely, 3 indicating sometimes, 4 indicating often and 5 indicating all the time) the degree to which they monitored or thought about the prospective memory task during the experiment. Other questions asked them to describe how they remembered to perform the key press task.

Results and discussion

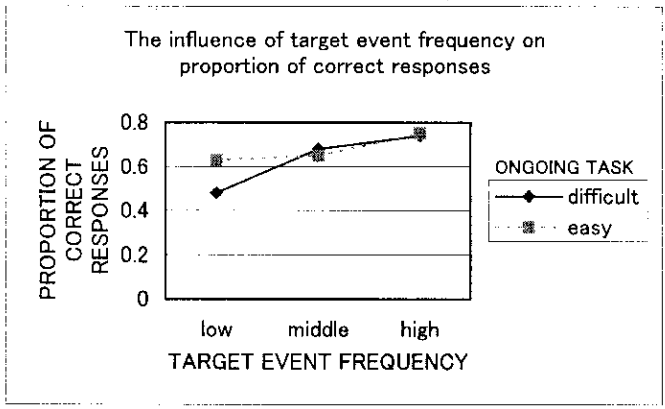
1) Effect of target event frequency

Raw scores were expressed as a proportion of the total number of target event presentations in the task. Fig.1. shows the influence of target event frequency on the mean proportion of correct responses in prospective remembering. Fig.2. shows the influence of target event frequency on mean response time of correct responses in prospective remembering.

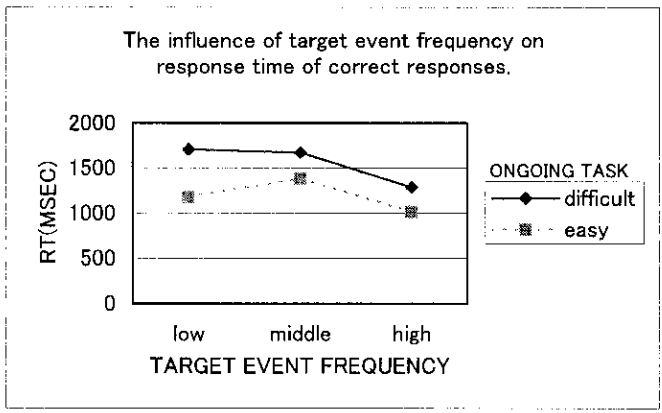
These results suggested that there was relative improvement in performance in high compared with low target event frequency. When target event frequency is relatively high and the length of the ongoing task is kept constant, the interval between presentations is relatively short and thus a target event will be more highly activated with shorter periods for de-activation between presentations. Successful recall and performance on one occasion is likely to increase the strength of the association between a target event and an intended action and thus reduced the likelihood of recall failure on subsequent target event presentations.

2) Effect of the ongoing task

The performance of a prospective memory task is relatively low when target events were embedded in a more difficult ongoing task as shown in Fig.1. and Fig.2. Fig. 3. shows the proportion of correct responses in ongoing tasks. Fig. 4. shows the



〈**Fig.1**〉 The influence of target event frequency on proportion of correct responses in prospective remembering.



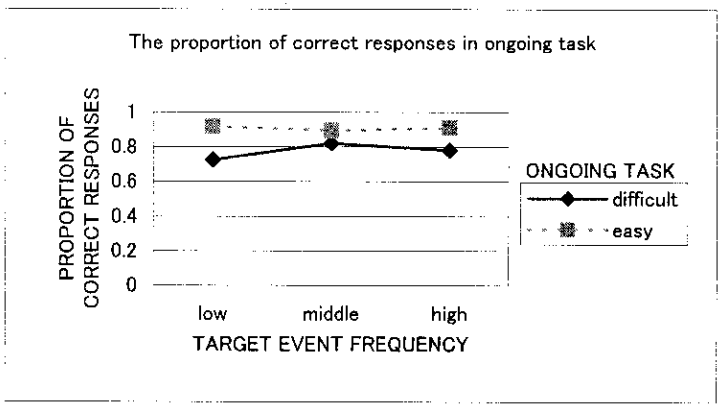
〈**Fig.2**〉 The influence of target event frequency on response time of correct responses in prospective remembering.

response time of correct responses in ongoing tasks.

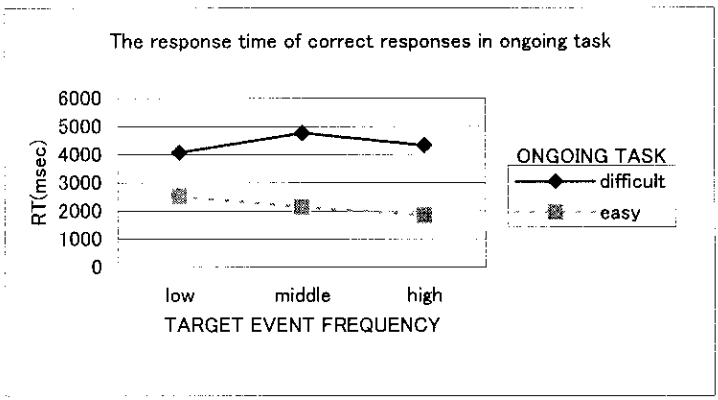
In the difficult ongoing task it was more difficult to obtain a correct answer than in the easy ongoing task, and this difference was significant $F(1,24)=7.73$, $P<.05$. The difficult ongoing task needs more time to obtain correct answers, and this difference was also significant $F(1,24)=13.65$, $p<.001$. The difference among frequencies of memory tasks was not significant.

3) Practice effect

To examine changes in performance across the duration, subjects' scores were divided into those relating to the target event presentations that occurred in the first half of the ongoing task and those relating to the second half. Fig.5. shows the practice effect of proportion of correct responses, and Fig.6. shows the practice effect of reaction time. The data suggests that the performance is generally enhanced in reaction time from the first to the second half of target event presentations.



〈**Fig.3**〉 The proportion of correct responses in ongoing tasks.



〈**Fig.4**〉 The response time of correct responses in ongoing tasks.

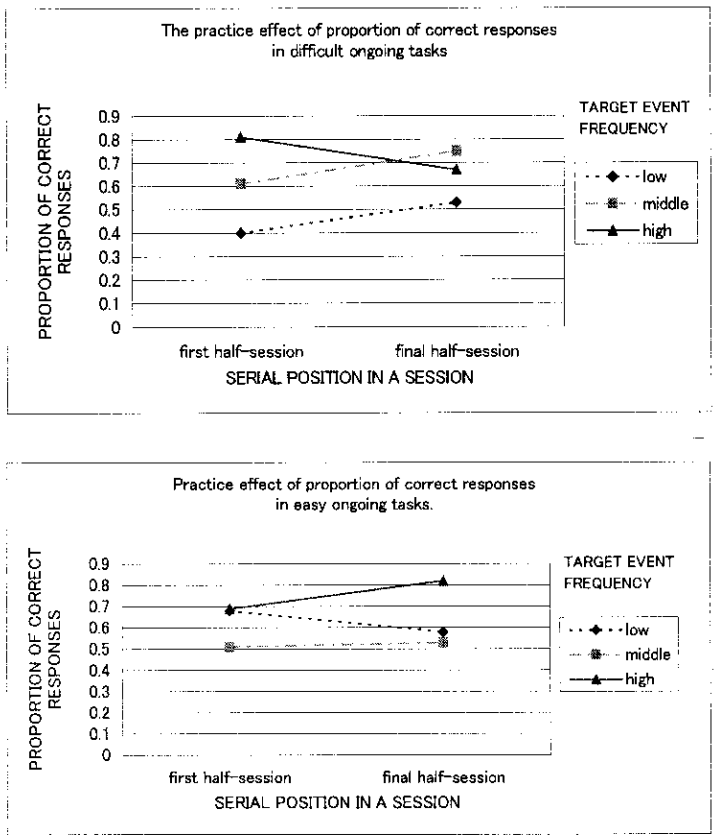
EXPERIMENT 2

Experiment 1 suggested that a relatively high target event frequency improved prospective remembering and that performance was lower when target events were embedded in a more difficult ongoing task. The data suggests that the performance is generally enhanced in reaction time from the first to the second half of target event presentations. In the second experiment we attempted to improve performance by emphasizing the importance of the prospective memory task.

Method

Design and subjects

Experiment 2 used a 2*2*2 between-subjects design. The first factor was weight of the prospective memory task. We gave 10 points to the prospective memory task,

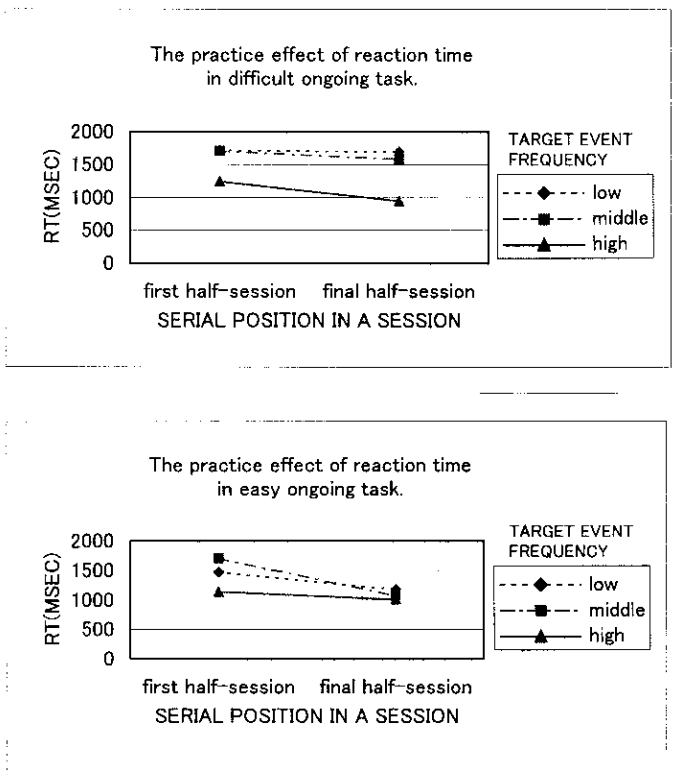


〈**Fig.5**〉 The practice effect of proportion of correct responses in prospective remembering.

and 1 point to the ongoing task in weighted condition. We gave 1 point to the prospective memory task and gave also 1 point to the ongoing task in non-weighted condition. The second factor was target event frequency. We adopted the low frequency condition in which a target number appears twice among thirty expressionsof division, and the middle frequency condition in which a target number appears four times among expressions, to avoid ceiling effect of performance (Einstein & McDaniel, 1990). One list consists of thirty trials and one session consists of eight lists. The third factor was the degree of difficulty of the ongoing task. Ten people were assigned to each of the eight experimental conditions. The subjects were undergraduate students, undertaking a variety of degree courses, who participated in the study and received either course credit or a small payment in return.

Materials and procedure

The material and procedure were identical to that described in Experiment 1 for the prospective memory task and those of ongoing task.



〈**Fig.6**〉 The practice effect of reaction time of correct responses in prospective remembering.

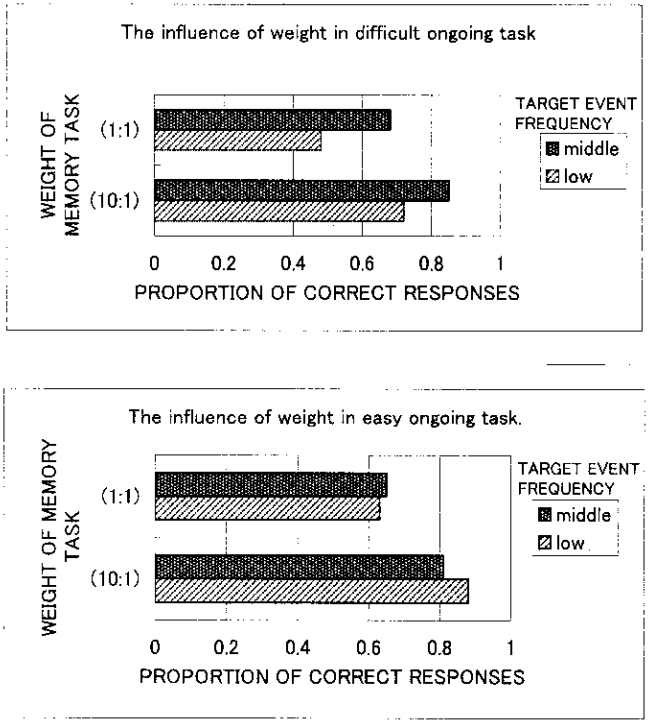
Results and discussion

1) The effect of weight of prospective memory task

Fig.7 shows the influence of weight of prospective memory task on proportion of correct responses. Fig.8 shows the influence of weight of prospective memory task on reaction time of correct responses. It was suggested that the weight on the prospective memory task improved the proportion of correct responses of memory tasks.

2) Post-experimental questionnaire and another memory task

Post-experimental questioning also revealed that most of the subjects who showed prospective memory forgetting simply could not think of what they were supposed to do when the target number appeared. The subject indicated that they remembered they had to do something when the target number appeared, but had forgotten what it was they were supposed to do while they were busy with ongoing calculation tasks.



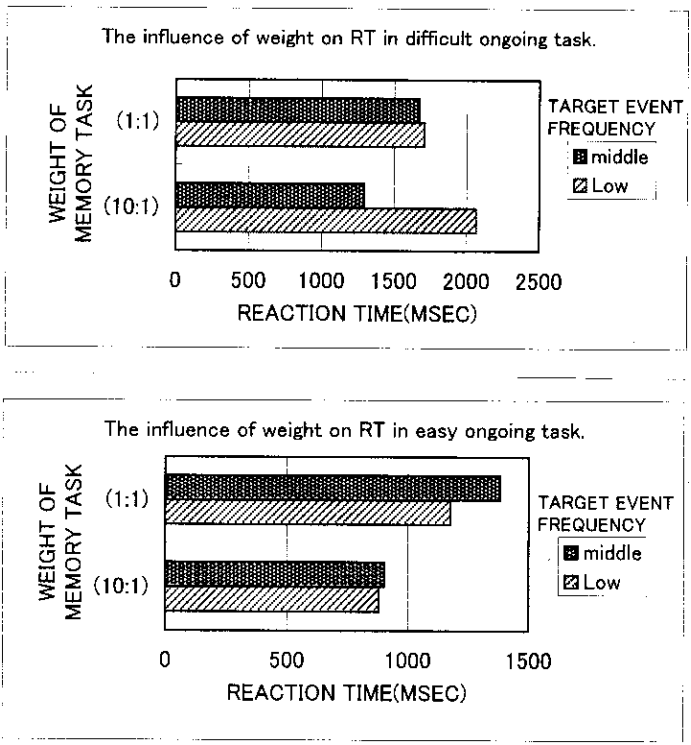
〈**Fig.7**〉 The influence of weight of prospective memory task on proportion of correct responses.

Before the experiments, the subjects were asked to write their name at the top of every sheet of paper of the post-experimental questionnaire. Fig.9. shows the results of the answer sheet. It was suggested that it was absolutely difficult to remember another memory task, without the underline indicating the place where they should write their name. The underline plays an important role as a retrieval cue in recalling the another prospective memory task.

GENERAL DISCUSSION

We have many intentions that we want to realize in the future. The ability to retain, recall and realize intentions is an important aspect of purposeful behaviour in our everyday lives (Mizuno, 2001). The person may remember that he or she wishes to act in a particular way, but fail to do so. There should be a distinction made between the decision to act in a certain way at some time in the future and the action itself.

It is clear that the decision to act in a specific way in the future is the central feature of prospective memory. Prospective memory involves the interrupting of



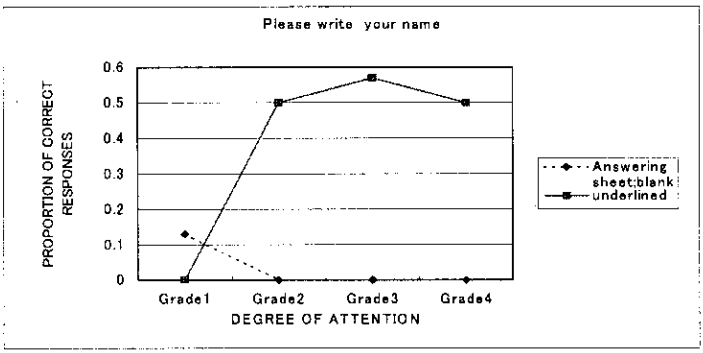
〈Fig.8〉 The influence of weight of prospective memory task on reaction time of correct responses.

habitual routines which require little thought to initiate and maintain. A single activity is one in which there is a single goal, such as remembering to put tea leaves in the pot while making the tea. A dual activity is one in which there are competing goals, such as driving home and buying some bread on the way. The single activity is best conceptualized as a sub-routine of a more general habitual routine, while the dual activity is one in which one activity must be interrupted. This is the basic feature of prospective memory (Morris, 1992).

There is a clear difference between what are known as prospective and retrospective memory in the social contexts. Prospective memory is memory for intentions, for actions that we wish to carry out in the future, while retrospective memory is the recollection of information from the past (Meacham, 1988). We form intentions to carry out actions in social contexts and it is the public nature of success and failure to carry out the actions that defines prospective memory. When most people are asked what type of memory error they would like to avoid, forgetting to carry out some action that had been planned comes high on the list (Morris, 1992).

One component of prospective memory is that the individual must remember what has to be done, which would include remembering the action to be performed and the proper target event. This might be termed the retrospective component of a prospective memory task. The other component is that the individual must remember to perform the action in response to the appropriate target event or at the appropriate time in the case of a time-based prospective memory task (McDaniel & Einstein, 1993). Recognizing a word as being a target event is different from simple recognition of a word: the latter has to do with past events, whereas the former implies the activiation of the prospective component of the task. That is, once the event has been recognized as a target event, it almost automatically prompts the feeling that something has to be done (Brandimonte & Passolunghi, 1994).

Unlike a retrospective memory task in which some agent prompts the



〈**Fig.9**〉 The remembering of another prospective memory task.

rememberer to try to recall or recognize target event information, a prospective memory task requires the subject to self-initiate, or spontaneously accomplish, recognition of the event or time as the stimulus for producing a response. The critical factor determining prospective memory performance seems to be the degree to which the target event triggers or evokes the memory for the action that is to be performed. From this point of view, prospective memory performance will depend on properties of the prospective memory target event (Einstein & McDaniel, 1990).

The results of two dual-task experiments investigating the effects of target event frequency on prospective memory task performance demonstrate that the high target event frequency improved prospective remembering. The relative ease with which target events are recognized influences the likelihood of successfully acting upon a delayed intention. High frequency appears to induce changes in performance over target event presentation.

Intention recall depends on: (1) the successful encoding and retention of an action-intent-cue relation; and (2) recall of this action and intent when the target event appears and is recognized as such (Brandimonte, Einstein, & McDaniel, 1996).

In a repeated-instance design the former processes are greatly simplified, and the same action is prescribed for each target event and thus performance is likely to depend on the successful operation of the latter (Ellis et al., 1999). There was only the artificial and temporary relation between the target event; a certain number, and the action; pressing response key in our experiment. But in the real world, presentation of any stimulus item always produces activation of that item's node in an associative network (Anderson, 1983). Activation then passively spreads to associated items, thereby increasing the resting activation levels of those associated items.

In our experiments, performance was lower when target events were embedded in more difficult ongoing tasks. The prospective recall, at least in some prospective tasks, is less open to reliance on external cues. The prospective recall requires the modification of habitual routines to allow the intention to be carried out. When leaving work, intending to collect some friends on the way, we have to remember to set off by a different route than we usually take. The difficulty of finding the possible retrieval cues from the current environment is one reason for failure in prospective memory, and the provision of such cues often leads to recall (Morris, 1992).

In our everyday lives, a rich set of these cues loosely related to that to be recalled must be primed so that we can trigger recall. Prospective memory performance was significantly affected by characteristics of the target event. A marked practice effect of reaction time was observed when target events are embedded in a routine ongoing task. Practice improves the ease of recognizing the

target event among ongoing tasks or increases the connection between the target event and the action itself. It is important to clearly delineate particular aspects of the target event and the relation between the target event and the ongoing task which influences the successful prospective memory performance. The importance of memory task itself is also suggested to improve the prospective remembering.

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