THE INFLUENCE OF RETENTION INTERVALS AND WARNING SIGNALS ON PROSPECTIVE MEMORY

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ABSTRACT

Prospective memory, memory for future events, is used for remembering duties and obligations that all people must complete. Past research has contributed to our understanding of the bases of prospective memory tasks (time versus event) and the kinds of situations requiring prospective memory (appointments, chores, deadlines, and medications). However, research has yet to examine how prospective remembering unfolds over time. For example, very little is known about how such remembering is affected by the time from when the task is encoded to the time that a task must be conducted (the retention interval), the length of the time in which a response can be counted as correct (the response window), and the time from a warning signal, if given, to the time that the prospective task must be completed (the anticipatory lag). This research explored the accuracy and temporal precision to remember to complete a prospective memory task. An accurate prospective remembering involves responding within a response window. The precision of a prospective response refers to how close in time a response is to the ideal time expected of a response. Participants completed prospective memory tasks with three retention intervals (45 second, 60 second, and 75 second) and attempted to respond within a response window of ten seconds. Warning signals were either not presented or presented at five and fifteen seconds prior to the expected reaction time. The results indicated that a warning signal affected both the accuracy and precision

of prospective remembering such that shorter anticipatory lags created greater accuracy and lower failure rates.

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INTRODUCTION

Prospective memory refers to one's memory for activities to be performed in the future (Einstein & McDaniel, 1990). Prospective memory is an important cognitive process for everyone because it enables a person to remember where people are expected to be and what people must do at a certain time.

Prospective memory failures can be costly to an individual and to those who work with the forgetful person. If a person is required to attend a meeting to discuss a business transaction and is not there, then that person will miss out on what the purpose of the transaction is, who will be involved in the transaction, where the transaction takes place, how the transaction will take place, and when the transaction will take place. Additionally, prospective memory failures will cause social damage with one's supervisor and co-workers (Meacham, 1988) who will see the forgetful individual as unreliable or not trustworthy.

Prospective memory can produce serious detrimental effects socially. An individual may forget an anniversary or miss a family function. A missed social function can cause embarrassment as well as a lack of trust by the person(s) whose function was forgotten.

The Nature of Prospective Memory Tasks

Prospective memory forgetting refers to the failure to do something at a specific time, or in a time interval (Kvavilashvili & Ellis, 1996). One reason for not completing a prospective memory task could be because of a failure to encode the information. If a person fails to properly encode that information then the action may never occur (Ellis, 1996). Additionally, if the information is encoded but encoded improperly, then the prospective memory task will occur but will not be at the right time or in the right way.

The nature of a prospective memory task may determine how well a person may remember to complete a necessary prospective memory task. Event-based prospective memory is when environment cues are used to remember a task; for example, an alarm alerts a person to complete a task. Time-based prospective memory is when the specific passage of time must be monitored to complete the task; for example, a person will estimate the amount of time that has passed without the aid of a reminder. Often prospective memory is influenced by both of these factors (McDaniel & Einstein, 1992).

Prospective memories also differ in temporal aspects (Brubaker & Herrmann, 1998). There are three important temporal variables involved in a prospective memory task. These are the retention interval, anticipatory lag, and response interval. The retention interval is the time from the start of the prospective memory task to the time the prospective memory task is to be completed. The anticipatory lag is the time from a warning signal to the moment that the prospective memory task is to be completed. The response interval is the range in time that a person can complete a prospective memory task and the response would be scored as a success. Appendix A illustrates the temporal aspects of a prospective memory task.

There are several types of prospective memory (See Appendix B). Prospective memory may be as simple as being able to remember to pick up milk on the way home from work or as complicated as remembering an entire day of activities. Some prospective memory tasks include professional assignments necessary for career success and advancement. Other prospective memory tasks involve social tasks, including remembering events and information about family and friends. Prospective memory tasks also are vital in that success and survival of lives depends on remembering to execute actions within a given interval. While the distinctions between these types of prospective memory tasks are not always clear and unambiguous, this typology does distinguish between these types of prospective memory.

Theoretical Explanations of Prospective Memory Remembering

A number of theories have been proposed to explain the processes involved in prospective memory. For example, Tulving suggested the Cue Theory to explain prospective memory (Tulving, 1983). This theory emphasizes that a number of cues or a single cue elicits a response to carry out a prospective memory task. The cue or cues may also trigger the intention or initiate the search for other cues whose discovery may remember the intention. A somewhat related theory that also relies on cues proposes that prospective memory is associated with a person's feeling of knowing (Ceci & Bronfenbrenner, 1985). The central idea is that a person experiences a feeling, or a cue, that there is a task to be completed and whereupon the person begins a conscious search. This search is meant to discover what task must be completed. If the memory for the task is found, the person may carry out the task.

While Ceci and Bronfenbrenner's theory relies on a search to complete a task, a proposal that remembering a prospective memory task has to do with the awareness of the passage of time. This time monitoring model assumes that an individual will perform an intention when it's perceived that an appropriate amount of time has lapsed so that the task may be completed (Andrezejewski, Moore, Corvette, & Herrmann, 1991). These theorists believed that people may refer to a clock or infer that the correct amount of time has passed for the prospective memory task must be completed. Once the intention is remembered then the intention may be completed.

In contrast, Einstein and McDaniel (1996) proposed a notice plus search model. This theory suggests that a person notices a cue from the environment and then the person goes into an active search of memory to retrieve the prospective memory task that must be completed. The cue attracts the attention of the person and the person then begins a more conscious search for the prospective memory task

A final theory is that an intention is completed once it emerges into consciousness (Herrmann, 1996) depending on familiarity and strength of the remembered intention. This theory explains how an intention can be remembered when there are few cues or other forms of remembering.

All of the theories explained above have different perceived effort in remembering a prospective memory task. A prospective memory task may be initiated by an active search or be assisted by the environment. These theories provide a comprehensive examination of the internal attributes that may also cause a prospective memory failure.

Reasons for Prospective Memory Task Failures

There are two distinct reasons why a prospective memory task may fail. As indicated in the theory by Einstein and McDaniel (1996), a cue from the environment will elicit a search response to find or remember the prospective memory task. A possible reason a person may fail a prospective memory task is the state of arousal that is incurred by the warning signal. For instance, if a prospective memory task comes too early an individual will be aroused to complete the prospective memory task but may respond too early resulting in a prospective memory task failure. Although, if the warning signal has occurred too early. an individual may forget to complete the task at a later time. However, this arousal will lessen as time passes resulting in the person forgetting what the warning signal was originally intended to do, which is remind the individual to complete the prospective memory task. Another reason is due to memory decay. Therefore, it is important to use an anticipatory lag that is appropriate in the sense that allows the individual to complete the task not early and not late. The appropriate anticipatory lag would arouse the individual to complete the task and should not come so late that the individual does not have adequate time to complete the prospective memory task.

Kinds of Cues for Prospective Remembering

Cues are critical to remembering. People can remember without external cues but it is unlikely that they will. Some cues are natural such as when the sight of some person or object makes a person to think of the future task. People arrange for certain cues to be present in a situation where the cues do not normally occur because these cues will elicit

the intentions to do something. Cues can be active or passive (Harris, 1984). An active cue changes or fluctuates, such as a beeping sound or a flashing light. The likelihood that a cue will catch attention, such as an alarm clock, and foster remembering increases across natural cues, passive cues, and active cues.

Findings Pertinent to Prospective Remembering

In examining why prospective memory fails it is important to examine a number of factors. Table 1 provides a summary list of studies that examine factors involved in the investigation of prospective memory. One factor is the amount of cognitive processing that must occur for the prospective memory task to be a success. One study investigated the number of cognitive tasks participants needed to complete and their prospective memory ability (Marsh & Hicks, 1998). In this study, participants were given range of tasks to complete and then measured on accuracy and completion of task. When participants had fewer cognitive tasks to complete, there were fewer prospective memory failures.

The Role of Reminding

A factor in determining if a prospective memory task will be completed is the reminder to complete the task. The work reported by McDaniel and Einstein (1992) indicated that the execution of a prospective memory task is either executed by the passage of time, by a time-based cue, or by an event-based environmental cue. Earlier research has shown that an event-based reminder is helpful in reminding the individual to complete the prospective memory task (Doerner, 1987). Event-based reminders are most

commonly audible, such as a warning signal. This may also be visual, such as a blinking light. Devices that present both audible and visual event-based reminders have been found to generally aid a person in remembering to complete a prospective memory task (Ceci & Bronfenbrenner, 1985; Einstein & McDaniel, 1990; Einstein, McDaniel, Richardson, Guynn, & Cufner, 1995; Harris & Wilkins, 1982; Herrmann, Yoder, Wells, & Raybeck, 1996; Kvavilashvili, 1987). Reminders improve prospective memory performance; however, it has been unclear what properties render a signal most effective.

In what capacity do reminders aid in a prospective memory task? In one study participants were allowed to use a clock to complete their prospective memory. A clock can be helpful to aid participants in their retention task (Ceci & Bronfenbrenner, 1985), but a clock does not actively remind a person such as done by an audible signal or flashing light (Harris, 1982). A study by Herrmann, Yoder, Sheets, Wells, and Brubaker (1998) examined how an audible warning signal, delivered by a palmtop-reminding device, aided performance on a prospective memory task. The device activated the signal for a prospective memory task in the morning, afternoon, and evening. Additionally, the signals were given at different anticipatory lags. The anticipatory lags occurred at zero minutes, ten minutes, and twenty minutes prior to the time that the task was to be performed. The results indicated that audible warning signals can help prevent memory failures but will not guarantee a successful execution of a memory task.

As suggested by Brubaker and Herrmann (see Appendix A), a warning signal that comes too late or too early may result in a failed prospective memory task. The anticipatory lag may influence whether or not a prospective memory task is remembered

at the appropriate time and may be the key to preventing an individual from completing the prospective memory task too early or too late.

Prospective memory, like all forms of memory, must be affected by the retention interval, the time from the initial encoding of the prospective memory task to the time that the prospective memory task should be completed. There are two features of a retention interval that favor completing a prospective memory task. One feature is that the retention interval must be long enough for an individual to encode the information and prepare to complete the prospective memory task. For instance, if a prospective memory task is to occur in two seconds it is likely by the time that you understand the task and what must be done to complete the prospective memory task, the correct time to complete the prospective memory task has passed. The second feature is that the prospective memory task be long enough that it is not a short-term memory task but not so far in advance that the person may forget the procedures to complete the prospective memory task. For instance, if a person is told to remember to call their sister in 30 seconds this may fall into a description of short-term memory. The person could simply rehearse "Call sister" until he/she has reached the phone. Also, the theory is that the decay of the short-term memory task has occurred and the person has taken steps to remember the prospective memory task. This theory is in specific reference to short-term memory decay examined by Peterson and Peterson (1959). In the research completed by Peterson and Peterson, subjects are asked to remember three consonants to remember. The participants are then asked to remember the consonants at different periods of time. During the course of remembering these words, subjects are asked to count backwards by

three. Over a number of trials the results showed that the correct recall rapidly declined over a eighteen second period.

Goals of the Present Research

The purpose of this research was to investigate the effects of temporal factors on the accuracy and precision of prospective remembering. These hypotheses about temporal factors were investigated. The first hypothesis is that a prospective memory task with a warning signal will be completed and will be more precise than a prospective memory task without a warning signal because the warning signal will arouse and remind the participant to accurately complete the prospective memory task. A second hypothesis is that an anticipatory lag of 5 seconds will result in a prospective memory task being executed more precisely than a prospective memory task with a 15 second anticipatory lag because the shorter reminder will result in less decay and the subject will remain aroused for the completion of the prospective memory task. A third hypothesis is that a retention interval that is shorter will result in a prospective memory task being executed more precisely than a prospective memory task with a longer retention interval because the participant may have an increased ability to remember what the prospective memory task is and when to respond to the task

PILOT STUDY ONE

This pilot study investigated the temporal variables of retention intervals, anticipatory lags, and response windows. In this study, participants completed twelve trials that varied by having a warning signal or no warning signal and two retention intervals of three and five minutes. If a signal was presented, the anticipatory lag was either five seconds or thirty seconds, and the response window was four seconds or ten seconds. It was anticipated that participants produce more accurate responses with a warned trial compared to an unwarned trial. Startle responses were not expected because the retention intervals were too long for participants to forget about the warning signal. An anticipatory lag of five seconds was expected to be more accurate than a lag of thirty seconds because participants would not have to wait a long period of time before responding with five seconds. It was also hypothesized that a response window of ten seconds would be more accurate than four seconds.

Method

Participants. A total of thirty participants (N=30) were asked to complete the study. The mean age of the nine male participants was 20.4 years of age. The mean age of the twenty-one female participants was 22.6 years of age. Twenty-seven of the participants were Caucasian, two were Asian, and one participant indicated Other in this study.

Apparatus. An IBM-compatible computer was used to run the MEL program. The computer has a 486(DX) processor, 4MB of RAM, standard keyboard, standard mouse, a 3.5 disk drive, and a monitor with VGA capabilities. The computer software was the MEL Computer Software Systems. The MEL program allows an experimenter to create an experimental task, record data, and analyze the data using statistical tests.

Procedure. The participants were asked to read and sign a consent form (see Appendix D) to participate in the study. Participants were then instructed verbally about what was expected of them. Appendix E presents a copy of these instructions. The experimenter then began the program and left the room. Participants saw a computer screen, which provided appropriate directions for the particular trial that they would be completing. Appendix F presents a copy of the directions for Trial 1. The directions change depending on which type of trial the participant was to complete. The participant began the trial by a key press; which activated a screen that provided instructions (see Appendix L). Table 2 presents an organization of these trials. After all twelve trials the participants were then asked to answer an eleven-item questionnaire anonymously. Appendix G presents a copy of this questionnaire.

Responses were evaluated for accuracy and precision measured by differential response lag. The differential response lag (DRL) is the actual time at which the participant will respond. The DRL is any response to the trial. There are three types of DRL. A positive DRL is any response that comes after the most appropriate response time. A negative DRL is any response that comes before the most appropriate response time. A DLR of 0.00 seconds would be the ideal response time.

Results

The results of Pilot Study 1 are presented in Figure 1. These results could not be fully analyzed due to a number of factors. As seen in Figure 1, the number of memory failures for participants was nearly 100% for five of the eight trials with an anticipatory lag of thirty seconds. The percentage of failures in several trials prevented the interpretation of information. Specifically, the participants were responding to the warning signal as soon as the warning signal occurred. This created a negative DLR which was too far ahead of the response window resulting in the high failure rate.

A questionnaire (See Appendix G) given at the end of the experiment was used to query participants about their performance. Ninety percent (90%) of participants responded that they use some form of a reminding device. The number of times the reminding device was used, however, was not significant. Twenty-seven of thirty (90%) respondents reported that the reminder was useful.

Discussion

The results of this pilot study indicated that participants had recorded responses right after the warning signal and before the response window. The participants reacted to the warning signal reflexively rather than remembering to complete the prospective memory task. After the experiment participants responded that the warning signal made them nervous and that the experiment was "boring". Thus, due to the quiet environment of the experiment the warning signal may have startled the participants into responding. Most of the participants reported that they did not use their memory to complete the task, rather, they were calculating the time that had passed.

PILOT STUDY TWO

This pilot study explored the temporal variables using a similar paradigm. Participants completed fourteen trials that were presented with a warning signal or no warning signal, two retention intervals of three and five minutes, three anticipatory lags of one second, five seconds, and thirty seconds, and two response windows of four seconds and ten seconds. It was anticipated that participants would record more accurate responses with a warned trial compared to an unwarned trial. Responding was expected to be more accurate and precise for an anticipatory lag of one second compared to five seconds and five seconds rather than thirty seconds. Responding was expected to be more accurate and precise for a response window of ten seconds rather than four seconds. The experiment was revised to prevent the misinterpretation of the instructions. Also, two practice trials were introduced to allow the participants to become familiar with the warning signal in order to prevent the "startle" response. Additionally, the one second anticipatory lag was added to test if this would be an appropriate anticipatory lag.

Method

Participants. Twenty-one participants (N=21) completed the study. The mean age of the three male participants was 21.7 years of age. The mean age of the eighteen female participants was 25.2 years of age. Sixteen of the participants were Caucasian, four were African-American, and one was Asian.

Apparatus. An IBM-compatible computer was used to run the MEL program. The computer has a 486(DX) processor, 4MB of RAM, standard keyboard, standard mouse, a 3.5 disk drive, and a monitor with VGA capabilities. The computer software was the MEL Computer Software Systems. The MEL program allows an experimenter to create an experimental program, record data, and analyze the data using statistical tests.

Procedure. The procedure of the second study was similar to the first pilot study with the following changes. The first two trials were practice trials and the experimenter stayed in the room with the participant to make sure the participant understood what was expected on them and if the participant seemed to understand the operation of the program. The participants were also warned verbally that the warning signal may startle them and that the experiment would require patience. The experimenter then left the room.

The experiment began then at Trial #3 and the directions are similar to those in Appendix F. The participant began a trial by a key press and instructions identical to Appendix L would appear. The directions changed accordingly with which trial the participant was conducting. The dependent variables were precision and accuracy as previously decided.

After all fourteen trials the participants were then asked to answer a nineteen-item questionnaire. Appendix H presents a copy of this questionnaire. Table 3 presents the organization of the trials.

Results

Figure 2 indicates the percentage of failures to respond within the response window for participants in the second study. As shown in the figure, a lower number of the participants incurred failures compared to the first pilot study. A 3(Anticipatory Lag)x2(Trials)x2(Warning Signals) ANOVA within-groups analysis revealed a number of differences. Table 4 presents the means and standard deviations between the different trials. Results indicate a difference between three minute trials and five minute trials, $F(1, 16) = 9.14$, $p < .008$, with three minute trials being closest to ideal response time. Results also indicate a difference between one second anticipatory lag, five second anticipatory lag, and a thirty second anticipatory lag, $F(2, 16) = 10.63$, $p < .001$, with the five second anticipatory lag being the most effective. There was no statistical difference between the four-second and ten-second response windows. Finally, within-groups analysis revealed a difference between warned and unwarned trials, $F(1,16) = 46.76$, $p < .0001$, with warned trials resulting in better performance.

Discussion

Participants responded closer to the ideal response time than compared to Pilot Study 1. The results support the hypothesis of that a shorter retention interval enables a participant to remember the correct moment to respond to a task more than a longer retention interval. In examining the most effective anticipatory lag, the five second lag resulted in optimal performance. The thirty second lag resulted in the person responding earlier than desired and a one second anticipatory lag resulted in the individual

responding almost four seconds after the best response time. In general, these data suggest that people benefit from warnings about prospective memory tasks when they occur very shortly before the task must be executed. When tasks are straightforward and relatively easy to complete, signals are highly effective at initiating behavior.

PILOT STUDY THREE

Participants completed forty-eight trials that varied the presence or absence of a warning signal. Retention intervals were created to be much shorter than in the previous two pilot studies on the assumption that accuracy would be higher than with the longer retention intervals used in the previous two studies. This procedural change minimized memory decay of the memory task that needs to be completed and the shorter retention intervals allow for more trials to be added to the experiment Anticipatory lags of five seconds and fifteen seconds were used and a response window of ten seconds. As in the previous studies, it was anticipated that participants would record more accurate responses with a warned trial compared to an unwarned trial and an anticipatory lag of five seconds rather than fifteen.

Method

Participants. Eighteen participants (N=18) completed the study. The mean age of the ten male participants was 19.2 years of age. The mean age of the eight female participants was 19.5 years of age. Fifteen of the participants were Caucasian, two were African-American, and one was Asian.

Apparatus. An IBM-compatible computer was used to run the MEL program. The computer has a 486(DX) processor, 4MB of RAM, standard keyboard, standard mouse, a 3.5 disk drive, and a monitor with VGA capabilities. The computer software

was the MEL Computer Software Systems. The MEL program allows an experimenter to create an experimental program, record data, and analyze the data using statistical tests.

Procedure. The procedure was similar to the two previous pilot studies with only one change. There were no practice trials, however, the experimenter stayed in the room until the participant understood what was expected of them and if the participant seemed to understand the operation of the program. The participants were also warned verbally that the warning signal may startle them and that the experiment would require patience. The experimenter then left the room. The program then provided directions similar to those in Appendix F. The directions changed with the trial the participant was to complete. The participant then began the trial by a key press whereupon instructions identical to Appendix L would appear. Appendix J presents an organization of the trials. As indicated earlier, the primary dependent variables were precision and accuracy.

After completion of all forty-eight trials the participants were then asked to answer a nineteen-item questionnaire. Appendix H presents a copy of this questionnaire.

Results

A 3(Anticipatory Lags)x2(Trials)x2(Retention Intervals) ANOVA within-groups analysis revealed a number of differences. Table 5 presents the precision and accuracy between the different trials. The total number of failures in pilot study 3 was 62 (7.1%) out of 864 trials.

The precision was greater for warned trials than for unwarned trials, $F(1, 16) = 20.48$, $p < .001$. The type of warning signal interacted with retention interval, $F(1, 16) = 8.41$, $p < .01$.

Discussion

Participants used the warning signal to aid themselves in completing the prospective memory task. In interviews after the experiment participants suggested that trials with a warning signal were easier to complete than trials without a warning signal.

An interaction occurred among the different types of anticipatory lags used and the type of retention interval. This interaction may have disposed participants to anticipatory lags differently for retention intervals of 45 seconds than 60 seconds. However, the data may be unreliable because subjects may have responded before a warning signal was given but the computer would not record their response. An artifact of the MEL program is that if participants respond prior to the signal, no response is recorded. This resulted in a high number of omissions which are actually simply outside of the recorded DRL.

EXPERIMENT ONE

In this experiment participants completed seventy-two trials that varied by warning signal or no warning signal, three retention intervals of forty-five, sixty, and seventy-five seconds. These retention intervals were used to determine if the interaction in pilot study 3 was replicable and could be extended to longer retention intervals. Two anticipatory lags of five seconds and fifteen seconds and a response window of ten seconds were used.

It was anticipated that participants would record more accurate responses with a warned trial compared to an unwarned trial, an anticipatory lag of five seconds rather than fifteen, and a retention interval of forty-five seconds rather than sixty and seventy-five seconds.

Method

Participants. Twenty participants (N=20) completed the study. The mean age of the eleven male participants was 19.0 years of age. The mean age of the nine female participants was 20.1 years of age. Sixteen of the participants were Caucasian, three were African-American, and one was Hispanic.

Apparatus. Two IBM-compatible computers were used to run the MEL program. The computers have a 486(DX) processor, 4MB of RAM, standard keyboard, standard mouse, a 3.5 disk drive, and a monitor with VGA capabilities. The computer software was the MEL Computer Software Systems. The MEL program allows an experimenter to

create an experimental program, record data, and analyze the data using statistical tests. This reconfiguring of equipment overcame a shortcoming in the equipment used in the prior studies, which precluded measuring latencies of responses prior to the warning signal. Previously, in a warned trial if the participant pressed the "a" before the warning signal was given to record a response the computer would not record the response. To circumvent this problem two identical computers were used. The computers had two MEL programs running simultaneously. One MEL program would be used to record any early responses and the other program would record the actual response time. One program would begin when the other program ended. One keyboard was used for participants to record their responses. This keyboard allowed the response to be sent to both computers at the same time. A Y-connector was used to connect the peripheral output so that the information may be passed to both computers.

Procedure. Due to the extended length of the experiment participants were given $10 for their assistance in the experiment. The experimenter stayed in the room until the participant understood what was expected of them and if the participant seemed to understand the operation of the program. The participants were also warned verbally that the warning signal may startle them and that the experiment would require patience. The experimenter then left the room. The experiment then began with the directions in Appendix K. The directions changed with each trial the participant was to complete. The participant then began the trial by a key press and instructions identical to Appendix L would appear. The trials are similar to those presented in Appendix J. As mentioned earlier, the dependent variables were precision and accuracy. After all seventy-two trials

the participants were then asked to answer a nineteen-item questionnaire (see Appendix H).

Results

Table 6 presents precision and error data between the different trials. The total number of failures in experiment 1 was172 (11.9%) out of 1440 trials. The number of errors in unwarned 45 second trials was greater than in the 60 and 75 second retention intervals, X^2 (df=4)= 12.51, p<.05.

Warned trials were more closer to a more ideal response time than unwarned trials, F(1, 19) =458.82, p<.001. Five second warning signals were closer to responding at the most ideal time than fifteen second warning signals, F(1, 19) =4.01, p<.06.

Discussion

The results of Experiment 1 are interpretable with standard assumptions that motivation and arousal decreases after the onset of a trial and after a warning signal. They are interpretable further by:

1. Extremes in the retention interval (45 and 75 seconds) for warned trials leads to more precise responses.
2. As the anticipatory lag increased from 5 to 15 seconds, the accuracy decreases. Thus, the longer an individual must try to remember to complete the task the greater the chance that the memory will decay and the intention will be forgotten.

Additionally, the number of errors increase form the warned trials to the unwarned trials. A possible purpose of the warning signal is to decrease the length of the retention interval to a very short length of time. For instance, an anticipatory lag of 45 seconds would become a retention interval of 5 seconds with a warning that comes at 5 seconds before the end of the trial. Another possibility is that a warning signal also arouses an individual to a task that is to be completed.

GENERAL DISCUSSION

The present findings indicate there are several factors involved in prospective memory. These factors may or may not be helpful depending upon the prospective memory to be completed. Experiment 1 indicated several possibilities in understanding prospective memory utilizing a warning signal. The pilot studies indicated several possibilities, although the data was not as reliable as data in experiment 1.

The present finding of this research provided mixed results in examining the experimental hypotheses. The first hypothesis was that warning signals would improve prospective memory performance. However, it was found that warned trials were not necessarily executed more precisely than unwarned trials but show that they are recorded closer to an ideal response time. It may be that a warning signal does not provided the necessary information to complete a prospective memory task. Additionally, the warning signal may confuse or provide more problems to remembering a response rather than aiding the response. Alternatively, perhaps when people know they will have a warning they take less personal responsibility for remembering to execute the task. It may be that if people believe a signal will occur, no further effort is allocated to the task.

The second hypothesis was that a warning signal with a shorter anticipatory lag aids an individual than a warning signal with a longer anticipatory lag (See Experiment 1). This may be due to that the warning signal acts as both an alert and as a refresher of the necessary task to complete. The short anticipatory lag does not allow time for the

task to be forgotten or additional problems to interfere with executing the task that needs to be completed.

The third hypothesis was that a shorter retention interval will be more precise and accurate than a longer retention interval (See Pilot Study 3 to Experiment 1). Although some of the data did support this hypothesis the information was not convincing enough to state that a shorter retention interval is necessarily better. This hypothesis was supported in Pilot Study 3 but the response rate in Experiment 1 indicated that the extremes in retention intervals (45 and 75 seconds) were the best response times.

Further Considerations

One important aspect of a warned trial is that the warning signal changes the nature of the trial. A warning signal changes a trial from a time based intention to an event based intention, especially if the anticipatory lag is very short. The warning signal alerts the individual that a task must be completed. However, a warning signal may act as a way to warn an individual but the task may revert back to a time based intention. The reason it may revert back to a time based task is because after the warning, time must still be monitored. For instance, if a warning signal is activated to remind a person to do a task five minutes before the task must be completed, there is a period of five minutes that the person must monitor without another warning signal. Therefore, the anticipatory lag may be a time based prospective memory task in itself.

In all of the studies, the warning signal affected the participant's remembering. The pilot studies indicated a changing effect depending on the amount of information provided to a participant. Additional instructions and practice trials prevented

participants from simply responding to the warning signal. The startle effect itself is an interesting response to a warning signal and may be a partial explanation for some prospective memory task failures. Additionally, as examined in experiment 1, the type of anticipatory lag may have increased the chance of prospective memory failure.

Finally, it is suggested that the process of prospective memory to be broken into smaller paradigms and studied individually. For example, prospective memory performance is probably dependent on the type of task. In these experiments the participants had to press a key. In real life prospective memory tasks are often complicated with multiple steps. In an applied setting, the use of a short retention interval to create a short prospective memory task would be the most advantageous. Additionally, attitudes toward that task may be wrong as well as other individual characteristics of the respondents. While temporal characteristics and signals do influence responding, these may interact with participant variables in the real world to dramatically impact responding. It is also interesting that warning sometimes adversely affected responding. Although unwarned trials were far more likely to be forgotten, when participants remembered the prospective memory task they were precise in remembering. That is, in these trials, participants felt more responsible for remembering and therefore may have been more attention to the passage of time.

Table 1. Studies that have investigated temporal factors involved in prospective memory

Author(s)	Area
Herrmann, Yoder, Sheets, Wells, Brubaker (1998)	Palmtop Reminding Devices
Einstein, Holland, McDaniel & Guynn (1992)	Complex and Simple Prospective Memory
Einstein & McDaniel (1990)	Event-based and time-based prospective memory
Einstein & McDaniel (1996)	Attention in short-term prospective memory tasks
McDaniel & Einstein (1992)	Event-based prospective memory tasks in laboratory settings-effective and easy to understand rather than time-based
Peterson & Newsome (1991)	External Memory Aids-remember better with external aids

Table 2. Organization of trials for Pilot Study 1

Trial #	Retention Interval	Warning Tone	Anticipatory Lag	Response Window
1	3 Minutes	Yes	5 Seconds	4 Seconds
2	5 Minutes	No	None	10 Seconds
3	3 Minutes	Yes	30 Seconds	10 Seconds
4	3 Minutes	No	None	4 Seconds
5	5 Minutes	Yes	5 Seconds	4 Seconds
6	3 Minutes	Yes	30 Seconds	10 Seconds
7	5 Minutes	Yes	30 Seconds	10 Seconds
8	5 Minutes	No	None	4 Seconds
9	3 Minutes	Yes	5 Seconds	10 Seconds
10	5 Minutes	Yes	30 Seconds	4 Seconds
11	3 Minutes	No	None	10 Seconds
12	5 Minutes	Yes	5 Seconds	10 Seconds

Table 3. Organization of trials for Pilot Study 2

Trial #	Retention Interval	Warning Tone	Anticipatory Lag	Response Window
1	30 Seconds	Yes	5 Seconds	4 Seconds
2	30 Seconds	No	None	10 Seconds
3	3 Minutes	Yes	5 Seconds	4 Seconds
4	5 Minutes	No	None	10 Seconds
5	3 Minutes	Yes	30 Seconds	10 Seconds
6	3 Minutes	No	None	4 Seconds
7	5 Minutes	Yes	5 Seconds	4 Seconds
8	3 Minutes	No	None	4 Seconds
9	5 Minutes	Yes	30 Seconds	10 Seconds
10	5 Minutes	No	None	4 Seconds
11	3 Minutes	Yes	1 Second	No
12	5 Minutes	No	None	4 Seconds
13	3 Minutes	No	None	10 Seconds
14	5 Minutes	Yes	1 Second	No

Table 4. Table of means and number of errors for Pilot Study 2

Precision

(As close to the most ideal response time)

	No Warning	1 Second	5 Second	30 Second
3 Minute	-.1929 N=18	2.82 N=17	-.6571 N=18	-.5857 N=18
5 Minute	.3867 N=18	1.266 N=17	-.2941 N=21	-.2923 N=17

Number of Errors

	No Warning	1 Second	5 Second	30 Second
3 Minute	3	4	3	3
5 Minute	3	4	0	4

Table 5. Table of means and number of errors for Pilot Study 3

Precision

(As close to the most ideal response time)

	No Warning	5 Second	15 Second
45 Second	1.526 N=140	.9386 N=130	1.045 N=129
60 Second	1.713 N=143	1.042 N=127	.9594 N=133

Number of Errors

	No Warning	5 Second	15 Second
45 Second	4	14	15
60 Second	1	17	11

Table 6. Table of means and number of errors for Experiment 1

Precision

(As close to the most ideal response time)

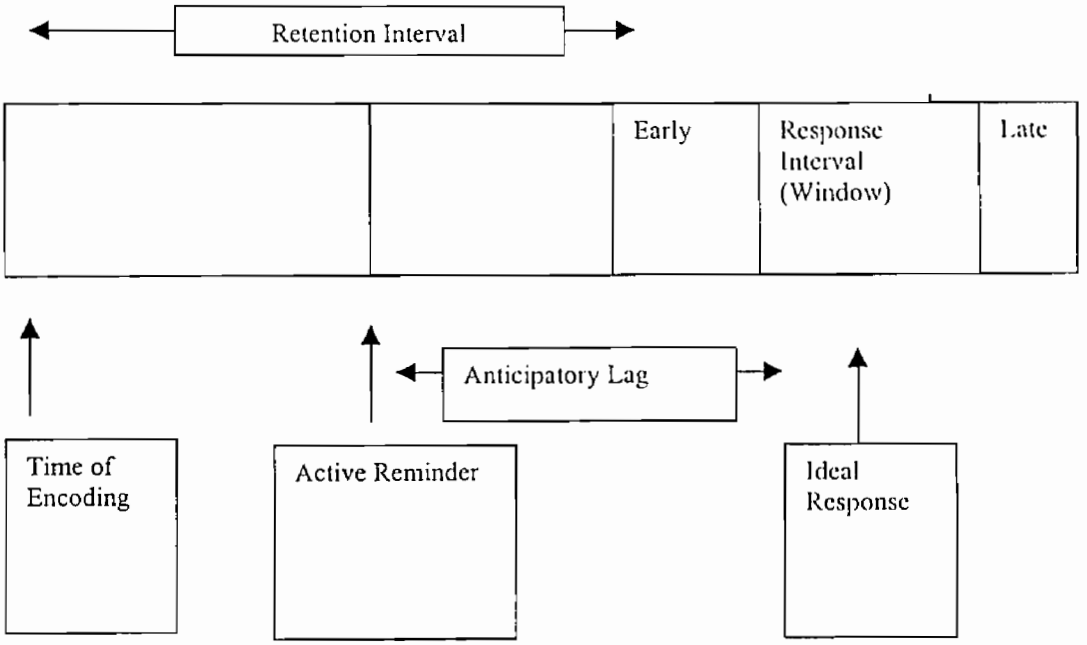
	No Warning	5 Second	15 Second
45 Second	-.7186 N=99	-1.65 N=139	-1.95 N=127
60 Second	-.6856 N=127	-1.87 N=136	-1.95 N=126
75 Second	-.4923 N=121	-1.70 N=130	-1.82 N=124

Number of Errors

	45 Second	60 Second	75 Second
No Warning	45	17	23
5 Second	5	8	14
15 Second	17	18	20

APPENDIX A

PROSPECTIVE MEMORY PARADIGM



APPENDIX B:

Examples of Prospective Memory

Professional

-Attending a meeting at 3:30

-Turning in a report on Friday

-Calling someone in 5 minutes

Social

-Remembering a birthday

-Remembering an anniversary

-Remembering to pick someone up

Vital

-Pilot remembering to lower landing gear

-Closing hatches in submarines

-Infamous "Red Button"

APPENDIX C:

Informed Consent Form

I understand that I am being invited to voluntarily participate in a study of prospective memory. This study is being conducted by Michael Sarapata of the Department of Psychology at Indiana State University.

I understand that this research will be conducted at Indiana State University. I understand that the research will take approximately one hour.

I understand that all data will be coded so that my answers will be kept confidential and will in no way identify me.

I understand that I may withdraw at any time and that there will be no penalty of any kind.

I understand that I will first be asked to answer some questions about my age and sex. I will then be asked to complete a number of prospective memory tasks on a computer. The research procedures have been explained to me to my satisfaction. I understand that I may ask additional questions in the future and may request a summary of the results by contacting the Department of Psychology.

This project has been reviewed and approved by the committee on Research Involving Human Subjects, Department of Psychology, Indiana State University as adequately safeguarding the participants privacy, welfare, civil liberties, and rights. The Chairperson of the Committee may be reached through the Department of Psychology, Indiana State University, Terre Haute, Indiana.

I have read the above material and any questions that I asked have been answered to my satisfaction.

_____ _____

Participant's Printed Name Date

_____

Participant's Signature

APPENDIX D:

INSTRUCTIONS

To be read verbally by experimenter:

Hello, this is a prospective memory experiment. Prospective memory is for future events. You will be using the computer in front of you to complete prospective memory tasks. There is a clock because this is a time based experiment. Please read the instructions on the screen for each of the trials. Some of the trials will have a warning signal and some trials will not. You will need to keep track of the time and press the "a" key when appropriate. At the end of the experiment you will need to complete a demographics sheet and receive your extra credit slip. Are there any questions?

APPENDIX E:

COMPUTER INSTRUCTIONS

This is the first trial. You are to press the "a" key in exactly three minutes from when you start the trial by hitting the space bar. You hear a warning tone before the three minutes are over to act as a reminder to help you complete the task.

In order for your key tap to be counted as correct it must occur between 178 and 182 seconds from the start of the trial. When you have finished reading these instructions press the SPACE BAR to start the trial.

APPENDIX F:

PARTICIPANT INFORMATION

Participant #_____

1. Age_____

2. Gender: Male Female

3. Ethnicity: White African American Asian Hispanic

American Indian Other_____

4. Do you use a daily planner, calendar, or electronic reminding devices?

Yes No

5. How often do you examine your daily planner, calendar, or electronic reminding device?

_____times a day _____times a week _____times a month

6. How would you rate the effectiveness of your daily planner?

1-------2-------3-------4-------5-------6-------7
Poor Useful

7. How often do miss planned events or intended actions in a given month?
_____times

8. Rate your anxiety or stress when you did not have a warning signal:

1-------2-------3-------4-------5-------6-------7
Low High

9. Rate your anxiety or stress when you had a warning signal:

1-------2-------3-------4-------5-------6-------7
Low High

10. A failure during the experiment, not being able to respond in time, was a result of:

Forgetting Miscalculation Other No failures

11. The computer did not respond to you pressing the 'a' key:_____times

APPENDIX G:

PARTICIPANT INFORMATION: EXPERIMENT ONE

Participant #_____

1. Age_____

2. Gender: Male Female

3. Ethnicity: White African American Asian Hispanic

American Indian Other_____

4. Do you use a daily planner, calendar, or electronic reminding devices?

Yes No

5. How often do you examine your daily planner, calendar, or electronic reminding device?

_____times a day _____times a week _____times a month

6. How would you rate the effectiveness of your daily planner?

1-------2-------3-------4-------5-------6-------7
Poor Useful

7. How often do miss planned events or intended actions in a given month?

_____times

8. Rate your anxiety or stress when you did not have a warning signal:

1-------2-------3-------4-------5-------6-------7
Low High

9. Rate your anxiety or stress when you had a warning signal:

1-------2-------3-------4-------5-------6-------7
Low High

10. A failure during the experiment, not being able to respond in time, was a result of:

Forgetting Miscalculation Other No failures

11. The computer did not respond to you pressing the 'a' key:

_____times

12. Did you plan to check the clock:

Every minute Every thirty seconds Not use the clock Always watch clock

13. You watch the clock during the trial the closest:

Beginning Middle End

14. Do you have a plan when you start the trial:

Yes No

APPENDIX H:

EXPERIMENT ONE INSTRUCTIONS

Welcome! This is an experiment in prospective memory. Prospective memory is memory for future events. This experiment is a way to simulate times when you have only around a minute to remember to complete a task. Pretend that you a pilot about to land a plane and that you must maneuver several buttons and levers. You may have warning signals for certain items and you may have no warning signals for other items. You will be asked to complete a number of trials that have specific conditions to complete a memory task. Your response will be recorded when you press the designated key to end a trial. Please read the directions given on this sheet and the directions that appear on the computer screen before each trial is to begin. Good luck and notify the experimenter of any difficulties.

You will have forty trials to complete in this experiment. Half of the trials will be 45 seconds and the other half will be 60 seconds in length. What you are trying to do is come as close to the end of the 45 or 60 second mark as possible. Therefore, in a 45 second trial the optimal response time is a close to the end of the 45 seconds as possible. Half of the trial will have a warning signal. A sheet is given to you help you to complete this experiment. This sheet states the trial number, when the warning signal will be given, and the length of the trial. This sheet is similar to having instructions to complete a prospective task. However, this sheet is to be used as a reference because your attention should be focused on completing the trial. Finally, a clock will be in sight to aid you in the prospective memory tasks.

Each trial will have a warning signal to alert you to the close of the trial and the end of the prospective memory task. When participating in this experiment it is important to use the reference sheet as well as using the warning to complete the prospective memory task. When finished with the experiment please contact the experimenter to be debriefed. If at any time that you choose not to continue the study please notify the experimenter.

APPENDIX I:

Trial Record Form

Block #1

Reference Sheet

Trial #	Retention Interval	Warning Signal
1	45 second	5 second
2	45 second	0
3	60 second	15 second
4	45 second	5 second
5	60 second	0
6	45 second	15 second
7	60 second	5 second
8	45 second	0
9	60 second	0
10	45 second	5 second
11	45 second	5 second
12	45 second	0
13	60 second	15 second
14	60 second	5 second
15	60 second	0
16	45 second	15 second
17	60 second	15 second
18	45 second	5 second
19	60 second	5 second
20	45 second	0
21	60 second	0
22	45 second	15 second
23	60 second	5 second
24	60 second	5 second

Block #2

1	45 second	0
2	60 second	15 second
3	45 second	5 second
4	45 second	0
5	60 second	15 second
6	45 second	15 second
7	60 second	5 second
8	60 second	0
9	45 second	15 second
10	60 second	5 second
11	45 second	0
12	60 second	5 second
13	60 second	15 second
14	60 second	15 second
15	45 second	0
16	45 second	15 second
17	45 second	5 second
18	60 second	0
19	45 second	15 second
20	60 second	0
21	60 second	15 second
22	45 second	5 second
23	45 second	15 second
24	60 second	0

*All trials have randomized using a random number table.

APPENDIX J:

COMPUTER INSTRUCTIONS: EXPERIMENT ONE

Welcome! This is an experiment examining prospective memory or memory for future events. You should have record sheet for this experiment. If you do not have a record sheet please notify the experimenter. You will be asked to complete forty-eight (48) trials. The trials will either be 45 or 60 long. Some of these trials will have warning signals and other trials will not have warning signals. Additionally, the warning trials will come at different times. If you look on your record sheet you will see that Trial #1 is 45 seconds long, it will have a warning signal, and that the warning signal will come 35 seconds after the start of the trial or in other words 10 seconds before the time that you must press the "a" key. The "a" key, on the keyboard is what will be used to record your response. You are allowed to use the clock and you will receive feedback on each response. You will see these directions prior to each trial. If you begin to feel lost use your trial record sheet for assistance.

Press the space to begin the next trial

APPENDIX K:

COMPUTER SCREEN

Trial #1 has started!

Press the "a" to record your response

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Figure 1 Results of Pilot Study 1

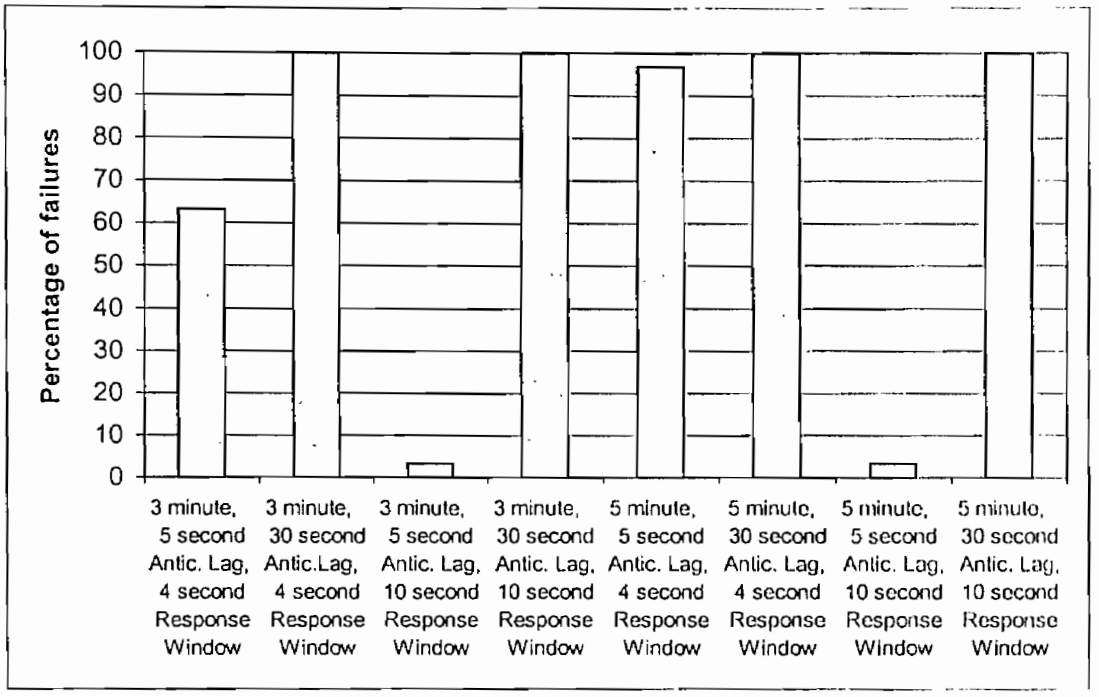

Figure 2 Percentage of failures of warned trials for Pilot Study 2