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The Effects of Reminder Distinctiveness and Anticipatory Interval on Prospective Memory

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THE EFFECTS OF REMINDER DISTINCTIVENESS AND ANTICIPATORY INTERVAL ON PROSPECTIVE MEMORY

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ABSTRACT

Prospective memory failures (or failures to remember a future intention) can result in a wide range of negative consequences. The use of reminders has been shown to improve the rate of PM successes. The aim of the current study was to examine the effectiveness of reminders based on their type (text or picture) and their timing. We hypothesized that successful PM performance would be successfully maintained over longer anticipatory intervals when paired with picture reminders rather than with simple text reminders because of the inherent distinctiveness of pictures. We also expected that performance for younger adults would be better than that of older adults except in conditions pairing a long anticipatory interval with a picture reminder. We expected that in these conditions, performance for younger and older adults would be statistically similar. Our hypotheses were not confirmed, suggesting that an increase in the distinctiveness of a reminder does not increase remembering performance. When considered with previous research, this suggests that design of future reminding aids should focus on increasing the distinctiveness at the initial time of cue encoding rather than increasing the distinctiveness of reminders.

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I. INTRODUCTION

Think of the last time you forgot to do something. Chances are you will not have to think back very far. You may have just chocked it up to having a bad memory, but this common occurrence is actually a failure of a specific type of memory: prospective memory (Einstein & McDaniel, 1990). Fifty to eighty percent of everyday memory problems are complications with prospective memory (Crovitz & Daniel, 1984). Prospective memory (PM) is remembering to complete a task in the future. Simply remembering to attend a lunch meeting requires PM and can result in an angry companion if a PM failure occurs. However, an irritated comrade is a very mild issue when compared to other possible consequences of PM failures.

Remembering to take medication relies on prospective memory and negative consequences can result if a PM failure occurs (Zogg, Woods, Sauceda, Weibe & Simoni (2012). In the older adult population, medication non-adherence ranges from 47% to 65% and the percentage increases with the number of medications the individual is taking (Kendrick and Bayne, 1982). Because of the potentially life-threatening consequences associated with PM failures in older adults and because of the negative consequences of PM failures for all people, PM research is of particular interest and necessity. Specifically, this research will examine how to enhance the likelihood that PM intentions are carried out in the future by altering the characteristics of the reminder itself.

Types of Prospective Memory

Prospective memory intentions can be classified into either time-based intentions or event-based intentions (Herrmann, Brubaker, Yoder, Sheets, & Tio, 1999). A time-based intention involves remembering to complete a task at a certain time or after a certain amount of time has passed (e.g., call Mary at 3:15pm or call Mary in 10 minutes). For an event-based intention, time is irrelevant. These intentions involve remembering to complete a task after a specific event occurs (e.g., call Mary after checking the mail). In this example, the individual must remember to call Mary after checking the mail, regardless of whether the mail is checked at 11:00am, 2:00pm, or 6:00pm. These types of intentions differ in that time-based intentions require active time monitoring while event-based intentions rely on a particular event to cue memory (Einstein & McDaniel, 1990).

Steps of the PM Process

The entire PM process can be described in six sequential steps (Brandimonte and Passolunghi, 1994): 1) forming an intention, 2) remembering *what* needs to be done 3) remembering *when* it needs to be done, 4) remembering to actually complete the action, 5) completing the action at the appropriate time and place, and 6) remembering the action was completed so that it is not repeated. Looking at these steps, it is clear to see that there are many opportunities for the PM process to fail. In these steps we also see that PM involves both a retrospective (step 2) and a prospective (step 3) component. At times, an individual will remember the prospective component of PM, but forget the retrospective piece (e.g., walking into a room, but forgetting the item you went to retrieve). Another

common situation occurs when the prospective aspect of PM fails while the retrospective piece remains intact (e.g., remembering that you have an appointment later today, but ending up late due to losing track of time). Although individuals may not know what PM is, they have come up with ways to alleviate the issues associated with what they believe to be generalized poor memory: the use of reminders.

Prospective Memory Reminders

Individuals use reminders to increase their chances of successfully completing PM intentions. These reminders can be a technology-based reminder such as the iPhone Reminders app or they can be as simple as a sticky note placed in a conspicuous location (e.g., under car keys). Research supports the intuitive notion that having a reminder will enhance the likelihood of PM success (Henry, Rendell, Phillips, Dunlop, & Kliegal, 2012). However, the ultimate memorability of the cue may be affected by the time between presentation of the cue and the time to act (Ebbinghaus, 1913).

Anticipatory Interval

The anticipatory interval is the time between the reminder and the ideal execution time of a particular action. The mere presence of a reminder typically increases the rate of PM successes but they are less helpful when the reminder occurs too far in advanced (e.g., 2 hours) of the target time or not far enough in advance (e.g., 1 minute before the desired time) (Herrmann et al., 1999). When the reminder sounds too early the individual will stop actively monitoring the time and will switch to the less reliable passive time monitoring (i.e., they will have time to forget again after the reminder). On the other hand, if a reminder appears too close to the execution time, an individual does not have

time to switch to active time monitoring before the time window has passed (i.e., they will not have time to complete the task before the correct time has passed) (Herrmann et al., 1999). This suggests that, perhaps for certain tasks, conditions or populations, there is an optimal anticipatory interval. However, some research has found no difference in PM performance as a function of anticipatory interval (Guynn, McDaniel, & Einstein, 1998) . One reason for their inability to find significant anticipatory effects is that Guynn et al. used an event-based PM context, which does not require active time monitoring. In an event-based PM scenario an individual must remember to complete the PM task when the target event occurs. However, in a time-based PM scenario the individual must monitor a clock for the appropriate time and cannot rely on an environmental event to cue them. It is possible that had they replicated the study using a time-based scenario, a significant effect of anticipatory interval would have been found due to the increased reliance on time monitoring. That is, an individual would be more likely to be affected by a long anticipatory interval when their completion of the PM task depends on self-initiated time monitoring as opposed to an outside cue. Another factor that may interact with anticipatory interval, and influence whether anticipatory interval exerts its effects is the distinctiveness or memorability of the reminder cue itself. A highly distinctive cue may be able to withstand longer anticipatory intervals due to enhanced memory trace. The purpose of the current study is to further examine how anticipatory interval and reminder distinctiveness (not content) impacts PM performance.

While there is a plethora of research on how different aspects of the reminder can affect PM performance (e.g., importance of the content; Guynn et al., 1998), none have

investigated the actual form of the reminder in terms of inherent distinctiveness. There is reason to believe that inherent distinctiveness, as it affects memorability, may affect successful PM intention completion. The following sections will describe how distinctiveness can be manipulated.

Distinctiveness via the Picture Superiority Effect

The picture superiority effect is the finding that individuals tend to have a higher level of recall when given pictures to remember instead of words. This effect has been demonstrated on simple recognition tasks and more complicated free-recall tasks.

Rajaram (1993) presented participants with both pictures and words on a projector at the rate of 1 every 5 seconds. After a delay interval, participants were asked to indicate whether or not they had seen each stimuli listed in a booklet. They were also asked to indicate whether they *remember* the word from the presentations or whether they just *know*. The findings showed that participants recognized pictures that had been presented previously more so than the words that were previously presented. Participants also indicated that they *knew* they had seen the pictures before more often than they *knew* they had seen the words before.

The picture superiority effect seems resistant to age-related differences. Another study showed that both younger and older participants remembered significantly more stimuli when presented as pictures rather than words. In the study, Maistro and Queen (1992) presented participants with lists of pure words, pure pictures, or pictures with word labels. Participants were presented with a stimulus every 5 seconds and after a delay interval, were instructed to list as many of the stimuli as they could remember. In

addition to showing the picture advantage, it curiously showed that older adult memory performance declined significantly when text labels were added to the pictures. The decline was attributed to the disadvantage of older adults in a divided attention situation such as having to process both a visual and verbal stimuli. However, the picture superiority effect was clearly demonstrated in the free recall task for both younger and older adults.

Finally, there is some evidence to show that the picture superiority effect can enhance PM. Fink (2013) evaluated the effects of the picture superiority effect by manipulating the type of PM cue (text or picture). A paper with either a word or a picture stimulus was presented and participants were asked to press Q on the keyboard anytime they saw this stimulus during the experiment. Fink found a significant main effect for stimuli form such that individuals in the picture condition performed more PM tasks than those in the word condition. This study is of particular interest because it confirmed the effects of picture superiority on prospective memory.

Picture Superiority in Older Adults

In addition to picture superiority research with younger adults, this topic has been evaluated with older adults producing mixed results. This effect was confirmed for older adults when participants were asked to remember either a word or a picture and its location. The results showed that not only were older adults able to recognize more pictures than words, but their spatial memory also improved when locations were paired with pictures instead of words (Park, Puglisi, & Sovacool, 1983).

Winograd, Smith, and Simon (1982; study 2 & 3) used the picture superiority effect to examine verbal (i.e., word) and visual (i.e., picture) encoding. The results of this study suggest that the picture superiority effect exists in older adults and can be used to benefit performance in retrospective memory. While these studies along with the previously discussed Maistro and Queen (1992) study found that there was a picture superiority effect for older adults, this idea is not always supported. Interestingly, in the first study of three completed by Winograd et al. (1982) the results showed that older adults did *not* recall more pictures than words. Research suggests that the picture superiority effect is less beneficial as age increased, potentially signifying that the picture superiority effect is substantial for younger adults, but not for older adult (Rissenberg & Glanzer, 1986; study 1). Because of the mixed results regarding the picture superiority effect for an aging population, more research is needed in this area.

Distinctiveness Models of Picture Superiority

There have been several mechanisms proposed to explain the picture superiority effect. The Sensory Semantic Theory (Nelson, Reed & McEvoy, 1977) attributes this effect to the increased distinctiveness that is inherent to pictures. While words are limited to certain shapes and features, the possible forms of pictures are endless. Distinctiveness models of PM suggest that it is the perceptual features of pictures that make them more distinctive and that this effect is not due to a difference in processing (Mintzer & Snodgrass, 1999). In addition to determining if a picture reminder could increase PM success, we also hoped to determine if this potential increase in PM performance could

be maintained over a long anticipatory interval and lessen the potential memory decrement for older adults.

Current Study

The purpose of the current study was to examine how reminder form (text or picture) interacts with anticipatory interval (5 minutes or 15 minutes) to affect PM performance. These two aspects of PM were selected because they were expected to interact. While a previous study (Fink, 2013) confirmed the picture superiority effect at the initial time of encoding, the current study hoped to verify this effect when the picture is contained within a reminder, not at the initial period of encoding the tasks.

The study also hoped to examine the differences in these conditions for younger and older adults. We expected that PM performance would be maintained over longer anticipatory intervals when paired with the more distinctive (i.e., picture) reminder. We expected that older adults would have lower PM performance than younger adults in text conditions, but that performance in the two groups would begin to equalize with the use of the more distinctive reminder. This is due to the well documented decline in older adults found in previous studies. We hoped to eliminate this deficit by using the more distinctive picture reminder to bring PM performance for older adults up to that of younger adults.

II. METHODS

Participants

Sixty-two undergraduate participants ages 18 to 23 (M=19.36 SD=1.35) were recruited and received course credit for completing the study. Sixty community-dwelling

older adult participants ages 63 to 80 (*M*=70.04, *SD*=3.85) were recruited through a database of older adults who expressed interest in participating in studies. Older adults were compensated $25 for their time.

Design

The current study is a 2 (age group: younger or older) × 2 (anticipatory interval: 5 minutes or 15 minutes) × 2 (reminder form: text or picture) design. The independent variables of age group, anticipatory interval and reminder form were between-subjects variables with each participant experiencing only one anticipatory interval length and one type of reminder. The dependent variables were PM task performance and data entry task performance. *PM task performance* was measured in terms of whether participants successfully completed the retrospective and prospective memory components of the four PM tasks (i.e., clicked on the correct task at the correct time). *Data entry performance* was measured by form errors and number of records completed. The number of clock checks and the number of times participants viewed the list of possible tasks were also recorded. Finally, the study ended with a question asking participants to state the tasks they were asked to complete. This data was used to eliminate participants who did not understand what they were asked to do.

Experimental Conditions

Figure 1 shows the two reminder conditions that were used. The top image shows the textual reminder and the bottom image shows the picture reminder. The pictures used for each picture reminder were chosen from the Bank of Standardized Stimuli (BOSS), a set of high quality stimuli that are normalized on several factors including familiarity and

name-image agreement (Brodeur, Dionne-Dostie, Montreuil, & LePage, 2010). The current study defined short and long anticipatory intervals as 5 minutes and 15 minutes respectively. While very short anticipatory intervals (i.e. 5 seconds; Sarapata, 2001) typically produce high levels of PM performance the current study used anticipatory intervals that are more reflective of those common of everyday situations.

Materials

Figure 2 shows the experimental screen. The form for the ongoing data entry task can be seen on the left while a sample picture reminder is shown on the right. At any point during the experiment a subject could have selected F1 to view a clock. In addition to the experimental screen, the study used paper forms. Paper forms were created containing basic information (e.g., name, address, phone number) of fictional individuals. The forms were placed in a binder as to maintain the correct order. An example of these forms can be seen in Figure 3 with the paper form on the top and the computer form on the bottom. Note that the fields between the paper and computer form are arranged so that participants must visually search for the information. This was a deliberate design decision, based on pilot data, to increase the level of engagement of the ongoing task.

Task

The tasks for this study were adapted from a prior PM study that used data entry in the context of a medical environment (Fink, Pak & Battisto, 2009). The primary task was to quickly and accurately input names, addresses, and phone numbers contained on paper forms into computer-based forms. Participants were instructed that data entry was their primary task, but additional actions could be necessary throughout the study. There

was also an "age" field on the computer forms that required participants to calculate the fictional person's age based on the date of birth from the paper form. This was done to increase engagement in the primary task and also to require a form of computation in addition to the transfer task. The memory task was to complete four PM events throughout the experiment that would be typical of a real-world office worker (e.g., shred papers).

The flow of the experiment can be seen in Figure 4. At the start of the experiment, participants were shown a list of four tasks and the target time for each task (e.g., shred papers after 600 seconds have passed), illustrated by screen 1 in Figure 4. The times were given in seconds instead of minutes to increase reliance on the clock (i.e., participants may intuitively know when approximately 5 minutes have passed, but may have little experience with "300 seconds". Additionally, unusual times were used (e.g., 2790) so that participants could not easily convert these times to minutes. After reading the list of tasks, the participants' memory for the four tasks was verified (Figure 4, screen 2). Once participants successfully verified their memory of the PM tasks they began the ongoing data entry task (Figure 4, screen 3).

Before the target moment for each PM event, a reminder appeared containing the task and target time for that particular PM event (Figure 4, screen 4). For short anticipatory intervals this reminder appeared 5 minutes before the target time while longer anticipatory intervals were reflected with reminders that appeared 15 minutes before the target time. The type of reminder shown depended on the experimental condition of each participant (i.e., participants in the picture condition will always see a picture reminder).

When the target time arrives, participants were able to access a list of possible tasks by pressing F2 on the keyboard (Figure 4, screen 5). They then clicked on the appropriate task using their mouse. A successful PM task completion was recorded when participants selected the correct task from the task list within the allowable time window (±60 seconds around the target time for younger adults and ±120 seconds for older adults). After completing the PM task, participants continued with the data entry task until they reached the next PM task time. A total of four target PM events occurred.

A variety of abilities tests followed the PM experiment to test perceptual speed, memory span, and vocabulary. A digit symbol substitution task was used to evaluate perceptual speed (Wechsler, 1981). In this task participants were shown a list of shapes and their corresponding numbers (e.g., a circle and the number 5). They were then shown item pairs (e.g., a circle and the number 4) and asked to indicate whether the given pair matched the reference pair (in this case, no). Participants completed multiple trials and their speed in answering correctly was recorded. In order to evaluate memory span, a reverse digit span task was utilized (Wechsler, 1997). In this task, participants were given a series of numbers (e.g., 34654) and asked to type them into the computer in the reverse order (e.g., 45643). The numbers increased in length and the number of trials completed correctly was recorded. Finally, Shipley's vocabulary test was used to evaluate their level of vocabulary. For this test participants were shown a target word accompanied by four words to choose from and asked to pick the one that most closely matched the target word. A total of 40 target words were shown and the number of correctly defined words was recorded.

Procedure

Participants were seated at individual workstations with PC-computers and notebook stands containing the paper forms. Participants were told the following: "In this study, you are playing the role of an office worker who must get these paper records (in the binders on the right side of your desk) transferred into the computer. You also have four tasks you need to get done at specific times. Imagine that you have already set up reminders for each of these tasks in your calendar and the computer will remind you. Please note that the reminder will appear well before the target time and does not mean it is time to complete a task at that moment. Just to review, your main task is to enter the records into the computer as quickly and as accurately as possible exactly as they appear on paper. You also need to complete these four tasks as close to the correct time as you can. At any time during the study you can see how much time has passed by pressing F1 key on the upper left of your keyboard. When you are ready to complete a task press the F2 key to see a list of tasks. You can then click on the appropriate task. Once you have clicked on a task, you have successfully completed that task." After acknowledging the instructions and asking any remaining questions, participants began the experiment independently. After completing all PM events or after one hour elapsed, the PM experiment ended and the abilities tests were completed. After participants completed the three abilities tests, they were told the experiment was over.

III. RESULTS

Two older adults were eliminated from the analysis due to taking a break during the experiment that caused them to miss a reminder. Data for two other older adults was lost due to a power outage during data collection. Additionally, 3 younger adults were excluded due to their outlying data on a clock check measure. This exclusion will be discussed in greater detail in the following section. The remaining 56 older adults and 59 younger adults were used for data analysis. Twenty nine participants (22 of which were older adults) did not complete any PM tasks. However, exclusion of their data did not alter the significance tests. Because of this, their data was included in calculations of means as they were not outliers on other measures. The number of participants in each condition can be seen in Table 1 below.

Table 1. *Number of participants in each condition*

	Younger		Older	
Anticipatory Interval	Short	Long	Short	Long
Text	14	15	14	13
Picture	15	15	12	17

Abilities Tests

Table 2 shows the participant characteristics sorted by both age group and gender. We found a main effect of age in the expected directions such that older adults perform better (M=35.23 SD=2.62) on Shipley's vocabulary test than younger adults (M=29.11 SD=3.04) ($F(1,107)=132.80$, $p<.05$, $\eta_p^2=.554$). There were no significant age differences between younger adults (M=1229.41 SD=226.72) and older adults (M=1996.79 SD=413.90) on measures of perceptual speed. Additionally, there were no significant

gender or age group main effects for memory span with younger adults having an average reverse digit span of 7.39 (*SD*=2.75) and older adults having an average span of 7.29 (*SD*=2.13). These results are generally as expected, suggesting that our participant sample is not unusual when evaluated from an abilities measures aspect. The lack of difference between younger and older adult performance on measures of perceptual speed could suggest that our older adult participants were better at these tasks than a typical older adult population.

	Older Adults (*n=56*)							
	Female (*n=40*)		Male (*n=19*)		Female (*n=29*)		Male (*n=27*)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age	19.33	1.39	19.42	1.31	69.00	3.37	71.15	4.08
Perceptual Speed[a]	1237.06	172.52	1213.32	317.40	1966.59	417.16	2029.22	415.78
Memory Span[b]	7.38	2.82	7.42	2.67	7.62	2.16	6.93	2.07
Vocabulary[c]	28.35	2.49	30.74	3.53	35.2	2.93	35.3	2.3

The remainder of the results section will discuss analysis of each dependent variable, beginning with measures of the ongoing task and then moving on to measures of the PM task. Analyses of Variance (ANOVAs) were conducted to analyze effects of age group, reminder type, and anticipatory interval on both the ongoing and PM tasks. For the following analyses, a p value less than .05 indicates significance.

Records Completed

The first measure of ongoing task performance was the number of records completed. This is the number of records a participant successfully transcribed into the computer during the experimental hour. No main effect of anticipatory interval or

reminder type was found for number of records completed. Age group did significantly affect number of records completed ($F(1,113)=95.97$, $p<.05$, $\eta_p^2=.459$) with younger adults completing an average of 44.14 records ($SD=10.12$) and older adults completing an average of 27.09 records ($SD=8.41$). There were no significant two or three way interactions. This result is not surprising as we would expect younger adults to outperform older adults on typing tasks.

Form Errors

The second measure of ongoing task performance was the number of form errors. This variable reflects the average number of form errors participants made for each record they completed. While there was no main effect of age group or anticipatory interval, there was a significant main effect of reminder type ($F(1,113)=6.57$, $p<.05$, $\eta_p^2=.055$). Participants receiving text reminders made significantly more errors ($M=1.72$, $SD=2.30$) than those receiving picture reminders ($M=0.82$, $SD=1.35$). No significant two or three way interactions were found. This finding of a main effect of reminder type is interesting as it suggests some differences between the two reminder conditions. It is possible that text-based reminders were more intrusive, causing more distraction from the ongoing task which may have led to more form errors.

Clock Checks

The first measure of PM performance was clock checks. During the experiment, participants were asked to complete tasks at a certain time; however, the clock was hidden and could only be accessed by pressing F1 on the keyboard. The clock checks

measure recorded how many times participants checked this clock during the experimental hour. Effects of reminder type and anticipatory interval were not significant. A main effect of age existed ($F(1,113)=17.49$, $p<.05$, $\eta_p^2=.134$) such that younger adults checked the clock significantly more ($M=128.19$, $SD=179.55$) than older adults ($M=26.97$, $SD=24.00$). Again there were no significant two or three way interactions. This main effect of age could indicate that younger adults were more aware of the PM task. A meta-analysis of PM and aging suggests that younger adults outperform older adults in laboratory PM settings while older adults perform better in more naturalistic settings (Henry, MacLeod, Phillips, & Crawford, 2004). This analysis could explain why the younger adults in the current study showed signs of increased engagement in the PM task.

View Actions

In addition to checking the clock by pressing F1, participants could view the list of possible actions to complete by pressing F2. Reminder type and anticipatory interval had no significant main effects on the number of times participants viewed the actions panel. A main effect of age did exist ($F(1,113) =7.86$ $p<.05$, $\eta_p^2=.065$) such that younger adults viewed the actions panel more often ($M=5.20$, $SD=3.94$) than older adults ($M=3.23$, $SD=3.58$). This is again consistent with the meta-analysis suggesting increased performance for younger adults in PM laboratory settings (Henry et al., 2004).

Retrospective Component of PM

Younger adults completed more PM retrospective events (M=2.54, SD=1.49) than older adults (M=1.50, SD=1.50), $F(1,113)=13.96$, $p<.05$, $\eta_p^2=.110$. This is expected as the previously mentioned research shows increased PM performance for younger adults in laboratory settings.

Prospective Component of PM

Prospective PM performance was also superior for younger adults (M=2.80, SD=1.39) than for older adults (M=1.79, SD=1.71), $F(1,113)=12.15$, $p<.05$, $\eta_p^2=.097$. Interestingly, prospective PM performance is slightly higher than retrospective PM performance. This suggests that some participants remembered *when* to act, but not *what* they needed to do.

Five Minute PM

An added measure called "FiveMinutePM" was calculated for older adults. This measure was calculated after the completion of data collection and served to artificially expand the allowable time window for older adults. That is, a PM event was initially counted correct if the task was completed within a one minute window on either side of the target time (e.g., if the task was scheduled to be completed at 120 seconds, completing the task between 60 and 180 seconds was counted as correct). During data analysis it became evident that some older adults completed the correct tasks, but missed the time window. To account for this, the additional measure of "FiveMinutePM" was

added to account for correctly completed tasks performed up to five minutes before or after the target time (e.g., if the task was scheduled to be completed at 600 seconds, completing the task between 300 and 900 seconds counted as correct). Figure 5 shows a visually representation of this manipulation.

Overall PM Performance

Figures 7 and 8 demonstrate the effects of reminder type and anticipatory interval for younger adults and older adults. No significant interactions were found, however, the graphs show trends in the hypothesized directions such that performance in the picture condition remains nearly constant over time while performance in the text condition experiences a decline as longer anticipatory intervals are experienced. The y-axes on these graphs depict that a PM Success for a younger adult was defined as completing the PM task within a one minute interval before or after the ideal target time. This "PM Successes" variable involved collapsing both younger adult retrospective and prospective components in order to get an overall number of successful PM tasks completed. For older adults, the previously mentioned "FiveMinutePM" variable was used. Figure 6 shows the graphs of older adult PM performance both before this change and after. This transformation shows that allowing older adults additional time to complete the PM tasks did enhance their performance, but did not alter significance findings.

IV. DISCUSSION

Understanding the factors that affect memory performance are crucial to avoid potentially deadly consequences (e.g., forgetting to take vital medications) The purpose

of this study was to examine how different types of reminders could affect PM performance. We hypothesized that successful PM performance would be maintained over longer anticipatory intervals with the use of picture instead of text reminders. That is, PM performance would decline with longer anticipatory intervals unless a picture reminder was used. We also hypothesized that the use of picture reminders could decrease the performance deficit for older adults, equalizing their performance with younger adults. Several interesting results were found in this study, most of which did not support our hypotheses. However, there were significant effects that support a performance difference suggesting that picture reminders do benefit PM performance

Effects of Anticipatory Interval on Intentions

Our first hypothesis was that PM performance would be better in shorter anticipatory intervals due to having to remember the intentions for a shorter amount of time. The results do not support this hypothesis, though the values do trend in the hypothesized directions. There are several reasons for the possible lack of findings for anticipatory interval, one of which may have been a design decision regarding the reminder. According to anecdotal reports from older participants, participants did not always notice the presence of the reminder. The study was designed to mimic a real life scenario in which a reminder would appear near the subject's main task, but would not directly interrupt the task (i.e., participants do not have to stop what they are doing to attend to the reminder). While this design decision was made to reflect a real situation, this may have detracted from the main purpose of this study. Several older adult

participants mentioned that they became so focused on the ongoing task that they never noticed any reminders. Given that anticipatory interval is the amount of time between the appearance of a reminder and the ideal execution time for a task, lack of noticing a reminder essentially negated anticipatory interval. Future studies should reexamine anticipatory intervals using reminders that interrupt the ongoing task and force acknowledgement or verify through survey that the participants did see the reminders. Ensuring that reminders are noticed would provide a more accurate comparison of true anticipatory intervals. It is also possible that anticipatory intervals of 5 and 15 minutes simply had no effect. This would be similar to the results found by McDaniel and Einstein (1998) where no significant differences were found between anticipatory intervals of 1 and 6 minutes. Perhaps a greater difference in intervals is required to truly see any effect.

Effects of Reminder Type on Intentions

Our second hypothesis was that PM performance would be better with picture reminders instead of text reminders. The results show that this hypothesis was not supported, with the highest performance in short anticipatory interval conditions with text reminders. There are several design decisions that may have resulted in the lack of findings related to the PM memory variables including text labels on the pictures, the lack of pictures during the initial encoding phase, the limited number of PM events, or limited usefulness of reminders. These possibilities will be discussed in more detail in the following paragraphs.

As previously discussed, Maistro and Queen (1992) found that older adults showed increased memory recall when pictures were used instead of text. They also found that pictures with text labels caused a significant decline in performance when compared to pictures alone. Because the reminders used in the current study contained both pictures and text it is possible that the detrimental memory effects due to divided attention between visual and verbal processes could account for the lack of picture superiority for older adults.

It is possible that having the picture present not only in the reminder, but at the initial time of encoding the PM event could have amplified the effect of the picture reminders on recall. Fink (2013) found that a picture cue presented at the time of encoding increased PM successes when compared to a text cue. Perhaps the lack of consistency in findings with the current study results from participants never seeing the picture until the moment the reminder occurred. While busy with an ongoing task, it is unlikely that participants had time to encode a new visual cue for the task during the 10 seconds the reminder was available. The previously mentioned anecdote that multiple participants did not notice the reminders would also have an effect on these results. While it was not stated as a necessary action, a "dismiss reminder" button was available to participants to acknowledge they had seen the reminder. Nearly half of the subjects never selected the button. We cannot know for sure that these participants did not see the reminder, but it suggests that future studies should verify that their reminders are not able to be ignored. A final possibility is that there were simply not enough PM events. Figures 7 and 8 show that the effects of anticipatory interval and reminder type are trending in the

hypothesized direction, but the results are not significant. Having more than four events could have expanded the effects enough to find significance. Perhaps the use of a common categorization task as was used by Fink (2013) could have increased these effects due to the greater number of possible successes. With only four possible tasks, the most and least successful participants are only separated by a small margin.

Finally, it is also possible that reminders simply do not help as much as one might think. Guynn, McDaniel, and Einstein (1998) tested several variations of reminders and found that the most helpful reminders referred to both the PM target event and the intended activity. This study used an event-based PM scenario, which differs from the current study. However, given that this research suggests a potential failure of certain reminders, it is possible that having a reminder that refers to the target time and intended activity, as in the current study, is not the best form of reminder for a time-based PM scenario.

Human Factors Implications

The results of this study suggest that the use of picture reminders do not significantly alter remembering performance. These findings could have design implications in that reminder devices may not benefit from an implementation of pictures. However, previous research (Fink, 2013) does suggest that increased distinctiveness at the time of encoding can benefit remembering. This suggests that the design of reminder devices should aim at increasing distinctiveness at the initial time of encoding and should focus less on the distinctiveness of the reminders.

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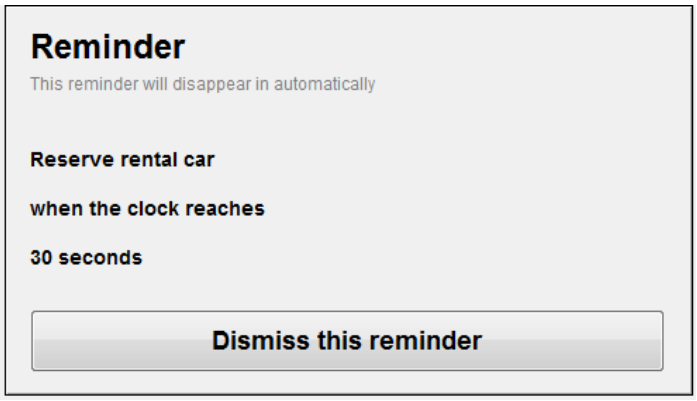
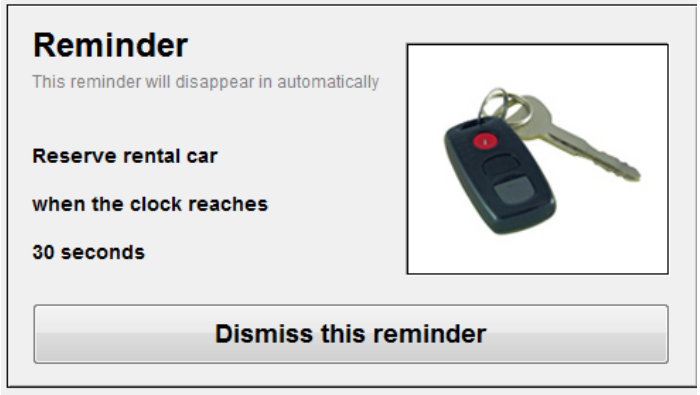
Figure 1



Text Reminder



Picture Reminder

Figure 2

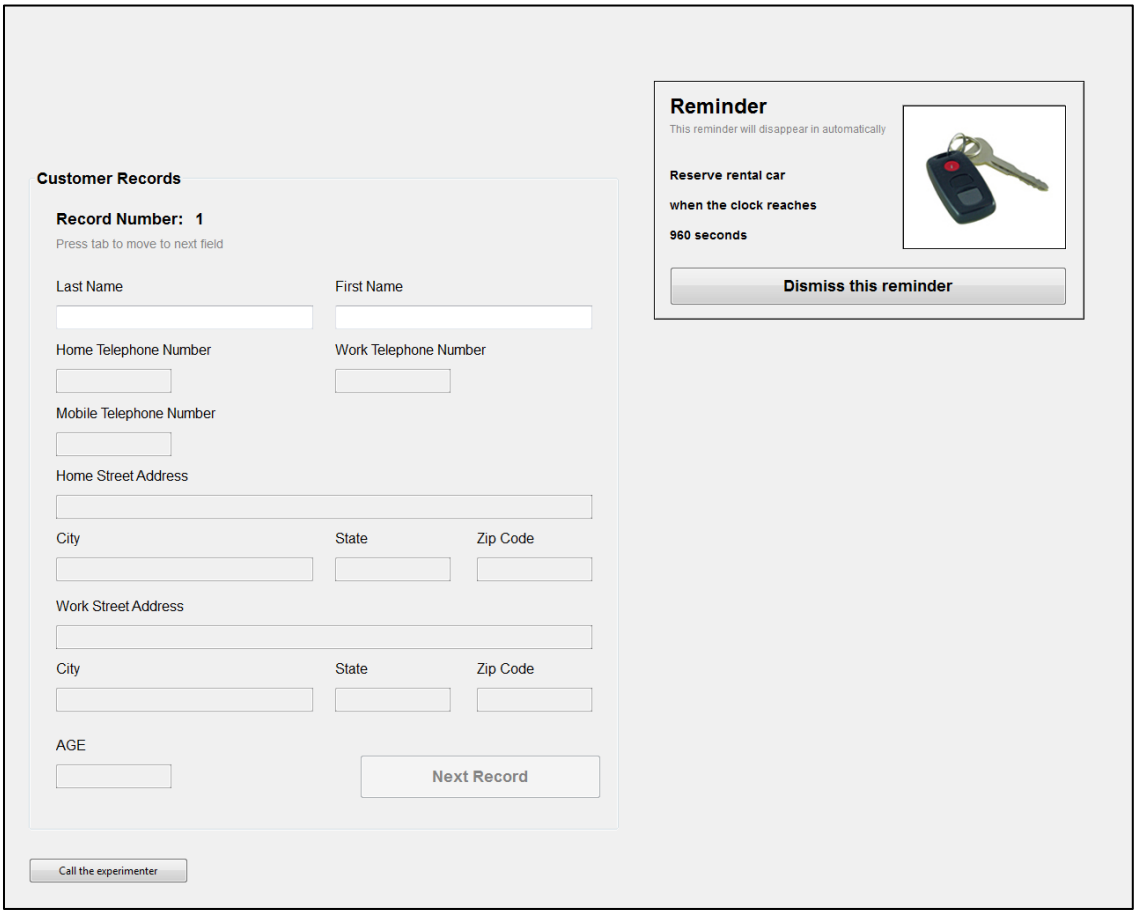

Reminder
This reminder will disappear in automatically
Reserve rental car
when the clock reaches
960 seconds
Dismiss this reminder
Customer Records
Record Number: 1
Press tab to move to next field
Last Name
First Name
Home Telephone Number
Work Telephone Number
Mobile Telephone Number
Home Street Address
City
State
Zip Code
Work Street Address
City
State
Zip Code
AGE
Next Record
Call the experimenter

Figure 3

First name	Martin	**Last name**	Adams
Work #	556-985-1523	**Mobile #**	556-908-7745
Home #	556-253-2536		
Work address			
Street	737 Broad Lane	**City**	Phoenix
State	NC	**Zip**	11452
Home address			
Street	200 Blackberry Run	**City**	Norris
State	NC	**Zip**	11105
DOB	07/18/1980		

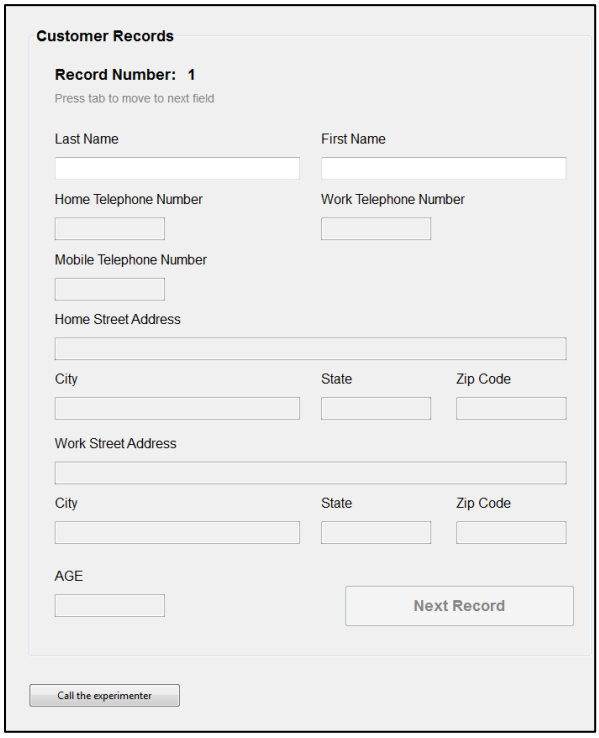


Figure 4

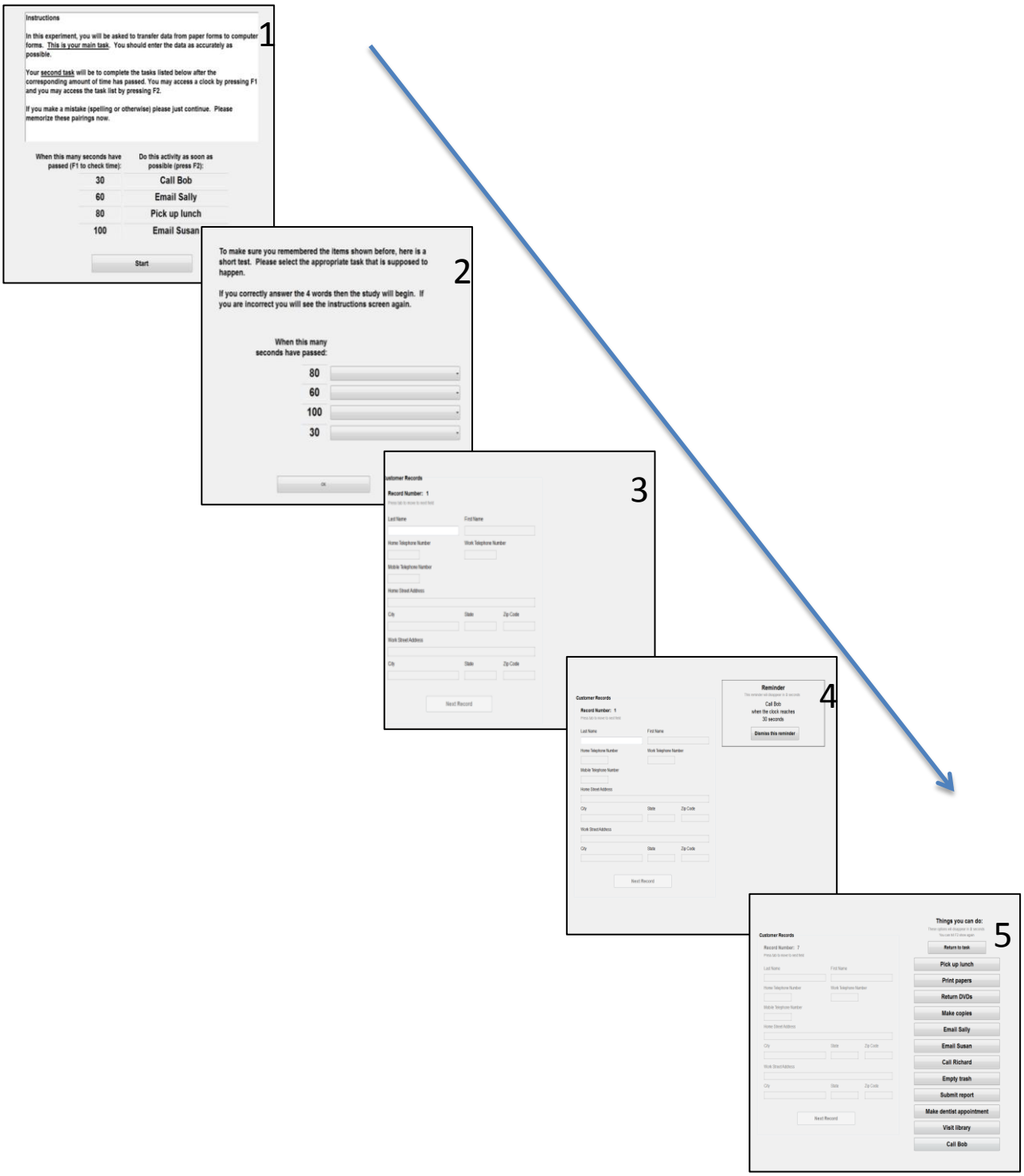
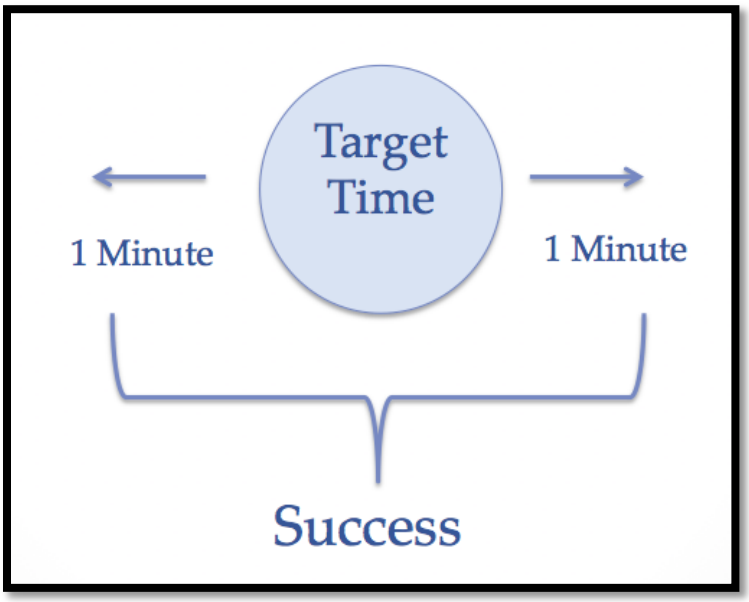

1
Instructions
In this experiment, you will be asked to transfer data from paper forms to computer forms. This is your main task. You should enter the data as accurately as possible.
Your second task will be to complete the tasks listed below after the corresponding amount of time has passed. You may access a clock by pressing F1 and you may access the task list by pressing F2.
If you make a mistake (spelling or otherwise) please just continue. Please memorize these pairings now.
When this many seconds have passed (F1 to check time):
Do this activity as soon as possible (press F2):
30
Call Bob
60
Email Sally
80
Pick up lunch
100
Email Susan
Start
2
To make sure you remembered the items shown before, here is a short test. Please select the appropriate task that is supposed to happen.
If you correctly answer the 4 words then the study will begin. If you are incorrect you will see the instructions screen again.
When this many seconds have passed:
80
60
100
30
OK
3
Customer Records
Record Number: 1
Next Record
4
Reminder
Call Bob
when the clock reaches
30 seconds
Dismiss this reminder
5
Things you can do:
Return to task
Pick up lunch
Print papers
Return DVDs
Make copies
Email Sally
Email Susan
Call Richard
Empty trash
Submit report
Make dentist appointment
Visit library
Call Bob

Figure 5


Target Time
1 Minute
1 Minute
Success

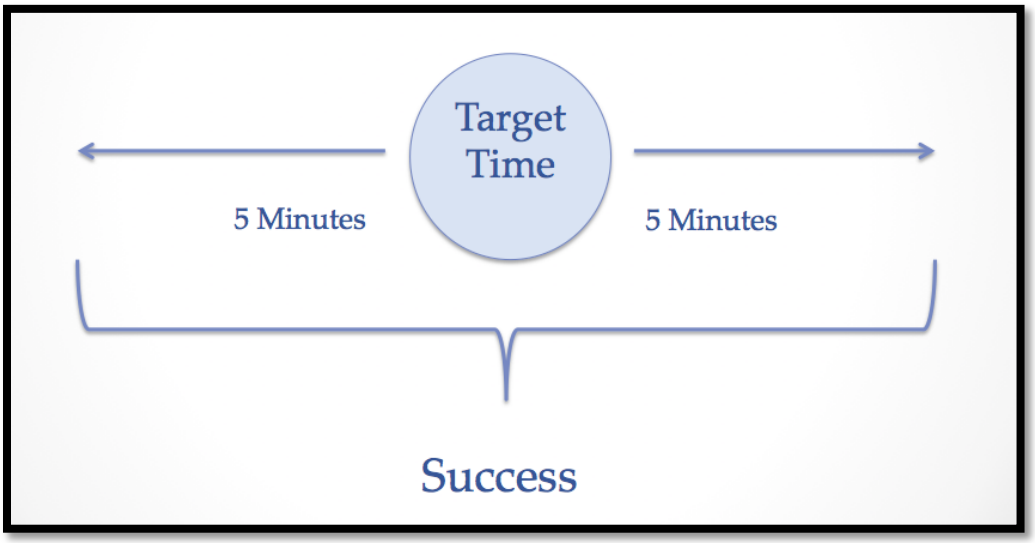
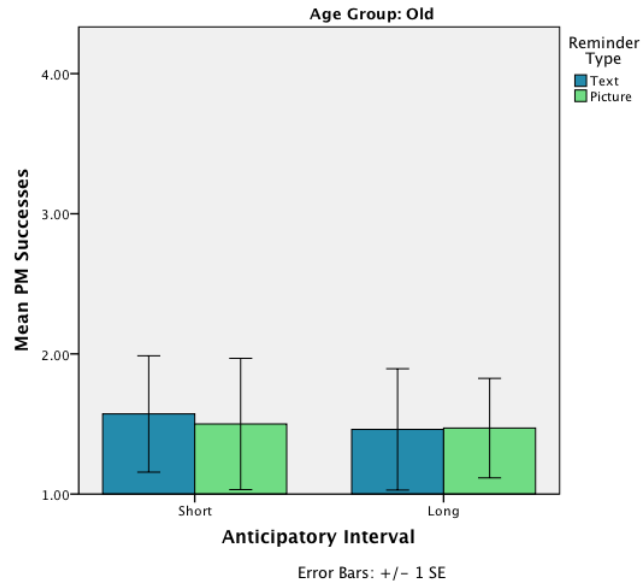

Target Time
5 Minutes
5 Minutes
Success

Figure 6


Age Group: Old
Reminder Type
Text
Picture
Mean PM Successes
4.00
3.00
2.00
1.00
Short
Long
Anticipatory Interval
Error Bars: +/- 1 SE

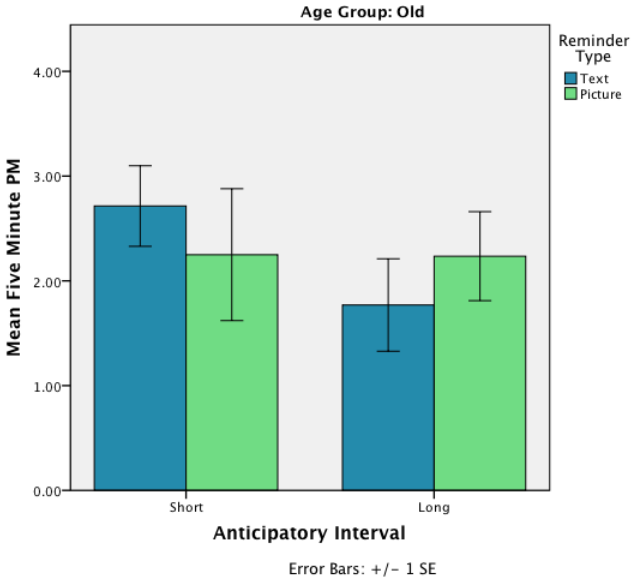

Age Group: Old
Reminder Type
Text
Picture
Mean Five Minute PM
4.00
3.00
2.00
1.00
0.00
Short
Long
Anticipatory Interval
Error Bars: +/- 1 SE

Figure 7

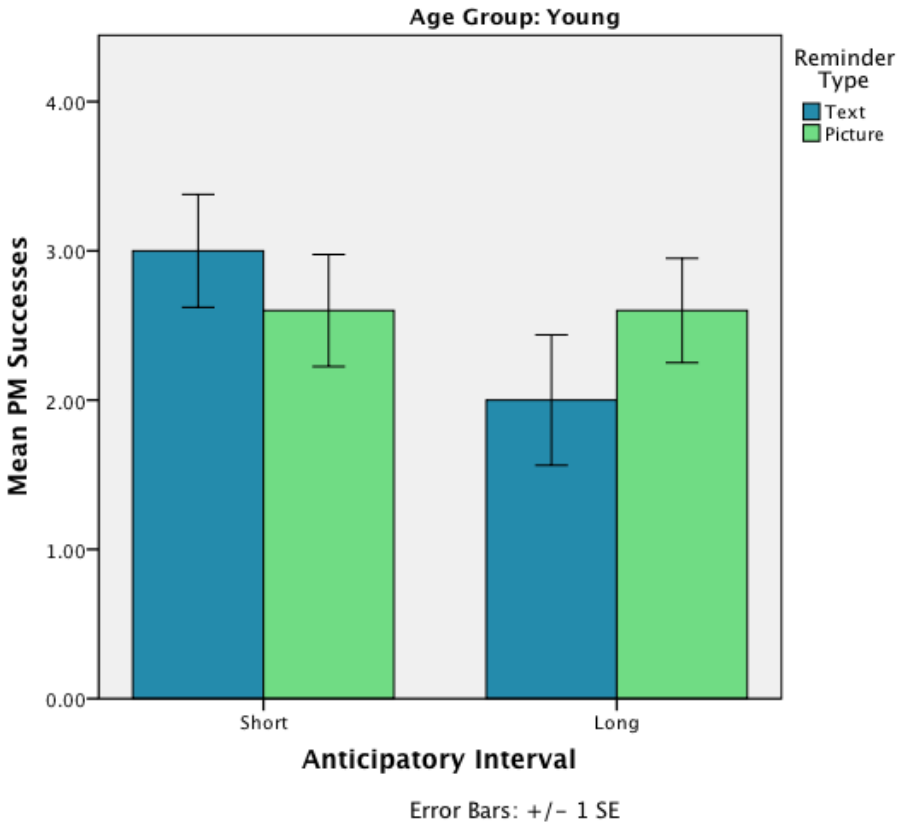
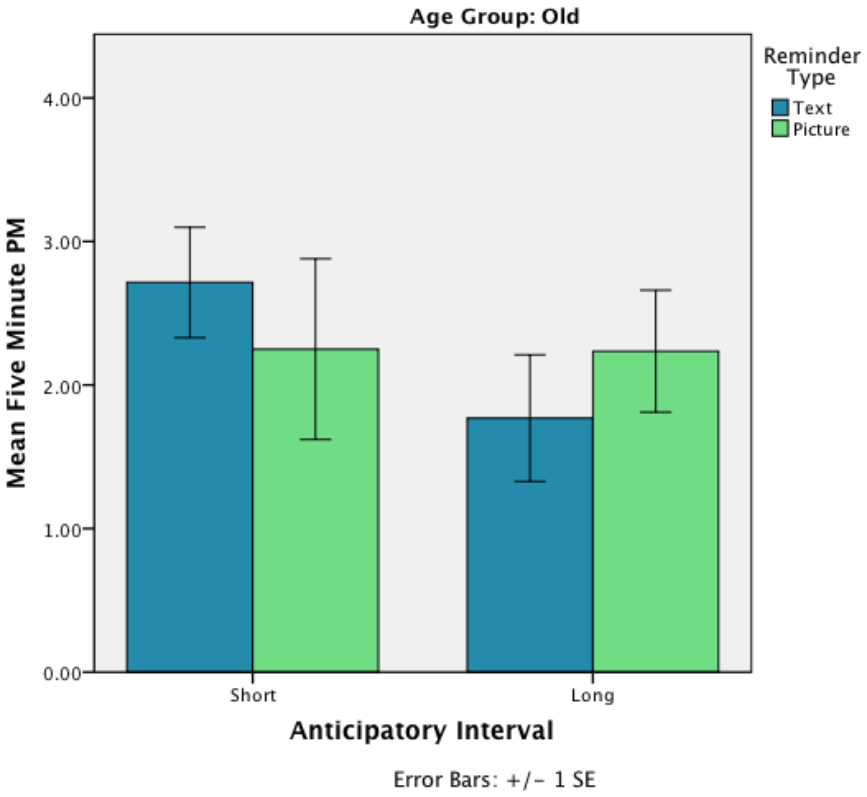

Age Group: Young
Reminder Type
Text
Picture
Mean PM Successes
4.00
3.00
2.00
1.00
0.00
Short
Long
Anticipatory Interval
Error Bars: +/- 1 SE

Figure 8


Age Group: Old
Reminder Type
Text
Picture
Mean Five Minute PM
4.00
3.00
2.00
1.00
0.00
Short
Long
Anticipatory Interval
Error Bars: +/- 1 SE