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AN EXPLORATORY STUDY OF PROSPECTIVE MEMORY:
EXAMINING THE EFFECTS OF AGE
AND THE RELATIONSHIP WITH RETROSPECTIVE MEMORY

by

LAWRENCE JOSEPH GRANDMAISON, B.A.

A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfillment of
the requirements for the degree of

Master of Arts

Department of Psychology

Carleton University
Ottawa, Ontario
August, 1992
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AN EXPLORATORY STUDY OF PROSPECTIVE MEMORY:
EXAMINING THE EFFECTS OF AGE
AND THE RELATIONSHIP WITH RETROSPECTIVE MEMORY

submitted by Lawrence Joseph Grandmaison, B.A.
in partial fulfilment of the requirements for
the degree of Master of Arts

A handwritten signature in dark ink, appearing to read "Tom Tambough", is written over a horizontal line.

Thesis Supervisor

Chair, Department of Psychology

Carleton University

17 August, 1992

Abstract

Prospective memory is that aspect of memory involved when one must remember-to-remember something, e.g., to take medication. It is one of the least researched topics in the field of human memory yet it represents one of the most frequently reported memory concerns, especially for the elderly. Past research, however, has generally failed to detect an age related decline in prospective memory performance or to demonstrate a relationship between prospective memory and retrospective memory. In three separate experiments, young and elderly subjects were required to learn a list of either two (Experiment I) or six different words (Experiment II & III), and, without prompting, recall the words at the appropriate future time. This task was imbedded within a seven subtest battery and the commencement of certain subtests acted as cues for the required response. It is shown that there are dramatic age-related declines in performance for the elderly subjects in all three experiments. As well, performance on this prospective memory task is shown to be correlated with performance on three retrospective memory tests; a visual, a verbal and a working memory test. The results are discussed with respect to the decreased ability of the elderly to utilize the cues available to initiate recall.

Acknowledgements

Many people contributed to the completion of this project, the most influential being Professor Tom Tombaugh, my advisor, my teacher and my friend. Thanks for the continued faith, guidance and pressure. Thanks mostly for taking a chance on me again.

I want to thank my committee, Professors Chris Herdman, Bill Petrusic, Bob Hoffman, Terry Nosenchuk and Tom Tombaugh, for the perfect closure to four years of work. You made it fun.

To my two typists, Maureen Walker and Kathy Ibel, thanks for coming through at crucial times and with great patience and spirit. I met deadlines because of your talents.

There were many people who contributed varying amounts of technical, administrative and graphic support, always yielding to my time constraints. In no particular order, but with much gratitude, they are: Dr. Barry Spinner, Bert Bowles, Sharon Sobczak, Steve McCrea, Penny Faulkner, Steve Callahan, Frances Gratsos, Illo Neri and Dana Noseworthy. I wish to also acknowledge my many friends who provided constant support and encouragement. Too many to name but you know who you are.

Finally I need to thank my wife Wendy and my children Amy, Megan and Eric for allowing me time to work at the expense of family time.

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Introduction

Nobody would argue that an accurate memory is a good skill to possess. So many activities are associated with our memory; success on exams, remembering names and faces, directions and phone numbers, remembering procedures, etc. These types of recollections are called retrospective memories. They are memories that we retrieve in response to self- or other-directed requests for personally stored information. They are memories of things we have learned or done in the past.

However, when people are asked to describe their most "typical" memory problems, many of the complaints center around the problem of forgetting what type of actions must be performed in the future, e.g., forgetting to keep appointments, taking medications or filling the car with gas (Harris, 1980). Forgetting of this type represents prospective memory failure. Prospective memory refers to the aspect of memory that is involved when one must remember-to-remember something. It is future directed memory.

The two features that differentiate prospective memory from retrospective memory are that in prospective memory the learned information is recalled at some future time and there are no obvious external cues to tell the person that the information should be recalled.

Prospective memory has not generated substantial amounts of research despite the fact that prospective memory failures are frequently reported. In the literature that is available, prospective memory has been referred to as prospective remembering (Meacham & Leiman, 1975), remembering-to-remember (Schoenfield & Stones, 1979), remembering-to-recall or self-cued memory (Wilkins & Baddeley, 1978), remembering to do things (Harris & Wilkins, 1982), remembering intentions (Lofhus, 1971) and remembering future actions (Morris, 1979).

Prospective memory tasks are markedly different from most retrospective memory tasks where the information is immediately recalled after the person has been told what type of information to remember (e.g., tell me all the words you can remember). The latter case is illustrated when a person attempts to answer exam questions. Here the person must supply only the answers to the questions - the questions are supplied by someone else. Prospective memory occurs, for example, when someone remembers that something is going to occur at 10 a.m. on Tuesday and then recalls precisely what that is. Here, both the "question" and the answer are supplied by the person.

Winograd (1988) has stated that three major differences exist between prospective and retrospective memory. First, retrospective memory is concerned with how much a person

remembers while prospective memory is concerned with whether a person remembers at all. Second, it is more difficult to detect retrieval cues for prospective memory than for retrospective memory. Third, retrospective memory failure tends to be attributed to an unreliable memory whereas prospective memory failure tends to be attributed to the unreliability of the person, e.g., chronic lateness for appointments.

Dobbs and Rule (1987) have conceptualized that a prospective memory task contains two essential elements. The first is remembering-to-remember. By this they mean that a person remembers something must be done at a specified future time or in a specified future situation. The specified situation may be, for example, "the next time I see Sally I must. . .", or "when we go to Florida I want to see. . ." Theoretically, no time limit is placed on when the prospective memory task can be executed. The second element is the "content" of the task. This is the message that one conveys to Sally or the "what" one wants to see in Florida.

The time element in a prospective memory task may be rigid, as in an exam start time, or fairly flexible as in the case that, "sometime this week I must buy an anniversary card". The successful execution of a prospective memory task typically has an optimal or critical time window in which to occur. Acting too soon or too late may result in failure.

Consider the captain of an airplane applying the brakes while still 1000 feet in the air or 1000 feet further down the runway than he should have.

The prevalence of prospective memory failures is evidenced in two studies that attempted to ascertain the types of memory aids people use and the reasons for their usage. Cavanaugh, Grady, and Perlemuter (1983) showed that over 60% of memory failures reported by older subject (mean age 59 years) and 57% of memory failures reported by younger subjects (mean age 28 years) were prospective memory failures (failure to remember routines and appointments). Harris (1980) asked participants to report the types of memory aids they used and their frequency of use. The two groups (mean ages 21 years and 46 years) reported many more uses of external aids (e.g., planners, writing on calendar, memos to self, etc.) to prevent prospective memory failures than external aids (e.g., lists) to prevent retrospective memory failures. Further evidence for the high incidence of prospective memory failures comes from the proliferation of services and products available to aid in the recall of future events. These include alarm watches, timers, whistling kettles, departure announcements at transportation centres and recent advances in automotive technology that warn of low fuel or the time for a tune-up. In short, while remembering information

from the past is important, we are also forward looking and are concerned about what we have to do in the future.

Factors that Affect Prospective Memory

Age.

Moscovitch and Minde (cited in Moscovitch, 1982) had young (ages 22-37 years) and old (ages 65-75 years) subjects call an answering service every day for two weeks at a time of their choosing. A second procedure involved them calling once a week for a two week period but the time of the call was chosen by the experimenter. In both situations, the elderly outperformed the young in meeting the appointed call-in times. The better performance of the elderly was attributed to their greater use of external memory aids. However, in a follow-up study which contained explicit instructions not to use any aids, the performance of the elderly declined to that of the younger adults.

Dobbs and Rule (1987) used two prospective memory tasks, short delay and long delay, with subjects ranging in age from 30 to 99: 30-39, 40-49, 50-59, 60-69 and 70+. On a short, 20 minute delay task, subjects were instructed to ask for a red pen when they reached the part of the test that required them to draw some shapes. Then an intervening task occurred which involved answering a variety of questions about their personal history. During this time a pencil was available but they

were not reminded that they were to ask for the pen. The results of this test showed that nearly 100% of the subjects in the 30 to 60 age ranges remembered to ask for the red pen. Performance fell to 70% for the 70+ age group. For the long delay task, subjects were asked to take home a questionnaire with the instructions that when they filled out the questionnaire they were to place the time and the date in the upper left hand corner. Two criteria were used to score this task. Performance was correct with a strict criterion if the subjects placed the time and the date in the correct location. Performance was correct with a lenient scoring system if they wrote either the time or the date in any location. With the strict scoring criterion, there were no age related declines in performance. However, with the lenient scoring criterion, the elderly were less likely to remember-to-remember. If they did remember to perform the task, they performed it correctly. Recall from above, these are the two aspects of prospective memory that Dobbs and Rule have labeled remembering-to-remember (lenient) and content (strict). It seems that remembering-to-remember declines with age but remembering content shows no age related decline in this study.

The opposite results were found by West (1988) who examined age differences in prospective memory. He had adolescents (mean age 16.3 years), young adults (mean age 32.4

years), and older adults (mean age 73.9 years) call a telephone answering machine before retiring for the night (the night of the interview) and mail a postcard two days later. They were also told to leave a message on the answering machine describing the strategy they used to remember each task. The younger groups more often forgot to perform the tasks completely (failed to remember-to-remember) while the older group more often forgot to provide the strategy message (content).

Finally, Einstein and McDaniel (1990) found no effect of age in two experiments where the mean ages of the older groups were 68.8 and 67.3 years, and the younger groups were comprised of 17-24 year old college students. The task required participants to press a response key whenever a target word was presented on a computer screen. This task was imbedded within a deception experiment, ostensibly to improve short term memory skills. In the first experiment, the target word, "rake", was presented three times across 42 learning trials. There was also a no-aid condition and an aid condition. Following the instructions, participants in the aid condition were given 30 seconds and a variety of materials (including pads, pens, elastic bands and tape) to create any external aid they wished. In the second experiment, there was no aided condition but there was a familiar and an unfamiliar word

condition. In the familiar condition, the target word for half of the subjects was "rake" and for the other half it was the word "method". In the unfamiliar condition, the targets were "sone" and "monad". Neither the use of external aids nor the use of familiar/unfamiliar targets aided either group in this task.

Intervening tasks, delay and cues.

At the beginning of a survey questionnaire containing either five or fifteen items, Loftus (1971) asked 200 students to report their state of birth upon completion of the questionnaire. Half of the subjects were told that they should report this information after the question about the Black Panther Party (explicit cue condition). The other half were not provided with any explicit cues. Loftus found that the information was reported more frequently in the explicit cue condition and in the five item survey condition. In an experiment that used a similar design, Meacham and Columbo (1980) told two groups of children to remind the experimenter to open a "special" box at the end of a seven minute interview. Half of the children were told that the presence of a clown doll would help them remember to remind the experimenter to open the box. The clown was left in plain view on the table for the duration of the test session. Remembering was greater in the cue condition, 75% vs 52%. Meacham and

Leiman (1975) also found a significant effect of cues when subjects were asked to mail postcards at various time intervals. For some subjects, tags were attached to their keys as a reminder that they must perform some task. In addition to the finding that there was a significant effect of tags, 88% of the subjects reported using another external cue to aid them in remembering, a finding consistent with the previously cited work of Harris (1980) and Cavanaugh et al. (1983).

Meacham and Singer (1977) had students return postcards under one of the following conditions; high or low incentive (money or no money) and habitual or episodic schedules (routine or random). The habitual condition demanded that the students mail the postcards every Wednesday for eight consecutive weeks. In the episodic condition the mailings were randomly distributed throughout the week days for the eight weeks. The high incentive condition produced more timely responses. The subjects in the high incentive condition also were more likely to use external cues. The reward may have made the task more meaningful and therefore more energy was expended on its completion. There was no effect of schedule. However, Wichman and Oyasato (1983) did show a beneficial effect of habitual schedules (this study is presented in detail in the next section). Sunderland et al. (1986) had elderly subjects (mean age 68.7 years) post cards in special

boxes at eight pre-determined times while they were concurrently participating in a research project. The times were associated with completion of different parts of the project. If the subject forgot to post the card, then increasingly more helpful verbal cues were provided until the subject responded correctly. Thirty-seven percent of the subjects performed perfectly and the remaining 63% required cues in as many as six of the eight postings. Since there was no younger group in this study it is impossible to determine if the difficulty experienced by the elderly also would have been evident in the young.

Finally, two groups of researchers utilized similar procedures to determine if a particular type of strategy was used with prospective memory tasks. Harris and Wilkins (1982) and Ceci and Bronfenbrenner (1985), engaged subjects in a distractor activity and concurrently had them monitor a clock in order to know when they should perform specific task. In analyzing the behaviour that occurred during the delay period, both studies found that subjects frequently watched the clock at the start of the period. Clock-watching was reduced in the middle portion, only to be increased again in the latter part of the period. What appears to have happened is that the subjects "set" an internal clock early in the test session by frequent observations of an external clock, so that their

perception of time passage coincided with real time passage. This allowed for less frequent time monitoring in the middle portion of the test which permitted them more time to engage in other activities. As the critical time approached, there was again an increase in time monitoring until the execution of the task. This seems to be a technique that would work for short intervals (minutes or hours) but not very well with extended time periods.

In summary, the above studies have shown that performance is adversely affected on tasks of prospective memory by longer delay intervals occurring between instructions and performance, complex intervening tasks and episodic (random) schedules. They have also shown that the use of cues attenuate these deficits.

Personality variables.

Two types of personality variables have been shown to be important in prospective memory tasks: (1) level of stress or anxiety and (2) internal/external locus of control. Stress was first reported to have an effect on remembering-to-remember by Drew (1940). Pilots undergoing flight training in England were required to monitor gauges in training aircraft and perform various tasks according to the information provided by them. As the amount of information increased through training, and the inferred level of stress increased,

so too did the error rate in monitoring the equipment. For example, 60% of the pilot trainees failed on at least one occasion to lower the landing gear at the appropriate time and essentially "landed" on the belly of the airplane. In this example, however, it is impossible to determine whether they monitored the proper gauges and failed to act or if they forgot to monitor the gauges. Only the latter case represents a case of failure of prospective memory.

Meacham and Kushner (1980) administered a questionnaire to college students to determine under what conditions they forgot to carry out a planned action as opposed to when they remembered-to-remember but failed to act. Forgetting was found to be associated with the perception of the task as being unimportant, partially supporting the conclusion from Meacham and Singer's (1977) low incentive condition. Remembering but not performing the task was found to be associated with high discomfort and anxiety. Failing to act was attributed to a variety of causes like changes of mind, conflict with other activities, or fatigue.

Wichman and Oyasato (1983) tried to assess differential performance of "externals" (people who believe that "forces" external to themselves determine their life) and "internals" (people who believe they control their own destiny) on a prospective memory task. Using high school students divided

on the basis of these variables, they employed a task that required the students to circle vowel pairs on a sheet of letters. Two degrees of difficulty were determined by how the letters were displayed. Concurrently, the subjects had to monitor a clock at certain episodic (random) or habitual (regular) times to acquire additional information. The dependent measure for the prospective memory task was whether the participants successfully obtained the additional information (numbers printed on a card). The results showed that: (1) prospective memory was more difficult with a complex task, and (2) maintaining episodic performance was more difficult than maintaining habitual performance.

The Relationship Between Prospective and Retrospective Memory

Most of the literature indicates that prospective memory and retrospective memory are unrelated. Harris and Wilkins (1982) found no relationship between how well their subjects remembered (incidentally) the content of a film and their performance on a prospective memory task. (The film was used as a distractor for the main task.) Similarly, Meacham and Leiman (1975) found no correlations between prospective memory (remembering to mail postcards), retrospective memory (free recall of lists of 5, 7, 9, or 11 words) or predictions of remembering abilities (based on an eight item metamemory questionnaire asking subjects to self-rate their remembering

abilities). Also, Wilkins and Baddeley (1978) found a negative correlation between verbal recall scores and prospective memory performance. Two groups were selected from 100 subjects screened on free recall of a serial list; the 16 highest scorers and the 15 lowest scorers. In a test analogous to pill taking, the subjects were required to operate a printout clock at four predetermined times a day for seven days. The subjects with high free-recall scores performed significantly worse than those with low free recall scores. Einstein and McDaniel (1990) found no relationship between their prospective memory task of pressing a response key at the presentation of a target word and either the recall or recognition of a word list.

One difficulty with trying to determine the relationship between retrospective memory and prospective memory is that all prospective memory studies have used essentially the same paradigm. That is, a task is established where performance is contingent on a specific time or situation, e.g., at 3 p.m. or at the end of a questionnaire. While other conditions have varied, for example habitual versus episodic schedules and complex versus simple intervening tasks, only one prospective memory test (Wilson, Cockburn, Baddeley & Hiorns, 1985), has required subjects to perform more than one type of task within the testing situation. The Rivermead Behavioural memory test

requires participants to give a personal item to the tester at the start of the test and to ask for it, without prompting, at the end of the test. As well, the participants must ask when their next appointment will be when a timer rings. Some tasks require a simple response once, for example asking for a red pen (Dobbs & Rule, 1987), and others require the same response many times, e.g., mailing postcards, punching time clocks and posting coloured cards (Meacham & Leiman, 1975; Meacham & Singer, 1977; Sunderland et al., 1986).

In terms of memory "load", these tasks may not have taxed the subjects' memory very heavily. While many prospective memory tasks are analogous to pill taking or to meeting a single appointment time, only the Rivermead has employed conditions that are analogous to keeping many (more than two) and varied appointments in a day. A more complicated, and perhaps more realistic, everyday schedule may require a person to do several different things such as; "take medication at 0800, remove the roast from the freezer to thaw, take medication again at 1200, pick up mom at 1400 for a 1430 doctors appointment, pass Tom his phone message when I see him, and put the roast in the oven before I get mom." In this example there are several episodic and habitual events which are time dependent and one episodic event that is situationally dependent. Some have more cues than others. "Tom" is a cue

to tell the person something and "time" is a cue for pill taking and for roast thawing, albeit not as specific for the roast (episodic) as for the medication (habitual). Some situations may have more personal meaning than others. Taking "mom to the doctors" would seem to be more important than "taking the roast out of the freezer", and therefore may get a higher priority. Thus, there are a variety of tasks in a "typical" day that not only have variable times between their execution, but also have different types of simple and complex tasks intervening between them. Moreover, the tasks differ in their degree of meaningfulness and possess different numbers of retrieval cues. To address the shortcomings of previous studies, one could test different responses at either fixed or varied times or in different situations. It would also be important to determine how many of the factors that interfere with or facilitate retrospective memory produce parallel effects on prospective memory.

Theoretical Speculation

Before discussing the methodology employed in the present series of experiments, some attention is directed toward providing a theoretical explanation of prospective memory.

There are at least three possibilities for any memory failure: the information never "gets in" (acquisition or encoding difficulties); the information cannot be accessed

(retrieval difficulties); or the information enters the memory system but is not retained (storage difficulties). Although we speak of acquisition and retrieval as separate functions, the two processes are highly entwined and it is probable that "efficiency of retrieval is dependent on efficiency of encoding" (Kasniak, Poon, & Riege, 1986, p. 173). (See also Craik, 1983; Tulving & Thompson, 1973). Since the task is explained explicitly in prospective memory research, most retrospective memory research, and in the real world, it is highly unlikely that prospective memory failures are the result of acquisition problems. Moreover, the subjects understanding of the task requirements are usually verified prior to starting the task.

The failure to retrieve information from memory may stem from many causes; organizational problems, anxiety, lack of cues, intrusive thoughts etc. The most appealing explanation for prospective memory failures relates to the number of cues present at the time of retrieval. Craik (1983) speculated that retrieval (and encoding) tasks vary in the degree to which they require self-initiated operations. The elements of the retrieval continuum (free recall¹, cued recall and

¹The term free recall may be used two ways: one, to mean the recall in order of information, like a word list, without cues; two, the recall of information in any order, without cues. The latter meaning is used here.

recognition) provide various amounts of environmental help. Free recall provides the least help, giving only the time to recall and general cues about the material, (e.g., Now, tell me all the words you remember.") However, free recall tasks are not devoid of cues. Although the cues may not be very specific, they guide responses to some degree. Cuing in free recall provides general information about when to recall and about what to recall. It is only "free" in the sense that the subject must explore all of his or her retrieval strategies to seek the cues employed at encoding or storage to aid in the recall. He or she is free of (i.e., not constrained by) categories imposed by the experimenter, which may or may not be the categories the subject used to encode and store the items. For example, the word "dog" may be encoded under any of the categories; mammals, pets, fur bearing animals and domesticated animals. Free recall may involve searching all these categories to retrieve the correct word.

Cued recall provides more help than free recall, the cues being related to the target in such a way as to reflect encoding operations or storage strategies (e.g., word categories). Recognition provides the most amount of environmental help and presumably requires the least amount of effort in terms of resources.

Prospective memory tasks may be considered to contain fewer cues than free recall tasks, but nevertheless cues are still present in a prospective memory task. There are still associations possible between the limited cues and the to-be-remembered items.

Craik has suggested that since remembering-to-remember requires the greatest amount of self-initiated activity and provides the least amount of environmental support (cues), prospective memory could be placed above free recall on the retrieval continuum. Conceptualized this way, prospective memory becomes just another type of retrospective memory task with the major distinguishing characteristic being the minimal number of cues present at the time of retrieval. That is, prospective memory tasks appear to have two components, content and remembering-to-remember (Dobbs & Rule, 1987). As previously described, the content is a fact or facts; e.g., "Doctor's appointment at 10 a.m. on Tuesday". Presumably, memorizing and retrieving this fact is no more difficult than memorizing and retrieving other facts such as a serial list or a paired-associate list. Thus, the problem with prospective remembering appears to originate, not at the stage of item retrieval, but at the stage immediately preceding that, when the appropriate retrieval cue is presented. Successful prospective remembering would appear to be contingent on the

triggering action of the cue. This speculation is consistent with the results of the Dobbs and Rule (1987) study where there was no difference between young and old subjects in remembering the content of the task but there was a difference in remembering-to-remember to perform the task. That is, if the subject remembered-to-remember (i.e., self-initiated the retrieval cue) then the relevant information was recalled. This finding is, however, at variance with the results reported by West (1988).

Given the above, it may be that the manipulation of cues could aid or hinder prospective remembering. This idea was explored by Einstein and McDaniel (1990) in their use of familiar/unfamiliar target words (cues) to prompt a response. While they did not find age group differences in this experiment, they did show that the use of an unfamiliar target word produced prospective memory scores nearly three times as high as those using a familiar target.

In a similar vein, West (1988) suggested that the context is of significant importance in successful prospective memory performance. He suggested that the salience of cues in the laboratory context (where everything around is associated with research) was lower than research cues in the home, where they would be out of context.

Summary

The results of the following studies will be interpreted within the general theoretical framework outlined above, namely, that cue utilization will govern prospective memory performance. The variable of primary interest, however, is not cue manipulation or saliency but the effect of age on prospective memory performance. Secondary to this is the question of the relationship between prospective memory and retrospective memory.

Method - General

Subjects

The following three studies used community-dwelling volunteers, recruited in the Ottawa area through contacts with churches, employers, community service groups and from booths in area shopping malls. The subjects ages varied from 20 years to 80 years.

Materials

Retrospective Tests. The retrospective tests were selected primarily from the Learning and Memory Battery (LAMB: Tombaugh and Schmidt, 1992) and the Weschler Adult Intelligence Scale-Revised (WAIS-R: Weschler, 1981). The basic test battery consisted of the following retrospective memory tests; paragraph, paired associate test, list learning, digit-span, supra-span learning, simple figure, Taylor complex figure, selected measures from the WAIS-R (vocabulary, similarities, block design and digit symbol) and a working memory test (Dobbs and Rule, 1988). Appendix A contains a brief description of these tests.

Prospective Test. The subjects were required to learn a set of words or phrases at the beginning of the test session. Subsequently, these served as responses that the subjects were instructed to provide at different parts of the test. For example, the subject was instructed to say "GROCERY

LIST" when the experimenter began the "list learning" subtest. The items were selected so as to have a natural association with the different parts of the test. The subjects were also informed that they would not be further reminded to say the words after the experiment began. If the subject did not produce the word(s) associated with the appropriate sub-test, the experimenter would provide increasingly more helpful verbal prompts in an effort to elicit the response. The procedure for the prompts used for all the experiments are as follows:

1. Spontaneous Recall. (Prospective Memory) The person remembered to say the correct response at the appropriate time in the test. (Y/N)
2. Prompted Recall. If the person did not spontaneously produce the correct response, ask: "Do you remember what you were supposed to say when I started talking about (the associated sub-test)?" (Y/N) "What was it?"
3. Cued-Recall. If the person was unable to answer the prompt, say: "You were supposed to tell me about (provide a specific cue to the required response). What was this?"
4. No Recall. The person was unable to respond.

Procedure

The majority of volunteers were tested at Carleton University but some were tested at their place of employment or at home. At the start of the test session the general rationale was explained to the participants. They were required to read and sign a consent form. Then a variety of biographic and demographic information was collected followed

by administration of the Mini Mental Status Exam (Folstein, Folstein & McHugh, 1975). Finally, the prospective memory instructions were given and the LAMB was administered. Total time for administration was approximately two hours.

Results - General

Prior to conducting a detailed analysis of each experiment, the intercorrelation matrix was examined to determine the optimal number of variables that should be used in the subsequent analysis. The approach to selecting the variables for further exploitation was based on both rational and statistical considerations.

The first step was to identify those tests that were highly inter-correlated and to select one test that best represented the variable of interest. A previously conducted factor analysis (Tombaugh & Schmidt, 1992) showed that the LAMB measures two independent processes, visual and verbal memory. Consequently, one test was selected to represent each factor. The word list was selected to represent the verbal factor and the complex figure was selected to represent the visual factor. In addition, digit span was chosen to represent a measure of attention and working memory.

The second step was to select the score that best represented that particular test. The total learning score (the mean score of the learning trials) was used for word list and complex figure. Both forward and backward digit span scores were used because they measure different processes; attention and working memory respectively.

The preliminary analysis reduced the variable list, for example, in Experiment I, from 29 to 8. This preliminary data reduction procedure was performed for each experiment. The reduced variable data was then subjected to the same basic set of analyses, designed to determine answers to the following questions:

1. Is prospective memory affected by aging?
2. Are prospective memory and retrospective memory related?
3. Can prospective memory performance be predicted from performance on retrospective memory tests and/or other variables?

EXPERIMENT I

The general purpose of the first experiment was to determine if any age differences existed with a prospective memory procedure containing two different items. This represents an attempt to replicate previous findings when subjects were required to remember two different prospective tasks, the limit used in prior research.

Method

Subjects

One hundred and sixty-five subjects were used in this experiment. They were divided into two groups; young (mean age 30) and elderly (mean age 71).

Materials and Procedure

Following the collection of basic demographic information, the LAMB (Tombaugh and Schmidt, 1992) was administered individually to participants. The prospective memory task was imbedded within this battery of tests. The order of presentation of the subtests was as follows:

- a. Paragraph Learning
- b. Word List Learning
- c. Simple Figure
- d. Paired Associate Learning
- e. Complex Figure
- f. Digit Span
- g. Supra-span Learning

The specific instructions for prospective memory in Experiment I were as follows:

"Most of the time I will be giving you instructions on what I want you to remember immediately before the task. However, some of the time you will be expected to remember things on your own, without my prompting. For example, when I begin talking about the list of 15 words, you are to say the phrase GROCERY LIST. You are to remember this information WITHOUT being reminded. Before I go on, I want you to tell me what you are going to say when I start telling you about the 15 words. (Verify that the person understands the task.) Remember, I won't remind you, so you will have to remember on your own. O.K., is this clear? Later on I'll show you four geometric figures. When I start talking about this part of the test, I want you to say the word GEOMETRY. I want you to remember to tell me this information WITHOUT being reminded. Before I go on, tell me what you are supposed to say to me when I start telling you about the four geometric figures. (Verify) Remember, I won't remind you so you will have to remember on your own. O.K. let's review them one more time to be sure you have them down.

The time between the instructions and the requirement to recall the appropriate prospective memory word was approximately 10 minutes (grocery) and 25 minutes (geometry).

Immediately following the prospective memory task instructions the retrospective memory tasks were administered.

Results and Discussion - Experiment I

Demographics

Table 1 shows the demographic breakdown of the two groups. The only significant difference in performance measures was in the vocabulary score ($t(163) = 3.29, p < .01$) with the elderly scoring higher than the young.

Table 1Demographic Characteristics of Participants for Experiment I

Variable	<u>Young (n=59)</u>		<u>Elderly (n=106)</u>	
	Mean	s.d.	Mean	s.d
Age	29.3	5.6	70.6	5.6
Age Range	20-40		60-80	
Education	3.9	1.1	3.6	1.0
Vocabulary (WAIS-R)	42.1	10.9	47.7	10.2*
Bl. Design (WAIS-R)	10.6	3.0	10.7	2.5
Gender -Male(N)	40 (68%)		56 (53%)	
-Female(N)	19 (32%)		50 (47%)	

Note: Education values. 3=some high school, 4=completed high school.

* $p < .01$

Retrospective Memory

The mean number of correct responses from the LAMB tests are shown in the upper portion of Table 2. T-tests indicate that significant differences occurred between groups on serial learning and complex figure, with the young group scoring higher than the elderly group.

Table 2Participants Subtest Scores for Experiment I

Variable	<u>Young (n=59)</u>		<u>Elderly (n=106)</u>	
	Mean	s.d.	Mean	s.d.
<u>Retrospective Memory Measures</u>				
Digit Forward	8.03	2.3	7.76	2.5
Digit Backward	6.97	2.8	6.27	2.0
Serial Learning	53.3	8.9	42.0	9.5**
Complex Figure	214.19	28.7	152.11	49.1**
<u>Prospective Memory Measures*</u>				
Prospective Memory	72.0	38.6	31.5	41.6**
Prompted Recall	94.9	17.8	76.4	37.3**
Cued Recall	98.3	9.1	84.9	31.7*

*Scores are percentages of perfect performance.

*p < .01 **p < .001

Prospective Memory

The mean scores for prospective memory, prompted recall and cued recall are shown in the lower portion of Table 2.

These measures were calculated in the following manner:

- a. Prospective memory score. The percentage of correct, unprompted responses given at the appropriate time of the test.
- b. Prompted recall score. The sum of the prospective memory and correct responses when the participant was given a general cue.
- c. Cued recall score. The sum of prospective memory, prompted recall, and correct responses when a specific cue was given. It represents the total number of correct responses obtained and is assumed to measure the total contents of memory for the task.

The individual trial scores for each measure are shown in Figures 1-3. The results for each measure were analyzed

Insert Figures 1-3 about here

by separate MANOVAs, with one between subject variable (age group) and one within subject variable (words). Significant age differences were found for the prospective memory score ($F(1,163) = 37.6, p < .001$), the prompted recall score ($F(1,163) = 12.85, p < .001$) and for the cued recall score ($F(1,163) = 10.02, p < .01$). Further, this age effect was substantiated by the finding that the elderly responded correctly with both words only 23% of the time while the young did so 61% of the time.

Another way to illustrate the results is to calculate the difference in mean performance for each of the three types of measures. If providing cues differentially benefits the elderly, the difference in mean performance should decrease as more cues are available. The difference between the young and the elderly group on the prospective memory measure is 40%. This difference declines to 19% with a general prompt (prompted recall) and to 13% with a specific cue (cued recall).

Figure 1. Age differences in prospective memory performance, Experiment I.

Figure 2. Age differences in prompted recall performance, Experiment 1.

Figure 3. Age differences in cued recall performance, Experiment I.

A significant word effect ($F(1,163) = 6.26, p < .05$) and an age $\times$ word interaction ($F(1,163) = 6.26, p < .05$) was obtained in cued recall. (The F ratio is the same for both of these analysis because the performance of the young group did not change from the first word to the second word and, therefore, added nothing to the results. They are a "statistical coincidence" resulting from the perfect performance of the young group on the cued recall aspect of the task).

In order to determine if prospective memory is related to retrospective memory, an intercorrelation matrix was constructed (Table 3). As can be seen, prospective memory is significantly related to verbal memory (list learning), visual memory (complex figure) and working memory (digits backward).

Finally, a multiple regression analysis was performed to determine if prospective memory performance could be predicted from the other variables. Because this research was exploratory, a stepwise multiple regression procedure was used (Spinner, 1989). Since age was the variable of most interest however, it was forced into the equation first, with the remaining variables allowed to enter in stepwise fashion. The summary step. are shown in Table 4. As can be seen, age maintained its position in the regression equation. Based on an examination of the correlation matrix, this was expected. Age and prospective memory are highly correlated, as are age and list learning, and age and complex figure. Once the effect

Table 3Intercorrelation Matrix for the Variables in Experiment I

	Age	Digit Fwd	Digit Bkwd	Voc	Block Design	Serial List	Comp Fig	Prosp. Memory
Age	--	-.08	-.15	.26**	.06	-.52**	-.53**	-.45**
Digit Fwd		--	.58**	.28**	.22*	.07	.11	.21*
Digit Bkwd			--	.36**	.32**	.19*	.27**	.28**
Vocab				--	.46**	.01	.27**	.23**
Block Design					--	.09	.37**	.23*
Serial List						--	.48**	.47**
Comp Fig							--	.48**
Prospective Memory								--

* $p < .05$ ** $p < .001$

of age was removed from the latter two tests, their contribution toward prediction was still significant, yet diminished. Age alone is found to account for 20% of the total variance in scores and 54% of the known (explained) variance.

Table 4

Results of Multiple Regression Analysis for Experiment I

Step	Variable	R	R ²	R ² Change	Significance
1	Age	.44	.20	.20	.001
2	Vocabulary	.57	.32	.12	.001
3	Serial Learning	.61	.37	.05	.001

This experiment produced several results that are incompatible with those reported in the literature. First, it was demonstrated that prospective memory performance is greatly affected by age. Although age differences have been observed previously in a prospective memory task (Dobbs & Rule, 1987) most evidence suggests that prospective memory is not affected by age (e.g., Einstein & McDaniel, 1990; Moscovitch & Minde, 1982). Second, it was shown that prospective memory is positively related to retrospective memory. This represents the first instance where such a relationship has been reported and it will be explored further in Experiments II and III. Third, it was demonstrated that prospective memory performance could be predicted from other memory tests.

Due to the uniqueness of these results, Experiments II and III were undertaken to determine if they could be replicated with a similar set of procedures. In Experiments II and III, the word list was lengthened to six different items thereby increasing both the number of responses required and the length of time that transpired between the instructions and the responses.

Experiments II and III

Experiments II and III were conducted to assess age differences (young vs elderly) with a multi-target (6 different items) prospective memory procedure. These experiments extended the level of difficulty of Experiment I, which used two items. The only difference in the following two experiments in the prospective memory tasks, is that one of the six items was different.

EXPERIMENT II

Method

Subjects

Thirty-one young (mean age = 28) and thirty-three elderly (mean age = 62) subjects were selected following the procedures described in the general methods section.

Materials and Procedures

The LAMB was administered individually, to participants. The Dobbs and Rule (1988) working memory tasks was added to the battery to provide a more adequate measure of working memory. This test had shown some promise as being able to distinguish young from elderly (Grandmaison and Tombaugh, 1990).

The specific instructions for this version of the prospective memory test were as follows:

"Most of the time I will be giving you instructions on what I want you to remember immediately before the task. However, some of the time you will be expected to remember things on your own, without my prompting. For example, when I begin talking about learning a paragraph, you are to say the word BOOK. This is easy to remember because a book contains paragraphs. When I mention a list of words, you are to say the phrase GROCERY LIST--a grocery list is a particular type of list. I want you to remember this information without being reminded. Before I go on, what are you going to say when I start talking about the paragraph? (Verify that the person understands--book.) When I mention the list of words what will you tell me? (Verify--grocery list.)

I'll also ask you to draw me a complex geometric figure. At this time I want you to ask me the following question: WILL I NEED A RED PEN? This can be easily remembered because you can draw a

figure with a red pen. When I ask you to repeat a series of numbers, I want you to tell me YOUR AGE. You can remember this because your age consists of two numbers. I want you to remember to tell me this information without being reminded. Now, what are you supposed to tell me when I start telling you about the geometric figures? (Verify--will I need a red pen?) When I mention the long series of numbers, what will you say? (Verify--age).

There are two other things I would like for you to remember on your own. When I get to a portion of the test which requires you to learn pair of words you are to tell me your FIRST AND LAST NAME. A little bit later I will ask you to cross out some letters. At this time you say the word ALPHABET. This can be remembered since an alphabet contains letters. What are you to say when I ask you to cross out some letters? (Verify--alphabet)

Let's be sure you understand what you are supposed to do. When I talk about each of the following parts of the test, tell me what you are going to say. (Use prompt if person is unable to remember words.) When I start talking about - --- what will you say?

PARAGRAPH - book (prompt, it is something that contains paragraphs)
 LIST OF WORDS - grocery list (prompt, it is a special type of list)
 COMPLEX GEOMETRIC FIGURE - Will I need a red pen? (prompt, it is something to draw with)
 SERIES OF NUMBERS - age (prompt, it is something that contains two numbers)
 WORD PAIRS - first and last name (prompt, it is something that contains two numbers)
 CROSS OFF LETTERS - alphabet (prompt, it is something that contains letters)

The time (minutes) between instructions and the beginning of the appropriate sub-tests requiring a response was, approximately 10 (book), 25 (grocery list), 35 (red pen), 45 (age), 55 (name) and 65 (alphabet).

Immediately following the prospective memory instructions, the tests of retrospective memory were administered.

Results and Discussion - Experiment II

Demographics

The demographic information for the participants are shown in Table 5. There is a significant difference between groups on the vocabulary measure ($t(62)=4.02$, $p<.001$), with the elderly

Table 5Demographic Characteristics of Participants for Experiment II

Variable	<u>Young (n=31)</u>		<u>Elderly (n=33)</u>	
	Mean	s.d.	Mean	s.d.
Age	27.9	8.35	62.3	7.34
Age Range	20-50		51-80	
Vocabulary	48.7	7.75	56.4	7.54*
Block Design	11.8	3.18	12.6	2.47
Gender				
-Male(N)	12(39%)		15(45%)	
-Female(N)	19(61%)		18(55%)	

* $p < .001$

scoring higher. Based on the Vocabulary and Block Design scores, both groups fall into the average range of I.Q. scores.

Retrospective Memory

Table 6 displays the performance of both groups on the variables of interest. As in the previous experiment, word list learning performance and complex figure performance differ significantly between groups, with the young obtaining better scores.

Prospective Memory

The results of the prospective task are shown in the lower portion of Table 6 and in Figures 4-6.

Table 6

Participants Subtest Scores for Experiment II

Variable	<u>Young (n=31)</u>		<u>Elderly (n=33)</u>	
	Mean	s.d.	Mean	s.d.
<u>Retrospective Memory Measures</u>				
Digit Forward	8.87	2.43	8.30	2.11
Digit Backward	8.0	2.43	7.72	2.35
Serial Learning	10.13	1.73	8.97	1.82*
Complex Figure	110.97	14.54	95.95	17.29*
<u>Prospective Memory Measures</u>				
Prospective Memory*	86.56	16.34	59.60	35.85**
Prompted Recall*	96.00	5.01	88.50	8.36
Cued Recall*	99.90	0.46	99.82	0.46

*Scores are percentages of perfect performance.

* $p < .01$ ** $p < .001$

A separate MANOVA was conducted on each of prospective memory, prompted recall and cued recall performance. For prospective memory, a significant difference was found between groups ($F(1,54) = 9.71$,

Insert Figures 4-6 about here

$p < .01$) and words ($F(5,54) = 3.58$, $p < .01$). There was no group $\times$ word interaction. This result is consistent with Experiment I where an age difference was observed with the two item task. This age difference did not extend to either the prompted recall ($F(1,54) = 3.21$, $p > .05$) or cued recall ($F(1,54) = .60$, $p > .05$). Near perfect performance was achieved for prompted recall by the younger group (mean = 96.0%) while the older group was still slightly, but not significantly, lower (mean = 88.5%). This is contrary to the results

Figure 4. Age differences in prospective memory performance, Experiment II.

Figure 5. Age differences in prompted recall performance, Experiment II.

Figure 6. Age differences in cued recall performance, Experiment II.

in Experiment I. However, the previous experiment had groups that represented more diverse positions and produced greater variance in scores. There were no middle-aged participants in Experiment I, therefore, the contrasts between groups were more extreme. For the present experiment, the inclusion of this middle group of 40-60 year old subjects into both groups probably diluted an effect that would be seen with greater age splits.

As in Experiment I, the young vastly outperformed the elderly in terms of perfect performance as measured by the percentage of participants who provided the correct response six out of six times; 50% and 23.5 % respectively.

The results of t-tests for between group performance on each of the six words in this task yielded the results shown in Table 7. It is clear from this analysis that different words (or times) acted in different ways in the experiment, resulting in the saw-tooth pattern seen in Figure 4. This pattern, and possible causes, will be explored in more depth in the general discussion. What should be observed at this point is that the pattern is the same for both groups. Whatever factor (or factors) that is influencing the response behavior in this manner is doing so regardless of age.

Table 7

T-test Analysis on Group Differences for Each Prospective Memory Word in Experiment II

	Words					
	1	2	3	4	5	6
T=	.94	2.15	2.58*	1.42	2.58*	3.48**

* $p < .01$ ** $p < .001$

The relationship between prospective memory and retrospective memory was explored via the intercorrelation matrix as in Experiment I. This is shown in Table 8. Again, as with Experiment I, several

Table 8
Intercorrelation Matrix for the Variables in Experiment II

	Digit Fwd	Digit Bkwd	Voc	Block Design	Serial List	Comp Fig	Work Mem.	Prosp. Memory
Age	-.20	-.11	.53***	.14	-.31**	-.33**	-.23*	-.52***
Digit Fwd	--	.53***	-.04	.34**	-.05	.32**	.48***	-.05
Digit Bkwd		--	-.05	.37**	-.03	.26*	.45***	-.06
Vocab			--	.06	.20	.08	.05	-.09
Block Design				--	.04	.25*	.37**	-.08
Serial List					--	.39***	.20	.50***
Comp Fig						--	.40***	.41***
Working Memory							--	.37***
Prospective Memory								--

* $p < .05$ ** $p < .01$ *** $p < .001$

retrospective tests are shown to be related to this prospective memory test; visual memory (complex figure), working memory (Dobbs and Rule) and verbal memory (list learning). The findings in the present experiment reinforce the fact that, in Experiment I, the relationships

seen between the types of memory were not an anomaly nor in some way attributable to the sample.

The final analysis, stepwise multiple regression, was used to determine which variables could predict prospective performance. Again, age was forced into the equation first, being the variable of most interest. The summary steps are shown in Table 9.

Table 9

Results of Multiple Regression Analysis for Experiment II

Step	Variable	R	R ²	R ² Change	Significance
1	Age	.52	.27	.27	.001
2	Serial List	.64	.40	.13	.001
3	Working Memory	.67	.45	.05	.001
4	Digit Forward	.72	.51	.06	.001

As can be seen in Table 9, age accounted for 27% of the total variance in scores and 53% of the known variance. Based on the results of Experiment I, this was expected. It is also remarkably close to the amount of known variance accounted for in the previous experiment, 59%. Although the predictors are not consistent between experiments, it may be premature to speculate on why that is.

Overall, the results of Experiment II are quite consistent with those of Experiment I. First, prospective memory performance is clearly superior in the younger group. This age difference disappears with the provision of cues, leading one to again suspect that it is cue utilization/access that is the key to successful prospective memory.

Second, there is another demonstration that prospective memory and retrospective memory are related. That relationship does not appear to be restricted to any one specific type of retrospective memory, rather all types are shown to correlate with prospective memory.

Third, it was again demonstrated through multiple regression that prospective memory is predictable from a minimum of other tests.

All of these major findings are at variance with most prospective research, yet are consistent within these two experiments. This is tentatively attributed to the fact that we did not isolate prospective memory for study, but imbedded it within an array of other tasks, much the way this ability would be used in "real life".

EXPERIMENT III

Method

Subjects

Sixty subjects, 32 young (mean age = 38) and 28 elderly (mean age = 68) were used.

Materials and Procedures

The LAMB was administered individually to participants.

The prospective memory test utilized six items which were presented during the initial instructions. The specific instructions for this version of the prospective memory test were as follows:

"Most of the time I will be giving you instructions on what I want you to remember immediately before the task. However, some of the time you will be expected to remember things on your own, without my prompting. For example, when I begin talking about learning a paragraph, you are to say the word BOOK. This is easy to remember because a book contains paragraphs. When I mention a list of words, you are to say the phrase GROCERY LIST--a grocery list is a particular type of list. I want you to remember this information without being reminded. Before I go on, what are you going to say when I start talking about the paragraph? (Verify that the person understands--book.) When I mention the list of words what will you tell me? (Verify--grocery list.)

I'll also ask you to draw me a complex geometric figure. At this time I want you to ask me the following question: WILL I NEED A RED PEN? This can be easily remembered because you can draw a figure with a red pen. When I ask you to repeat a series of numbers, I want you to tell me YOUR AGE. You can remember this because your age

consists of two numbers. I want you to remember to tell me this information without being reminded. Now, what are you supposed to tell me when I start telling you about the geometric figures? (Verify--will I need a red pen?) When I mention the long series of numbers, what will you say? (Verify--age).

There are two other things I would like for you to remember on your own. When I get to a portion of the test which requires you to learn the location of different types of buildings placed on a map, I want you to say ROAD MAP. One way to remember this is to remember that it looks like a road map. A little bit later I will ask you to cross out some letters. At this time you say the word ALPHABET. This can be remembered since an alphabet contains letters. Now, when I ask you to learn the location of houses on a map, what should you say? (Verify---road map). What are you to say when I ask you to cross out some letters? (Verify--alphabet)

Let's be sure you understand what you are supposed to do. When I talk about each of the following parts of the test, tell me what you are going to say. (Use prompt if person is unable to remember words.) When I start talking about ----what will you say?

PARAGRAPH - book (prompt, it is something that contains paragraphs)

LIST OF WORDS - grocery list (prompt, it is a special type of list)

COMPLEX GEOMETRIC FIGURE - Will I need a red pen? (prompt, it is something to draw with)

SERIES OF NUMBERS - age (prompt, it is something that contains two numbers)

HOUSES LOCATED ON A MAP - road map (prompt, it is something about a map)

CROSS OFF LETTERS - alphabet (prompt, it is something that contains letters)

The time (minutes) between instructions and the beginning of the appropriate sub-tests was, approximately 10 (book), 25 (grocery list), 35 (red pen), 45 (age), 55 (road map) and 65 (alphabet).

Immediately following the prospective memory instructions the LAMB was begun.

Within this experiment was another experiment to determine if self-paced, experimenter-paced or read-along instructions would produce different results in the verbal learning tests. In the self-paced condition, the participant read the instructions to themselves and there was no time limit imposed on how long they could take. In the experimenter-paced condition, the subjects listened to the instructions while the experimenter read them aloud. In the read-along condition, the subjects had a copy of the instructions which they read to themselves while the experimenter read them aloud. For the list learning, paragraph learning and the paired associate learning tasks these different methods were used.

Results and Discussion - Experiment III

For the prospective memory, prompted recall and the cued recall conditions the participants were divided into three groups, as per the types of instructions described above (self-paced, experimenter-paced, read-aloud), and subjected to separate analysis of variance. Since no group differences were found for any of the conditions, the participant scores were combined for the remaining analyses.

The other variables selected for analysis are the same as those used in Experiment II except for Block Design, which was not part of this experiment.

Demographics

Table 10 shows the demographic characteristics and measures for this sample of participants. There is no difference between the groups on the vocabulary measure as was previously observed.

Table 10

Demographic Characteristics of Participants for Experiment III

Variable	<u>Young (n=32)</u>		<u>Elderly (n=28)</u>	
	Mean	s.d.	Mean	s.d.
Age	38.2	13.4	68.1	5.24
Age Range	20-60		60-80	
Vocabulary (WAIS)	57.34	7.7	57.12	8.2
Gender	-Male (N)		13 (46%)	
	-Female (N)		15 (54%)	

Retrospective Memory

The scores on the LAMB sub-tests are shown in the upper portion of Table 11. Consistent with the previous two experiments, significant differences occurred for list learning and complex figure.

Table 11

Participants Sub-test Scores for Experiment III

Variable	<u>Young (n = 32)</u>		<u>Elderly (n = 28)</u>	
	Mean	s.d.	Mean	s.d.
<u>Retrospective Memory Measures</u>				
Digit Forward	9.37	2.15	8.68	2.26
Digit Backward	9.12	2.29	8.35	2.36
List Learning	8.84	1.02	8.18	1.19*
Complex Figure	64.15	10.58	52.89	15.23***
<u>Prospective Memory Measures*</u>				
Prospective Memory	83.8	22.5	60.7	39.0**
Prompted Recall	97.9	5.6	88.1	24.8***
Cued Recall	100.0	0	94.6	15.7

*Scores are percentage of perfect performance

*p < .05 **p < .01 ***p < .001

Prospective Memory

The results on the prospective task are shown in the lower portion of Table 11 and Figures 7-9. Separate MANOVAs were conducted on the three different types of memory measures (levels of cue availability).

Insert Figures 7-9 about here

Figure 7. Age differences in prospective memory performance, Experiment III.

Figure 8. Age differences in prompted recall performance, Experiment III.

Figure 9. Age differences in cued recall performance, Experiment III.

The MANOVA on the prospective memory performance yielded a significant effect for age ($F(1,58) = 8.13, p < .01$) and words ($F(5,290) = 4.26, p < .001$) with no interaction. The same effects were found for the prompted recall results; age ($F(1,58) = 4.76, p < .001$) and words ($F(5,290) = 2.92, p < .01$). No other effects were detected for this or for the cued recall condition. In keeping with the previous experiments, as the availability of cues decreased from the cued to the prospective condition, the age effect increased. The age difference in mean scores was 23 percentage points in the prospective condition, 10 in prompted recall and 5 in the cued recall.

The results of t -tests performed on the prospective memory scores for each of the six words are shown in Table 12.

Table 12

T-test Analysis on Group Differences for Each Prospective Memory Word in Experiment III

	Words					
	1	2	3	4	5	6
T =	2.26*	2.71**	2.17*	1.18	2.70**	1.77

* $p < .05$ ** $p < .01$

As with Experiment II not all words acted the same way between groups, and a similar saw-tooth pattern of responses seen in Experiment II, is also evident in Figure 7. Words 1, 2, 3, and 5 (or their respective cues) appear to be acting differently than 4 and 6.

The intercorrelation matrix was again used to explore relationships between the prospective memory and retrospective memory tests. This is shown in Table 13. As can be seen, prospective memory is related to the visual memory test (complex figure) and the verbal memory test (list learning). These results substantiate those reported in Experiments I and II.

Table 13

Intercorrelation Matrix for the Variables in Experiment III

	Age	Digit Fwd	Digit Bkwd	Voc	Work Memory	Serial List	Comp Fig	Prosp. Memory
Age	--	-.22*	-.17	-.01	-.24*	-.30**	-.47***	-.44***
Digit Fwd		--	.52***	.30**	.30**	.20	.28*	.14
Digit Bkwd			--	.23*	.32**	.27*	.34**	.18
Vocab				--	.20	.03	.44***	.43***
Working Memory					--	.15	.42***	.19
Serial List						--	.43***	.29*
Comp Fig							--	.61***
Prospective Memory								--

* $p < .05$ ** $p < .01$ *** $p < .001$

Finally, a stepwise multiple regression analysis, with age forced first, was conducted in an attempt to determine if prospective memory scores could be predicted from performance on some or any of the variables of interest in this experiment. The results are shown in Table 14. The variance accounted for by age is less than in the previous two experiments, yet is still highly significant; 19% of the overall variance and 41% of the known variance.

Table 14

Results of Multiple Regression Analysis for Experiment III

Step	Variable	R	R ²	R ² Change	Significance
1	Age	.44	.19	.19	.001
2	Complex Fig	.64	.41	.21	.001
3	Vocabulary	.67	.46	.05	.001

Referring to the three main research questions, all were again supported in this experiment. Prospective memory performance is definitely affected by age, prospective memory and retrospective memory are related and prospective memory scores can be predicted from the tests in the LAMB.

General Discussion

Collectively, the three experiments produced two major findings: (1) prospective memory decreased with increasing age and (2) performance on prospective and retrospective memory tasks was highly correlated. As the following discussion will show, these findings are robust and consistently observed across the three experiments.

The first major finding, an age-associated decrease in prospective memory, was observed in all three experiments. This effect occurred regardless of whether the prospective memory task employed a two-item or a six-item procedure. It also occurred with different samples of participants, differing in their age range and estimated intelligence. While it is not surprising that age and performance are inversely related on retrospective memory tasks (Babcock & Salthouse, 1990; Craik, 1977; Tombaugh & Schmidt, 1992), only one previously published study (Dobbs & Rule, 1987) has reported that performance decreased as a function of age on a prospective memory task. All other studies have failed to show any type of an age-associated effect (Einstein & McDaniel, 1990; Moscovitch & Minde, 1982; West, 1988).

The second major finding is that performance on retrospective and prospective tasks were related. This effect was very robust and it occurred on tasks representing a variety of different types of retrospective memory including working memory, verbal memory and visual memory. The latter two represent long-

term memory while the former represents short-term memory. Again, this finding is inconsistent with those reported in the existing literature. All studies have reported that either no relationship existed between the two different types of memory tasks (Einstein & McDaniel, 1990; Harris & Wilkins, 1982; Meacham & Leiman, 1987), or found that a negative relationship existed (Wilkins & Baddeley, 1978).

Before turning to an interpretation of the results reported above, some attention must be directed toward the possibility that the inconsistency between the results reported here and those reported previously were due to differences in the types of subjects employed in the different studies or that the present samples were somehow biased and not representative of the population.

With regards to the first case there are two concerns: (1) subject resistance to the task and (2) non-normal cognitive functioning.

One concern with research using human subjects is that they don't always behave the way we assume they will or the way we would like them to. That is, they don't always comply with our stated requirements of the task. Winograd (1988) commented that prospective memory, more than retrospective memory, overlaps other areas of psychology not traditionally associated with memory. One of these areas is compliance. He posed the following rhetorical question, "should failing to take medication be

assessed as an error of prospective memory or as non-compliance for whatever personal reason?" From this question it is clear that non-compliance could well play a role in what appears to be prospective failures, e.g., "forgetting" to take medication, to do homework or to meet someone you don't particularly like.

In the present case it is assumed that participants are not consciously choosing to omit the appropriate response. There is no apparent logical reason why only the elderly participants should not comply with the requirements of the prospective memory tasks and thus show a decrease in performance. Firstly, they are all volunteers. Secondly, all the participants were unknown to the testers and we can therefore assume that they held no animosity toward the researchers (at least not initially). Thirdly, the participants performed to the best of their ability on all the other subtests in the LAMB so there is no reason to suspect that they would isolate this particular test to be resistant to. Therefore, in light of the above, we assume that non-responses were errors.

Regarding the second participant concern, it has already been demonstrated that the participants are normal in terms of intellectual functioning as measured by the WAIS-R verbal score and their performance on the other LAMB subtests (Tombaugh & Schmidt, 1992).

The second possible reason that differences were found in this study relates to the design of the experiments. It is

speculated that previous research generally failed to detect an age related deficit or a relationship between prospective and retrospective memory for the same reason that counting to ten wouldn't distinguish between grade 6 students and university graduates. For neither group would the task be challenging, therefore producing no variation in scores. That is, it is likely that most prospective memory experiments in the literature were too easy, too repetitive, lead to habituation and/or did not control for the use of external memory aids. The present research was repetitive; in the sense that the same general type of response was required throughout the experiments, however, the specific stimulus for the response and the response itself differed on each occasion. Moreover, there were either two or six responses required and they were imbedded within a difficult and lengthy battery of tests where there was no opportunity for participants to utilize external memory aids. These more challenging aspects of the task may have allowed more realistic response patterns to emerge. In short, it is believed that the present results are real, not an artifact of the sample or the experimental design.

Relative to other investigations of prospective memory, the three experiments presented here are in some ways more comprehensive and, it is believed, more sensitive to what are presumed to be more real life demands on prospective memory. Because we believe that the tasks are more reality based, so too do we

believe are the results. For example, while it is true that many prospective memory tasks are repetitive, like pill taking, it is unlikely that a person is only engaged in one type of prospective memory demand at a time. Otherwise, what would we have to look forward to in a day and why would we require the myriad of memory aids that we do. The job of remembering all of our "appointments" must surely be resource demanding, for if not aided, we so often forget them.

Overall, the effects from the present study appear to be related to differential availability of cues in prospective and retrospective memory tasks and the manner in which aging affects the utilization of these cues. The remaining portion of the discussion will be devoted to further developing this hypothesis and will propose a hierarchical recall model of retrieval that is consistent with the overall results.

The age-associated effect observed with prospective memory scores is probably related to the absence of retrieval cues. Throughout this series of experiments, the elderly appeared more susceptible to retrieval difficulties than did the younger subjects under the condition where the fewest number of recall cues were available. That is, this occurred when the subjects were required to respond spontaneously (e.g., prospective memory recall). When additional prompts (cues) were used, the differences in performance between the two groups decreased. Indeed, in Experiments 2 and 3, the performance of the two groups were

virtually identical under the cued recall condition. This finding is significant for two reasons.

First, it shows that prospective memory scores cannot be attributed to the older group "forgetting" the content of the task (i.e., the response word). If they had forgotten, they would not have been able to retrieve it. Thus the results appear to reflect a decreased ability to "remember-to-remember" rather than a failure to recall "what to remember".

Second, this finding is important since it clearly shows the practical and theoretical importance of cues in prospective memory. The present finding shows that performance of the older subjects on the prospective memory task is affected by the availability of cues in much the same way as it is in retrospective memory tasks. It appears that the ability to maintain many prospective memory demands or to utilize the cues associated with those demands is somehow diminished in the elderly relative to the younger subjects. It is as if the elderly are deficient in their ability to self-cue in order to "remember-to-remember". This suggests that prospective memory may simply represent a retrospective memory task where less environmental support (cues) is present. Moreover, if the same type of relationship is hypothesized to exist between prospective memory and free recall as exists between free recall and cued recall (i.e., the elderly consistently perform at a lower level than the young), the present findings are not surprising. This view is similar to that

described by Craik (1983), where prospective memory is a less cued condition than free recall on a hierarchy of environmentally supported remembering (see Table 15). As such, it may not be a distinct type of memory. Viewed in this way, prospective memory is more easily understood and fits more readily into existing knowledge of how cues can govern remembering.

Table 15

Recall Hierarchy

Environmental Support	Memory Task	Recall Difficulty
Least	Prospective Memory	Hardest
	Free Recall	
	Cued Recall	
Most	Recognition	Easiest

There is ample evidence that the utilization of appropriate cues facilitates recall for both prospective memory (Loftus, 1971; Meicham & Columbo, 1980; Meicham & Leiman, 1975) and retrospective memory (Tulving, 1983) regardless of age. However, when compared to the young, the elderly appear to benefit more from retrieval cues (Craik, 1977).

That retrieval cues work to improve memory performance is clear. How they work is not so clear. There are, however, some general rules. In no particular order, cues work best when they are self-generated (Tulving & Thomson, 1973), specifically related to the target, active and timely (Harris, 1984) and distinctive (Mantyla & Nilsson, 1988). It could also be added

that a cue must be recognized as being a cue. It must prompt the person to ask themselves, "why is this important to me?" or "how does this cue (memory, word, feeling, sound, etc.) relate to what I am supposed to remember now?"

Cue saliency, within a prospective memory task, has been investigated by Einstein and McDaniel (1990) and West (1988). Einstein and McDaniel found that the distinctiveness or unfamiliarity of a cue aided prospective memory performance. They also lend support to the present discussion regarding the importance of the cue in successful prospective memory performance.

"The critical factor for successful prospective memory performance in our experiment, and probably in a lot of other prospective memory situations, seems to be that the target event triggers memory for the action that is to be performed."

Why the elderly should show decreased performance compared to the young probably lies in an inability to recognize/utilize the available cues. Why they should fail to recognize a cue for what it is may lie in a decreased ability to learn the cue associations as well as the young or, if learned as well, there may be difficulty recognizing the cue when presented.

Returning to the discussion of how cues govern remembering, it is necessary to define the purpose of a cue: its sole purpose being to elicit a bit of information. The information, the content of memory, can be thought of as a distinct piece of hard data, an end in itself. Memories may be instructive, such as a reminder to buy bread, but regardless of how we act on the

memory, once the information is recalled, the cue has served its purpose.

It is submitted that the generally accepted hierarchy of cues (recognition, cued recall and free recall), needs to be expanded in order to appreciate the position of prospective memory. At the one extreme could be prospective memory and at the other, recognition. In between would be prompted recall, free recall and cued recall. (One could probably rank order different types of cued recall as well, such as; semantically related cues, first letter priming, subject categories and the like.) In addition, as was stated previously, free recall is used in two ways, one of which is probably harder than the other, namely, the recall of information in a specific order as opposed to the recall of non-ordered information. Table 16 shows the hierarchy proposed here with examples of possible cues in the various levels.

The present findings, interpreted within the framework outlined in Table 16, would suggest that prospective memory is not a unique type of memory; that it would fit into the general model of cue aided recall. While there is still much to know about prospective memory, it appears to behave in the same manner as retrospective memory with respect to cues, but that the added variable of time confuses the understanding somewhat. That is, for retrospective memory the cues are present and obvious and the time to recall is the present. For prospective memory, the cues

Table 16

Proposed Recall Hierarchy

Type of Recall	Cue Support	Example
Prospective	none recognized linking a cue with the appropriate time or situation	a cognitive function
Prompted	minimal cue, not related to the target	string on finger alarm,
Free	cue minimally re- lated to target	list two counties of Nova Scotia
Cued	cue specifically related to target	they are Royal titles
Recognition	target embedded in distractors	which of these is ...

Note. Above the line is future oriented remembering.

may or may not be present at a certain time and the time (or situation) may or may not be right for the cues to act. Only when the appropriate time or situation and cue work in conjunction does a prospective memory retrieval succeed.

Further to the major effects observed here is the response pattern seen in Figures 4 and 7. This saw-tooth pattern indicates that certain responses or their associated cues are acting differently from others. One possible explanation is that there is something about the responses themselves that make them easier or more difficult to recall, e.g., they are more novel or they hold more personal meaning for the subjects. However, because the pattern is so consistent, it is unlikely that all the

subjects in both groups would attach significant meaning to the same words.

Another explanation may be that the cues associated with the responses are better or worse at eliciting a response. However, considering the properties of cues that make them effective, this explanation is weak for the same reasons as the first, namely, it is too unlikely that the cues act the same way for all the subjects.

A third, and most probable, reason for the observed pattern is that the subtest immediately preceding a particular cue is somehow interfering with the ability of the cue to trigger the memory. Some tasks are probably more resource demanding than others and, following their completion there may be a relaxing of vigilance, taking a breather so to speak, or a temporary depletion of attentional resources. If either of these is the case then the participant may not be attentive to, or aware of, the cue within its context of cueing. These are, however, empirical questions requiring further exploration.

Concluding Remarks

While the evidence in the literature is not consistent with regards to age-related differences in prospective memory performance, the present results demonstrate that there are clear and dramatic differences. It may be that the results from this research are limited to this particular paradigm, however, this is an empirical issue and worthy of further exploration. With an aging population and a seemingly ever-increasing amount of information to deal with, it is likely we will see more of the

type of problems present with a failing ability to remember what to do next. The limits of prospective memory ought to be defined, as should the conditions under which the deficits appear and possible methods to prevent them.

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Appendix

Retrospective Memory Tests Used in the LAMB

Verbal Tests

1. Paragraph Learning. The individual recalls a short paragraph read by the examiner. Immediate and delayed recall trials are used to evaluate the individual's ability to learn and retain (memory) sequentially presented and interrelated verbal material. Free recall, cued recall and recognition trials are used to provide sensitive measures of the way information is stored and retrieved.

2. Paired Associate Learning. The individual learns a list of 14 word pairs over four trials. Three word pairs represent associations which are easy to learn (e.g., up-down), three are difficult (e.g., mind-frame) and eight are rated as moderate (e.g., arm-sky). Memory for the word pairs is tested on trial five which occurs 20-30 minutes after completion of trial four. This test, particularly the most difficult pairs, is sensitive to verbal learning deficits.

3. List Learning. This test is a serial learning test which requires the individual to memorize and retain a list of 15 words. Each word represents a different category (e.g., dog is an exemplar of the category animal). The number of words learned, as well as the rate of learning, is assessed over the first five acquisition trials. A 20-30 minute delay is imposed after the fifth trial to determine the degree to which the material is retained. In addition, free recall, cued recall and recognition trials are included to assess potential deficits in the way information is stored (encoded) and retrieved.

4. Supra-span Learning. The individual is required to repeat a nine digit number (normal digit span is seven). The same nine digit sequence is repeated for 12 trials or three consecutive errorless trials.

5. Word Fluency Test. Individuals are required to verbally produce as many words as possible in one minute with each of three letters, F, A and S, with a 15 second pause between letters.

Visual Tests

1. Taylor Complex Figure - Revised. The individual is required to learn and remember a complex geometric design over four trials. On each trial the figure is visually presented for 30 seconds. After it is removed, the individual has two minutes to reproduce it from memory. A delayed recall test is administered 20-30 minutes after the last learning trial. Finally, the figure

is placed in front of the individual and the person is required to copy it.

2. Simple Figure. The simple figures are considered, on the continuum, easier but cognitively the same as the complex figure. In the LAMB the simple figures consist of four figures on one sheet of paper that are presented over three timed memory reproduction trials, a delay trial and copy trial.

Attention Test

1. Digit Span (Digits Forward from the WAIS-R). This test consists of seven pairs of random numbers in lengths of three to nine digits. The numbers are read aloud to the subjects who must repeat the sequence in the order presented. The test stops when the subject has completed the entire set of all numbers or has erred on both strings of a pair.

Working Memory Tests

1. Digits Backward from the WAIS-R. This test is similar to digits forward except that when the digits are presented to the subject they must be repeated back in the reverse order. Discontinuation of the test is the same as digits forward, errors on both strings of a particular pair or completion of all strings.

2. Dobbs and Rule Working Memory Test (1988), modified by Tombaugh (1989). This test utilizes digits that are arranged in four levels of difficulty. Every level has one practice trial and two test trials, each with a string of numbers that is ten digits long. The levels are called lags and progress from 0 to 3 lags. The numbers are presented by auditory tape with a two or a three second interval between numbers and 15 second interval between strings in the same lag. In the 0 lag condition, the subjects task is to repeat the number just heard, in the 1 lag condition the subject must repeat the number one back from the one just heard, and so on to 3 lag. Therefore, in the three lag condition the subject must hold the first three numbers in memory until the fourth one is presented and then respond with the first number, when the fifth number is presented the subject responds with the second number, etc. The task requires the person to continually add a number to the list in memory, drop the one from the beginning that is no longer required and to remember the overall "rules" of the test.

END

2|5| 0|5| 93|

FIN