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By

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ABSTRACT

AGE AND PROSPECTIVE MEMORY: A NEUROPSYCHOLOGICAL ACCOUNT BASED ON EXECUTIVE FUNCTIONING

By

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Prospective memory (PM) has been described as the realization of delayed intentions. The impact of age, attention, retrospective memory (RM) and executive functions (EF) on PM was examined in a sample of able elderly (N = 115; 42 males and 73 females). In addition, it was hypothesized that PM would be poorer after longer intervals when external memory aids were unavailable. The final hypothesis considered self-perception of PM and actual performance when the use of external cues was controlled.

An age-associated decline in PM was observed in the present sample ($r = -.29$, $p < .01$) and Age predicted 9% of the variance in PM performance ($p < .01$) in a hierarchical regression equation. In the second step, RM performance provided additional information ($p < .05$) beyond the effects observed for Age alone. Next, three EF variables were added to three control variables (Age, Attention, and RM) in predicting PM, all of which accounted for 28% of the variance ($p < .001$). The increase in R^2 over the control variable model was significant ($p < .05$), suggesting that EF contributed significantly to PM.

A Generalized Estimating Equation (GEE) was used to explore the variables of Cue, Time and Age on PM. The analyses did not reveal a significant three-way interaction; however, the Cue x Time interaction term was meaningful ($p = .00$) as was a main effect for Age ($p = .02$) suggesting age does effect PM, but it does so regardless of the effects of cue and time interval. A relationship did not emerge between self-assessment of PM capability and actual performance on uncued PM performance. A preliminary investigation into the remediation of PM declines revealed that participants (N = 68; 27 male and 41 female) did improve from pre- to post-testing.

Overall, the data support current theoretical explanations of the construct of PM, especially that the cognitive requirements of planning and monitoring are unique aspects of PM which differentiate it from its retrospective counterpart. Both research and clinical applications of the findings are discussed.

This dissertation is dedicated to my father,
Eugene P. Klein (1939-1997), whose love, kindness and support
opened the door to my education
and to
Dr. Edward Gibeau whose exceptional insight and patience
taught me to understand
what I found on the other side.

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INTRODUCTION

Recently, there has been a growing interest in the investigation of memory processes in the elderly which have ecological validity (Conway, 1991; Harris, 1984; Larrabee & Crook, 1989; Schaie, 1974). Traditionally, older individuals often complained of failing memory in everyday situations; the scientific community, however, would attempt to understand this area of decline through laboratory study using artificially presented memory situations (Maylor, 1993). The scientific trend toward delineating the nature of memory functioning in an aging population by focusing on real-life processes has brought to the foreground the study of a specific memory component, namely prospective memory (Meacham & Leiman, 1975). In general, prospective memory can be described as the mechanism of remembering to carry out activities in the future such as remembering to attend an appointment or to take one's medication at a specific time.

The explicit consideration of forgetting intentions in everyday life can be traced to Freud and his seminal work The Psychopathology of Everyday Life (1901). He wrote:

> "If I form an intention in the morning which is to be carried out in the evening, I may be reminded of it two or three times in the course of the day. It need not however become conscious at all through the day. When the time for its execution draws near, it suddenly springs to mind and causes me to make necessary preparations for the proposed actions." (p. 152)

In this context, the forgetting of intentions in everyday functioning was considered to be due to the process of repression. The neuropsychological ramifications of the process of "forgetting to remember" is the focus of the present study. The first experimental investigation of remembering intentions was carried out in the mid-1920's by Birenbaum (1930) under the guidance of Kurt Lewin. In her work, Birenbaum (1930) asked subjects to sign a sheet of paper after solving problems and writing their answers on the sheet. The purpose of her investigation was to determine under what circumstances the subjects would forget to carry out the request. Since that time, a number of authors have studied the prospective aspect of memory; however, the various experimental contexts in which this has occurred has led to a multiplicity of labels. Prospective memory has been widely referred to as "remembering to remember" (Schonfield & Stones, 1979), remembering to recall (Wilkins & Baddeley, 1978), remembering to do things (Harris & Wilkins, 1982), remembering intentions (Loftus, 1971), remembering future actions (Morris, 1979) and operational remembering (Kantor & Smith, 1975).

Even though prospective remembering has been well-established as a psychological phenomenon, it has not been given much experimental attention until recently when a growing concern with understanding memory processes in the elderly emerged. Prospective memory is probably the most important aspect of everyday memory since it is necessary for successful independent functioning (Maylor, 1990). Sinnott (1989) indicates that it is valuable to pursue the study of prospective or intention memory since prospective memories are highly relevant and adaptive and have many interpersonal implications. In addition, prospective recall has been scarcely studied in the context of its meaning for the elderly (Devolder & Pressley, 1991; Einstein & McDaniel, 1990). The experimental investigation of the prospective memory construct is necessary in elucidating those factors which contribute to successful memory functions in the elderly.

Following a theoretical account of prospective memory processes, this proposal will outline the distinction between retrospective and prospective memory operations. The importance of this differentiation will be apparent in the review of prospective memory and aging. Specifically, the prospective memory process is considered to draw upon various cognitive capacities, including retrospective memory. Therefore, the explicit consideration of retrospective memory is required in any study of age-associated decline of intention memory. A review of the literature on prospective memory and aging suggests that this memory process may decline across the life span when tested under controlled conditions. As such, the question becomes what neuropsychological processes might account for an age-related deficit in "remembering to remember?" In this context, the frontal lobes and the specific neurocognitive functions which are subserved by this brain region (e.g., executive functions), especially as they relate to memory and aging, are reviewed. Both anatomical, functional, and clinical aspects are considered as they relate to the domains of prospective memory, aging, and frontal lobe efficiency. Subsequently, the objectives for the current study are described.

A THEORETICAL FRAMEWORK OF PROSPECTIVE MEMORY

Beyond the need to investigate a neglected area in aging and memory, there are cogent theoretical grounds for studying prospective memory abilities in the elderly. One influential theory of memory and aging has been developed by Craik (1986) who suggests that prospective memory may be particularly susceptible to age-related decline in the elderly. Craik's (1986) suppositions focus on the functional nature and the process of memory rather than its structural components. Until more recently, a structural account of memory processes has been an empirical emphasis in a large majority of scientific investigations and theoretical formulations of memory (Atkinson & Shiffrin, 1968; Tulving, 1983).

Additional theoretical accounts of the vulnerability of prospective memory to the aging process hypothesize that fewer information processing resources may be available (i.e., resource deficiency hypothesis; Salthouse, 1991) and that a larger number of cognitive operations are called upon in prospective memory each being subject to age-associated decline (i.e., probability model; Levy & Loftus, 1984). These theoretical suppositions will be discussed below.

Craik's functional account of memory processes differs from a structural one in the respect that he considers any instance of recall to entail an interaction of environmental and organismic (i.e., internal mental operations) factors. Therefore, he surmises that recall will be enhanced to the extent that the original context of the memory store is replicated during retrieval, thus emphasizing environmental factors. When these external cues are not present, recall relies to a greater extent on the self-initiated mental operations of the rememberer (i.e., organismic operations). Craik (1986) suggests that self-initiated cueing is least required in tasks such as recognition and cued recall which can rely upon external information to enhance recallability. Conversely, self-initiation is required to execute memory traces which have fewer environmental cues to draw upon (e.g., free recall; Craik & Jennings, 1992; e.g., less organization of stimuli; Norris & West, 1993). According to this author, "remembering to remember" or prospective memory requires the greatest amount of self-initiation. In addition, Craik (1986) goes on to hypothesize that the ability to self-initiate memory searches becomes increasingly difficult with age. Craik's (1986) theoretical perspective draws upon Hasher and Zacks (1979) "levels of processing" paradigm to explain why these age related differences might exist. He suggests self-initiated memory operations require more effort and deeper processing resources in order to bring them into action and that the elderly are less likely to engage in the deeper levels of memory processing needed to carry out self-initiated memory functions.

Similar to the "levels of processing" theory proposed by Hasher and Zacks (1979), the resource deficiency hypothesis (Salthouse, 1991) posits that age-related memory decline can be attributable to increasing limitations in information processing resources. In other words, memory decline can be due either to the decreasing efficiency of such resources or to the less efficient use of memory strategies (i.e., those requiring less time and energy). As will be discussed below, some possible explanations for discrepancies in research findings on age and prospective memory decline is the differential use or control of external memory strategies. It seems reasonable to assume that the resource deficiency hypothesis may explain the tendency for older individuals to rely more on external memory strategies when internally-generated approaches become less efficient.

Verhaegen, Marcoen, and Goossens (1993) cited the resource deficiency hypothesis to explain their findings in a meta-analytic review of the aging and memory literature which included studies from 1975 to the present. Overall, their results indicated that age differences in memory abilities are quite "large and omnipresent." These authors conclude that, potentially, a general factor is responsible for the majority of observed memory proficiency decline across the adult life span. Namely, a deficiency or inefficiency in information processing resources (Salthouse, 1991) was forwarded as an explanation for the observed age main effect.

Hasher and Zacks (1988) have developed a theoretical framework regarding inhibitory mechanisms and aging. In this particular framework, the performance of cognitive tasks (e.g., prospective remembering) involves the limited-capacity operations of working memory. According to this theory, prospective memory and other age-related declines may result from an inability to inhibit irrelevant or minimally pertinent stimuli, thoughts, or information. In a recent investigation in which both young (N = 40, mean age = 18.9) and old (N = 37, mean age = 69.5) subjects were asked to read one word in a pair of a certain color while ignoring the other, older subjects were found to show a significantly greater difficulty in suppressing distractors and avoiding interference from distractor items (Kane, Hasher, Stoltzfus, Zacks, & Connelly, 1994). A deficit in inhibitory mechanisms might account for an age-related decline in self-initiated prospective memory functioning.

Consistent with the theoretical frameworks discussed above, Levy and Loftus (1984) have developed a probability model which identifies potential variables which collectively function to carry out a memory operation in the absence of environmental cues (e.g., the absence of the person who assigned the to-be-remembered action). Specifically, Levy and Loftus (1984) suggest that the probability of remembering to perform an act is a function of the joint probabilities of (a) generating a cue that a particular action will be carried out at the appropriate time; (b) remembering the contents of the action itself (i.e., retrospective memory); and (c) the probability that the action is actually carried out given the previous two components. Traditional studies, which usually entail investigation of the recallability of past information (i.e., retrospective memory), have focused on the second aspect of this probability model (i.e., the probability of remembering some piece of information given some cue). In fact, Winograd (1988) discusses the existence of a dichotomy between these two memory systems in that retrospective remembering is often facilitated by external cueing, whereas remembering future actions, in its purest form, relies on self-generated cueing. This supposition about "remembering to remember" is consistent with Craik's (1986) theory of prospective memory and aging.

Huppert and Beardsall (1993) suggest that the above probability model presupposes that prospective memory may be more vulnerable to cognitive impairment than other aspects of memory given the involvement of a variety of cognitive operations (e.g., the joint probability of the three components), any of which could break down. In other words, the invocation of the prospective memory process is complex and therefore, it is logical to assume that such a process summons the capacities of other systems (e.g., retrospective memory, executive functioning) which may be vulnerable to the effects of aging.

FUNDAMENTAL DIFFERENCES BETWEEN PROSPECTIVE AND RETROSPECTIVE MEMORY

Prior to summarizing the research on prospective memory and aging, it may useful to delineate the differences between the two major memory categories of prospective and retrospective memory. As will become apparent in the review on aging and prospective memory, intentional (i.e., prospective) memory is reliant upon the abilities of the retrospective memory system and the present study will differentiate performance in these domains in order to draw definitive conclusions about age-associated decline. *Prospective* memory does entail some retrospective memory operations, since planning the action has occurred in the past. However, it is fundamentally distinct from retrospective memory because intentional memory includes more than just recalling past events. For example, prospective recall also includes memory for events that will continue through time and are personally motivating and relevant for the remember (Sinnott, 1989). Furthermore, remembering to execute some future activity involves planning, organizing, and other strategic aspects of learning and memory (Shimamura, 1990).

Retrospective, or declarative, memory skills are those which are typically assessed in standard tests of memory. This trend is partially attributable to the emphasis on the laboratory setting for studying memory as well as the prevailing tenet that remembering information from the past is the hallmark of memory ability. It is well known in the literature on aging that age-related decline on episodic retrospective memory tasks is firmly established (Einstein, Holland, McDaniel, & Guynn, 1992; Lezak, 1983; Light, 1991). Conversely, subjects in prospective memory experiments are instructed by the experimenter to perform a task at some specified point in the future (Maylor, 1993). Therefore, prospective memory can be considered a "means to an end" and in the final outcome, goal accomplishment is the indicator of memory success in this domain (Sohlberg, White, Evans & Mateer, 1992). As such, one fundamental distinction between retrospective and prospective memory systems is that the former emphasizes one's ability to store and retrieve information whereas the latter requires the ability to manipulate and organize memory for the purposes of future retrieval.

A number of studies suggest that the prospective memory system is dissociated from the retrospective memory system. In other words, performance on prospective memory tasks is apparently uncorrelated with retrospective memory performance (Einstein & McDaniel, 1990; Maylor, 1990; Meacham & Leiman, 1982; Wilkins & Baddeley, 1978). This distinction has been empirically demonstrated by Kvavilashvili (1987) in a study which required subjects to ask a question at some future point. Results from this study indicate that remembering to ask the question was independent of remembering the content of the question, thus concluding that these types of recall rely on different processes. Hitch and Ferguson (1991), in a similar vein, developed an objective breakdown of the processes required in prospective recall. Parelleling the probability model of Levy and Loftus (1984), they divided the prospective memory task into a series of stages including the ability to form an intention, holding the intention in memory during a specified time interval, and executing an action for the intention at the required time.[1] This last stage of the prospective memory task is often referred to as "remembering to remember" and it is thought to be the defining characteristic which differentiates intention memory from memory for past events (Kvavilashvili, 1992).

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Maylor (1993) would add an additional stage to the three identified by Hitch and Ferguson (1991) above. She states that prospective memory also requires that an individual remember that a task has been performed in the past so that it not be repeated at some later point. This area of prospective remembering has been the focus of recent aging and memory research which investigates the use of compensatory strategies for memory failures in everyday life (e.g., ways to remember whether or not medication has been taken; Backman, 1989) and is often referred to as output monitoring (Koriat, Ben-Zur, & Sheffer, 1988).

PROSPECTIVE MEMORY AND AGING

In reviewing the literature on age-associated effects on prospective memory, an age-related decline in "remembering to remember" (Cockburn & Smith, 1988) has sometimes been observed. However, other empirical investigations have found results of no significant effect of age (Sinnott, 1986) as well as an increasing prospective memory capability with age (Moscovitch, 1982). These contradictory findings are further confounded by the fact that intentional remembering has been tested in varying contexts and under diverse conditions including both laboratory and naturalistic settings using either prospective memory tasks or self-report measures.

Maylor (1993) suggests that a significant factor in beginning to understand these contradictory findings is whether or not there is control of the use of external memory aids within the study. For instance, Patton and Meit (1993) found that older subjects (N = 17) performed relatively better than younger subjects (N = 24) on prospective memory tasks (e.g., mailing postcards) when they were allowed to supplement their remembering with memory aids. In addition, results indicated that subjects who exhibited a greater degree of motivation (i.e., rating of task importance) employed external memory aids more effectively. Maylor's (1993) contention is that these results must be interpreted with caution since the experiment did not explicitly control for the use of memory aids. Rather, subjects were allowed free access to memory aids and were then questioned about their use of such aids in a post hoc fashion. Subjects reported using both internal and external memory aids to varying degrees.

Although it is unclear which is more beneficial, internal or external cues, a number of authors have concluded that older subjects demonstrate better *aided* prospective memory when compared to a younger cohort group (Devolder, Brigham, & Pressley, 1990; Martin, 1986; Moscovitch, 1982); such studies, however, cannot demonstrate definitively if prospective memory remains intact in older cohorts or whether deficient prospective memory is compensated for through the use of external cues. In general, when both older and younger subjects are denied access to external memory aids, the advantage that older subjects enjoy with respect to superior prospective memory performance seems to disappear. Under these controlled conditions (e.g., laboratory study), younger subjects often display relatively greater intentional recall capabilities. In fact, when both students and older adults are asked about their use of memory aids (Jackson, Bogers, & Kerstholt, 1988), older subjects report relying more extensively on external cues for *prospective* memory tasks. Interestingly, in the case of *retrospective* memory, both groups employed internal and external cues equally.

The review below will consider prospective memory findings in various contexts and will demonstrate that the control of cues is imperative in understanding the relationship between age and prospective remembering. In order to understand the prospective memory and aging research, investigations will be summarized according to whether they have been conducted in the laboratory or in more naturalistic settings. This dichotomy is necessary in demonstrating that laboratory studies have more conclusively established an age-associated decline in prospective memory due to the increased ability to control for the use of memory aids. In addition, results of investigations using self-report measures will be summarized to demonstrate that the successful implementation of external memory aids may lead the elderly to perceive that their prospective memory capabilities have improved.

Laboratory Studies. Despite the current trend in memory research to focus on ecologically valid measures and settings, it is noteworthy that laboratory settings have proven effective in controlling for the use of external memory aids while simultaneously employing prospective memory proxies of everyday memory tasks. As discussed previously, controlling for the use of external memory aids is imperative in studying this memory domain given that mnemonic devices can be employed to such a degree as to mask an underlying characteristic of "absentmindedness."

According to Maylor (1993), the majority of laboratory based investigations which control for the use of external memory aids find a negative relationship between prospective memory and age. For example, Dobbs and Rule (1987) instructed a series of age cohorts (i.e., 30-39, 40-49, 50-59, 60-69, and 70+ year olds) to request a red pen at a later point in the session when they were asked to draw a cube and a circle. Nearly all of the subjects 30-60 years old successfully completed the prospective memory task (i.e., remembering to request the red pen) whereas only 70% of the 70+ year olds completed the task successfully thus differing significantly from the other age groups. Furthermore, a multiple regression analysis performed using age, education, and gender as potential predictors found only the age variable to be a reliable predictor of performance on the prospective memory task.

Cockburn and Smith (1991) have employed the Rivermead Behavioral Memory

Test (RBMT; Wilson, Cockburn, & Baddeley, 1985) as a means of assessing prospective memory. The RBMT is a laboratory measure which includes three prospective memory items embedded within a series of everyday memory tasks. In this particular study (Cockburn & Smith, 1991), 94 elderly subjects (70-93 years) were administered the RBMT. Results indicated that all three prospective memory items showed a significant decline. In addition, age was found to be a significant predictor of performance on these items to a greater extent than measured intelligence. Taken together, these two studies (Cockburn & Smith, 1991; Dobbs & Rule, 1987) suggest that age can account for a greater degree of variance in prospective memory performance than other variables including gender, intelligence, or education.

In an additional study of prospective memory and aging, West (1988) asked both students (N = 26; 19-23 years) and elderly subjects (N = 26; 63-83 years) to remind the experimenter to check the tape recorder and get a pen out of a folder. These tasks were prompted by a verbal cue from the experimenter (e.g., "This is the end of the passage recall test"). Results revealed that younger adults remembered significantly more message details than older adults pointing again to a significant effect of age. Age accounted for approximately 25% of the variance when assessing the accuracy of the completion (i.e., within two minutes of the cue) of the prospective memory task. West (1988) posits that the contextual cues provided in the laboratory may be less personally relevant or meaningful (e.g., experimenter generated vs. self-generated) than those cues available to subjects in more familiar settings such as their home, thus accounting somewhat for the main effect of age on prospective memory performance. The nature of the cues in this study was such that they were less likely to compensate for an underlying prospective memory deficiency given that they were generated by the experimenter, were unfamiliar, and less personally relevant.

The studies cited above have generally concluded that intentional remembering declines with age; however, there are also a limited number of laboratory-based investigations which have not found significant age effects for prospective memory performance. Sinnott (1986) asked older and younger subjects (N = 79; age 23-93) to recall both incidental and prospective information. Results demonstrated a significant effect of age for the incidental, but not the prospective, tasks. Nevertheless, it should be noted that Maylor (1993) cautions against the significance of these findings based on three arguments including (a) ceiling effects were likely present for prospective memory items; (b) prospective items were rated as more important by subjects than incidental items; and (c) Sinnott (1986) may have been investigating the retrospective aspect (i.e., memory for acquired information) rather than the prospective aspect of the tasks (i.e., goal completion).

Einstein and McDaniel (1990) did not find a significant effect for age in either of two experiments in which a prospective memory task was embedded in a retrospective memory task. They did find significant main effects for variables such as the use of memory aids and the familiarity of the event which triggers the required prospective memory response. Nonetheless, in a subsequent study using the same experimental paradigm but an increased memory task complexity, a significant effect for age did emerge (Einstein et al., 1992). In this more recent study, these authors differentiate between *event-based tasks* and *time-based tasks*. Event-based prospective memory tasks are those in which an external event triggers the to-be-remembered activity (e.g., remembering to press a key when a target word appears). Time-based tasks are those which involve only time monitoring (e.g., remembering to press a key in 10 minutes). It is argued that time-based tasks require more self-initiation than event-based tasks and are therefore, more susceptible to the effects of aging (Craik, 1986; Craik & Jennings, 1992). Despite finding no significant effect for age in their previous study (Einstein & McDaniel, 1990), age differences did emerge in this study for event-based prospective memory tasks.[2] Therefore, increasing the complexity of the task may have dealt with the possible confounding of results due to a ceiling effect in the initial study.

In an interesting study of prospective memory over time, Maylor (1993) did not find age differences on initial performance, but did observe a "forgetting curve" over trials for older subjects. Both young-old (mean age = 57.3 years; N = 43) and old-old (mean age = 74.6 years; N = 43) subjects were instructed to write the names of famous persons in response to a slide. The prospective element of the task required subjects to circle the number on their paper when they viewed a person with a beard and put a cross through the number of the slide when a person with a pipe appeared. Subjects were exposed to four trials of 30 slides each. Results indicated that younger subjects demonstrated generally better performance on the prospective task than older subjects. Furthermore,

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While the authors constructed the distinction between event-based and time-based prospective memory tasks, an event-based task was the only one to be included in the study. However, this construct of prospective memory will be explicitly considered in the present study.

the performance of both groups was equivalent during the first trial, but performance differences between the two age cohorts increased significantly on subsequent trials. In explaining the significance of these results, Maylor (1993) draws a noteworthy distinction between retrospective and prospective memory. She indicates that the literature on aging and retrospective memory suggests that age impairs initial performance, but not subsequent forgetting; however, a different pattern emerges for prospective memory. Qualitatively, Maylor (1993) posits that age does not affect initial performance on prospective memory, but does affect subsequent forgetting. Therefore, she suggests, that learning, rather than retrieval, may be an important determinant in observed age-related effects on intentional memory.

In reviewing empirical investigations of prospective memory, Maylor (1993) outlines four necessary factors in designing a study of prospective memory and aging. First, a large number of subjects covering a wide age range is required. Second, prospective and retrospective memory performance acquired under the same experimental conditions is necessary in parcelling out which factors account for observed findings. The absence of floor and ceiling effects is also imperative in drawing definitive conclusions based on discriminative performance. Third, it is necessary to demonstrate that if no age effects on prospective memory are detected, that the dependent variable of prospective memory was sensitive to other experimental manipulations. Last, external cues must be controlled in any investigation in order to account for the potentially compensating effects of cues on declines in intentional memory. For this reason, laboratory studies seem to demonstrate most definitively that a relationship between prospective memory and age may exist. Naturalistic studies, on the other hand, have not been able to control for this potentially confounding variable. Nevertheless, several naturalistic investigations will be briefly reviewed below to demonstrate this experimental bias more explicitly.

Naturalistic Settings. Although inconsistent, nonlaboratory studies of prospective memory generally reveal that this facet of memory function improves as age increases (Maylor, 1993). For instance, in an archival study of attendance records at a research laboratory, Martin (1986) found that older individuals were less likely to miss appointments than younger subjects (i.e., 0.9% and 4.4% appointments missed, respectively). What this trend reflects, however, may be an increasing proficiency in using external memory aids given that the majority of naturalistic studies of intentional memory do not control for this factor (Harris, 1984).

For example, in a series of studies by Moscovitch (1982), college students and older college graduates (age 65-75) were asked to telephone the experimenter at specified times and dates. Results revealed that the older subjects carried out the task more successfully than their younger counterparts. However, when examined more closely, it appears that the superior performance of the older individuals could be attributable to their use of mnemonic devices whereas the younger subjects relied on more internal methods to generate recall as indicated in their proclamation that they simply "trusted their memory." A subsequent experiment instructed subjects not to employ any external aids when carrying out the prospective memory tasks. In this case, the advantage that older subjects had demonstrated on the prospective memory task disappeared. In a comparable paradigm, Poon and Schaffer (1982) found a prospective memory advantage for their older subjects (mean age = 73.2 years) over the younger individuals (mean age = 25.3 years); however, this study again did not control for how the subjects chose to carry out the prospective task (aided vs. unaided) once they left the laboratory.

These findings are consistent with more recent studies as well (Maylor, 1990; Experiment 1, West, 1988). While a number of design flaws can be cited as accounting for these findings such as small sample sizes, floor/ceiling effects, and social/motivational factors, it appears that in all cases a significant factor seems to be that external aids are not controlled. When data regarding the utilization of mnemonic aids was obtained in a post hoc fashion (Maylor, 1990), the results point toward the use of aids as the significant and determining factor in the observation of a positive relationship between prospective performance and age. A number of explanations have been forwarded in explaining the observed relationship between intentional memory and age including the idea that external aids serve an adaptive function in optimizing everyday memory capabilities (Sinnott, 1989). In addition, some authors have recognized that the elderly may structure their environment to compensate for deteriorating prospective memory (Maylor, 1993; Moscovitch, 1982). The possibility, however, that prospective memory may differentially decline in the elderly has not been definitively ascertained through naturalistic studies of intention memory due to the confounding effect of uncontrolled use of mnemonic aids.

Metamemory Investigations of Prospective Memory. As with other prospective memory investigations, self-reports of memory failures may be minimized by the effective use of external memory aids (e.g., calendars, diaries, lists). Furthermore, little empirical investigation has been done which considers the correlations between age, self-report of ability, and actual performance on aided and unaided prospective memory tasks. Only two studies have been cited in the literature related to these variables, each with conflicting findings. Dobbs and Rule (1987) found a negative correlation between metamemory scores and prospective remembering performance; while, Harris and Wilkins (1982) found self-reported failures in everyday life to positively correspond to failures on similar laboratory tasks. Given this gap in the literature, one aspect of the present investigation will be to explore the relationship between prospective memory performance (aided vs. unaided) and self-assessment of these abilities on a metamemory questionnaire (i.e., The Memory Assessment Clinic Self-Report Scale, MAC-S; Crook & Larrabee, 1990). It should be noted that studies exist (Larrabee and Crook, 1989) which have attempted to correlate age, "everyday memory" performance, and metamemory using such measures as the MAC-S; however, these studies include both retrospective and prospective tasks under the rubric of everyday memory assessment and therefore, do not specifically assess the functional construct of prospective memory.

Rather than focusing on actual memory performance, self-report measures aim to delineate older individuals' perceptions of their memories. This aspect of memory study is referred to as metamemory and can be assessed in respect to both prospective and declarative (i.e., retrospective) memory. Metamemory can be broadly defined as "cognitions about memory" (Hertzog, Dixon, & Hultsch, 1990) as well as an individual's assessment of their intentional memory capabilities and an understanding about what strategies might be employed to improve memory (Shimamura, 1990). Such an awareness is necessary for and inherent in successful prospective remembering given that the remembering of intentions, more than any other memory capacity (i.e., retrospective memory), relies on one's ability to plan, monitor, and organize one's memory. Older adults, for instance, have been found to be less efficient in using "metacognition" to judge the usefulness of different memory strategies and effectively choose which strategy to employ (Brigham & Pressley, 1988).

According to Maylor's (1993) review of this dimension of prospective memory, findings generally indicate a positive relationship between age and self-reports of prospective remembering (i.e., as age increases, intentional remembering is perceived as improving). Conversely, predominantly negative correlations have been observed in the literature with regard to self-reports of retrospective memory and age (i.e., decreasing capability with increasing age). For example, several studies (Cohen & Faulkner, 1984; Martin, 1986) queried young, middle-aged, and older individuals about their memory. Results have indicated that age was not a significant factor on items of prospective memory (e.g., attending appointments, taking medication, and answering letters) whereas older subjects consistently give decreased ratings for subsets of retrospective items (e.g., remembering telephone numbers and names of famous people). The present study will attempt to determine if indeed perceptions of prospective ability correspond with demonstrated capabilities and explore how this relationship changes across the life span.

The clinical relevancy of studying prospective memory can be found in a recent study in which prospective memory impairment was demonstrated to be an early indicator of dementia (Huppert & Beardsall, 1993). In the study, subjects classified as having a minimal level of dementia performed as poorly on prospective memory tasks as subjects displaying a more advanced stage of dementia. On the other hand, performance on retrospective memory tasks for subjects with minimal dementia fell somewhere in between normal control and more demented subjects. One of the most clinically challenging tasks facing the neuropsychologist is to differentiate the early stages of dementia from either age-associated cognitive decline or depression in the elderly (Lamberty & Bieliauskas, 1993). In other words, it is generally difficult to delineate what various neuropsychological profiles might look like in the early stages of a disease process and a large gap exists in the neuropsychological (and medical) arena in determining what subgroups of elderly individuals might be at risk for developing a more serious neuropathological condition. From a clinical perspective, beginning to determine the age-associated nature of prospective memory may help to elucidate the fine gradations which are necessary in specifying early neuropsychological correlates of dementia processes. Given that an age-associated decline of prospective memory does emerge in laboratory studies in which the use of mnemonic devices can be controlled, the next section will attempt to identify neurological substrates which might account for this relationship.

NEUROPSYCHOLOGICAL MODELS OF FRONTAL LOBE FUNCTIONING AND PROSPECTIVE MEMORY

It has been hypothesized, from a neuropsychological perspective, that the prospective memory operations require access to an "executive role" in the memory system including such functions as monitoring, organizing, and retrieving memory representations needed to execute future activities (Shimamura, 1990). Given these characteristic performance features of the construct of prospective memory, it has been inferred that intentional memory is reliant upon the integrity of the frontal lobes (Furst, 1986; Shimamura, 1990). Theoretical accounts of the tie between prospective memory and frontal lobe functioning can be traced to distinctions drawn between different types of memory. For instance, Squire (1987) has posited that the function of the frontal lobes involves a special kind of memory. Namely, specialized working-memory capacities (e.g., keeping a memory trace active for future use as with prospective memory) are considered to be functionally present in the prefrontal cortex whereas the general capacity for long-term memory (i.e., retrospective memory) depends to a greater degree on the functional integrity of the medial temporal region and diencephalic brain structures (Squire, 1987). Recently, Shimamura and Jurica (1994) have suggested that in normal aging, observed cognitive decline associated with frontal lobe integrity may precede that associated with medial temporal lobe dysfunction. For purposes of the present investigation, it is argued that intact frontal lobe functioning contributes to efficient prospective memory functioning (although other functional connections may augment) and that this association may decline across the life span.

Much literature has been generated which attempts to link memory changes in normal aging to amnesia. The classical amnestic syndrome involves the diencephalon (e.g., the hippocampus) and age-related loss of neurons in this area (Miller, Alston, Mountjoy, & Corsellis, 1984; Zola-Morgan, Squire, & Amaral, 1986) has been observed. Neuropsychologically, hippocampal dysfunction has been linked to retrospective memory decline in laboratory studies (Lezak, 1983). However, this aspect of the neurological literature will not be considered here given that the focus of the present study is how changes in the *prefrontal cortex* result in behavioral disturbances of memory in the elderly.

Anatomical Considerations. Squire (1987) identifies three types of neurostructural changes which have been studied with regard to memory and aging. These include (a) neuronal loss; (b) changes in neuronal size and in the relative number of synaptic connections; and (c) the frequency of neuropathological structures within neurons (e.g., neurofibrillary tangles, senile plaques). Squire (1987) further suggests that it is the first of these, neuronal loss, which has offered the most unambiguous findings with regard to the aging brain. For example, Haug, Barmwater, Eggers, Fischer, Kuhl, and Sass (1983) conducted a morphometric analysis of neuronal loss in the aging brain by using automated equipment and correcting for total tissue volume to control for biased effects. Their results indicate that a number of cortical areas (e.g., parietal cortex, striate cortex) do not lose a significant number of neurons during the life span; however, the neostriatum and the *prefrontal cortex* were found to have lost 15-20% of neurons between young adulthood and old age. Furthermore, several studies have observed the most intense changes in the aging mammalian brain to take place to a greater extent in the frontal cortex (Mervis, 1981; Vernadakis, 1985). Therefore, one cortical region that appears to be differentially affected by normal aging is the prefrontal cortex (Jernigan, Archibald, Berhow, Sowell, Foster & Hesselink, 1991; Lim, Zipursky, Watts & Pfefferbaum, 1992).

According to several leading theoreticians in the area of brain functioning and memory, the prefrontal cortex serves a specialized function in the memory process (Luria, 1966, 1973; Squire, 1987; Stuss & Benson, 1986). Luria (1973) suggests that frontal lobe pathology leaves the operation of primary memory intact, but :

> "...the ability to create *stable motives* of recall and to maintain the *active effort* required for voluntary recall, on the one hand, and the *ability to switch from one group of traces to another are deficient*, with the result that it is the <u>process</u> of recall and reproduction of material which is significantly impaired." (p. 211)

Stuss and Benson (1986) suggest, therefore, that the frontal lobes are intimately involved with the memory process; however, their function is to organize strategies for storage and retrieval as well as to compare the results of remembrance with original intentions. In his work with frontal lobe patients, Luria (1973) concluded that these patients are particularly susceptible in their ability to monitor irrelevant, interfering, or inappropriate information. One can see how this pattern would be specifically related to prospective memory. If prospective memory entails the ability to hold some future intention in memory and then carry it out at some later point, then age-associated frontal lobe inefficiency could result in any interference causing remembrance of that intention to disintegrate.

In particular, lesions to the *inferior convexity* and *dorsolateral cortex* of the frontal lobes have been shown to result in a particular pattern of inflexibility, perseverative responding, and the inability to alter one's response to changing environmental demands (Mishkin & Manning, 1978). The perseverative response tendencies observed in the animals with inferior convexity lesions was hypothesized to be due to an inability to overcome responses that compete with to-be-learned responses. This supports the notion that, in general, frontal lobe inefficiency results in memory traces which are vulnerable to the effects of interference. Luria (1973) coined the term "pathological inertia", or the inability to switch from one trace to another, in referring to the perseverative tendency he observed in his patients with lesions of the frontal lobes. In describing this syndrome further, he states that pathological inertia coupled with aspontaneity also resulted in an inability to compare the results of one's actions with the original plan. For the purposes of the present study, it is suggested that such changes in frontal lobe efficiency in the elderly would interfere with their ability to generate and carry out future intentions as well as monitor the outcome of these goal-directed behaviors. Obviously, substantial differences exist between changes in frontal lobe functioning due to normal, age-associated processes and those seen in various clinical samples with neurostructural impairment. However, the investigation of cerebral changes following neurostructural damage has provided a great deal of material in understanding the processes of the healthy brain.

Neuropsychological Considerations. Craik's (1986) theory on the functional aspects of prospective memory suggests that older individuals perform more poorly on memory tasks which require them to execute self-initiated operations. For example, older individuals have been shown to perform more poorly on free recall tasks than tasks of cued recall and more poorly on tasks of cued recall than recognition, each requiring varying degrees of self-initiated memory processing. This is true even when these tasks are equated for task difficulty (Craik, 1986). Clinical investigations of frontal lobe patients and memory reveal a similar pattern. In other words, normal subjects are able to demonstrate skills in organization and strategy implementation in free recall tasks, while frontal lobe patients are not (Squire, 1987; Stuss, Alexander, Palumbo, Buckle, Sayer & Pogue, 1994). Stuss, Eskes and Foster (1994) summarized the functional impairments of memory and learning which are associated with frontal lobe damage. These deficits include (a) working memory capacity impairment; (b) susceptibility of learning to the effects of interference; (c) limits in context learning; (d) impaired memory of source and order of recall information; and (e) deficits in metamemory.

Prospective memory can be identified as involving the capability to remember information that is tied to its temporal orientation. For example, individuals must remember to take their medication at a certain point in time and also recall how recently this act was completed. This is what Koriat and his colleagues (1988) have described as output monitoring or the memory that a planned action has already been performed. These authors further stipulate that perseveration might be defined as a failure in output monitoring. Furthermore, memory functions related to frontal lobe efficiency (e.g., prospective memory) have been considered to involve the ability to manipulate and retrieve associations within a temporal-spatial context (Butters, Kaszniak, Glisky, Eslinger & Schacter, 1994; Shimamura, 1990). This can include source amnesia in which an individual can remember what is said during a conversation, but have difficulty recalling who said it, or where and when the information was obtained (i.e., the contextual aspects of the memory). Shimamura (1990) suggests that remembering what was said in a conversation, for instance, is a distinct process from recalling who said it and where and when it was said. This latter aspect of recallability requires a search of memory which is thought to rely on the capabilities of the prospective memory system because access to these spatial-temporal aspects of information is necessary in making contextual associations to memory traces.

Source memory as a specific function of frontal lobe capacity has been shown to be impaired in older adults (Craik et al., 1990; Janowsky, Shimamura, & Squire, 1989). The relation of frontal lobe functioning to the spatial-temporal context of memory information was demonstrated in a study by Milner (1971) which required both unilateral temporal lobe and unilateral frontal lobe lesioned patients to recall the temporal order of a series of 184 stimuli. After presenting the stimuli, subjects were asked to recall which of two stimuli were presented most recently. Those subjects with frontal lobe pathology, but not those with temporal lobe involvement, displayed significantly impaired performance when making these judgments of recency. Furthermore, in a well-designed study of temporal order and interference conducted by Petrides and Milner (1982), subjects were exposed to twelve pictures of either objects, abstract designs, or words. All the stimuli appeared together on each page, but with successive pages the stimuli were in varying arrangements. The task of each subject was to point to a new and different stimulus on each page which required recalling which items had been selected on previous pages. This task required that the subjects be able to relate information about their own actions and subsequently make selections among repeatedly presented items. Results revealed that patients with frontal lobe lesions were most severely impaired on this task. Petrides and Milner (1982) interpreted this apparent deficit in frontal lobe patients to be related to symptomatic difficulties with planning and organizing memory recall.

Shimamura and Jurica (1994) recently employed this same experimental paradigm to investigate memory interference effects and aging. The sixteen stimuli of visual patterns were presented on a computer screen. Subjects were instructed to select a design that had not been selected on a previous trial, the interfering stimuli, therefore, being the other fifteen designs present on the screen. Three groups of subjects participated in the study including college students (N = 41, mean age = 20 years) and two groups of healthy elderly individuals (N = 17, mean age = 66 years and N = 11, mean age = 75 years). Results indicated an age-related impairment on this measure sensitive to frontal lobe dysfunction. Moreover, this cognitive impairment pattern was more pronounced for subjects in their seventies than those in the sixth decade. Results were interpreted as being consistent with a deficit in working memory.

From this review, it is apparent that the difficulties with recall seen after frontal lobe impairment cannot be attributed to a primary memory deficit alone. Stuss and Benson (1986) refer to amnesia associated with frontal lobe involvement as a disorder of organization. Changes in frontal lobe functioning do not produce classical disorders of memory (e.g., impaired recall only), but do result in deficits which influence the overall functioning of memory. On a posterior-anterior brain axis, posterior brain lesions produce more primary disturbances of memory which are considered to be modality-specific. On the other hand, memory disturbances associated with loss of frontal lobe integrity affect the memory systems "executive" role or its operational capabilities. Goldberg and Bilder (1987) indicate that deficits of the prefrontal cortex are universal in terms of their impact rather than modality specific because of the superordinate nature of this brain region and its "executive" role in functioning. Moreover, to Luria (1973), frontal lobe impairment leads to mnemonic activity which "easily yields to uncontrollable irrelevant associations, or the influence of existing stereotypes...and goal-directed activity is replaced by the recall of irrepressible associations, with no attempt at correction" (p. 345). It is these elements of frontal lobe functioning and memory which are hypothesized in the present study to account for potentially observed deficits in prospective memory in the elderly.

Aging and Frontal Lobe Functioning. While the above mentioned studies attempt to tie the phenomena of an age-associated decline in prospective memory to possible frontal lobe dysfunction, it may be worthwhile to also explore recent studies which point to neuropsychological changes in frontal lobe functioning which accompany the aging process. It is often cited in the literature that attentional resources are more limited for older than younger adults and therefore a geriatric population is considered to perform more poorly on tasks because they may involve "effortful or attention-demanding processing" (Hasher & Zacks, 1979; Salthouse, 1991). Shimamura (1990) rejects the notion that most patterns of age-associated cognitive decline can be attributed to deficits in attention and disregards this theoretical account based on several arguments. First, he cites an inadequacy of theories of cognitive decline in defining "effortful" processes and indicates that when common definitions are employed, older individuals do not exhibit deficits on "effortful" tasks (Light & Burke, 1991). Furthermore, Shimamura (1990) suggests that some tasks which are considered to be "effortless" do show age-associated performance decrements (e.g., simple classical conditioning).

Instead, Shimamura (1990) suggests that it is possible to integrate the attentional resource perspective into contemporary neuropsychological thought. He surmises that observed attentional deficits can be attributed to frontal lobe dysfunction and therefore, subsequent prospective memory impairment. It is well documented that frontal lobe pathology often involves attentional deficiencies and this neurostructural region has extensive connections with systems of arousal (Luria, 1966; Stuss & Benson, 1986). In addition, Shimamura (1990) hypothesizes that descriptions of "effortful" processing and prospective memory are similar since both require planning, self-initiation, selection of responses, monitoring, and cognitive mediation. Therefore, he suggests that demonstrated attentional difficulties observed in the elderly can be traced to an inefficiency in frontal lobe functioning.

Shimamura's (1990) suppositions have been supported by a growing body of research which suggest that the prefrontal cortex may be particularly vulnerable to the effects of aging. The implicit assumption growing out of this area of study is that "normal" aging is associated with cognitive impairments that approximate (i.e., are milder than) those seen in frontal lobe patients. It was originally argued by Klisz (1978) that older persons, in the absence of pathology, have similar neuropsychological patterns to individuals with right hemisphere involvement. This aging and lateralization hypothesis continues to permeate the aging literature; however, it has been challenged in the more recent past. Neurophysiological studies have suggested that such indicators as regional cerebral blood flow show significant declines in prefrontal regions beyond the sixth decade while corresponding changes are not observed in posterior cerebral regions (Shaw, Mortel, Meyer, Rogers, Hardenberg, & Cutaia, 1984; Warren, Butler, Katholi, & Halsey, 1985). Contemporary neuroradiologic techniques, such as magnetic resonance imaging, have been employed in recent investigations which also point to age-related changes in the frontal lobes (Jernigan et al., 1991; Lim et al., 1992). Furthermore, a number of qualitative studies have confirmed the supposition that anterior-posterior changes in brain functioning occur to a significantly greater degree than left-right lateralization changes (Albert & Kaplan, 1980; Veroff, 1980). Hochanadel and Kaplan (1984) early on hypothesized that a prefrontal model of normal brain aging exists based on their observations of the behavior of geriatric subjects, especially with regard to inflexibility of response sets (i.e., perseveration). These authors contend that a tendency toward perseveration is at the heart of their prefrontal model of aging. In support of this theoretical supposition, Ruff, Light and Evans (1987), in addition to decreased fluency, found perseverative errors on a design fluency test to be highly correlated with age.

Findings from qualitative studies which have observed age-associated decline in frontal lobe functioning have been corroborated by normative, quantitative studies of frontal lobe functioning in the elderly. For instance, Whelihan and Lesher (1985) completed a neuropsychological assessment with groups of young-old (N = 31; 60-70 years) and old-old (N = 48; 76-92 years) cognitively intact subjects. Results revealed that the old-old cohort performed significantly below the young-old group on frontal lobe measures whereas only minimal differences were observed on nonfrontal measures. These authors suggest that "normative and nonpathological age-associated changes" accounted for their findings. Similarly, Mittenberg, Seidenberg, O'Leary and DiGiulio (1989) evaluated five groups of subjects (20-35, 55-59, 60-64, 65-69, and 70-75 years) on a neuropsychological test battery. A stepwise multiple regression of all measures included in their study revealed that frontal lobe functions best discriminated older from younger cohorts, and explain "essentially all of the variability in age-related performance decline." A study conducted by Daigneault, Braun, and Whitaker (1992) also lends support to the notion that frontal lobe functions are among the first to decline in normal aging. Their results suggest that noted age-associated decline in frontal lobe functioning may occur as early as 45-65 years and includes deficiencies in the ability to regulate behavior based on plans, environmental feedback, abstract concepts, or one's own responses.

The evidence regarding the decline of frontal lobe functions in the elderly is certainly compelling and beyond theoretical explication, its relationship to noted declines in prospective memory is as yet unexplored. On a cautionary note, however, Boone, Miller, Lesser, Hill, and Elia (1990) suggest that cross-sectional data may artificially enhance the findings related to frontal lobe inefficiency in the elderly. Moreover, after strictly controlling for medical, neurological, and psychiatric illnesses in their sample of 61 middle-aged and elderly individuals (50-59, 60-69, and 70-79 years), few statistically significant differences among groups emerged. Even so, some trends did emerge related to frontal lobe inefficiency including difficulties with verbal fluency and inefficient selection of problem-solving strategies. These authors, therefore, have suggested that in a medically and psychiatrically healthy population of older adults, minimal evidence emerges for age-associated decline in frontal lobe abilities.

Elsewhere it has been suggested that these results may be inconclusive given that range restriction in the age of the sample (i.e., lack of inclusion of an age group $\geq$80 years) as well as a cohort which demonstrated high intelligence (mean WAIS-R Full Scale IQ = 113.79) and education (mean = 14.24 years) may have attenuated the reported findings (Uchiyama, Mitrushina, D'Elia, Satz, & Mathews, 1994). In addition to controlling for medical and psychiatric illnesses in a sample of geriatric (N = 68; mean age = 78) and nongeriatric (N = 193; mean age = 48) individuals, Uchiyama and his colleagues found frontal lobe functions to be decreased in their elderly sample and were able to rule out education, gender, and decreased psychomotor abilities as possible moderating influences for the noted effect.

Prospective Memory and Frontal Lobe Functioning: Clinical Evidence. Clinical samples of patients with neurostructural damage to the frontal lobes are often described as displaying a clinical syndrome which includes difficulties in planning, categorizing, attention, output monitoring, verbal fluency, and inferential problem solving (Janowsky, Shimamura, Kritchevsky, & Squire, 1989). Yet this same group of patients can display relatively well preserved capabilities in the area of declarative or retrospective memory. Such a deficit, again, demonstrates the functional distinction between retrospective and prospective memorial systems. Luria (1966) observed frontal lobe patients to be able to verbalize a desired response (i.e., the retrospective component of prospective memory), but unable to carry out the requested action (i.e., the measure of successful prospective memory), thus exhibiting a disconnection between knowing and doing. Hecaen and Albert (1978) characterized this deficit as "forgetting to remember", a familiar descriptive nomenclature for intentional memory processes. Despite a preservation of retrospective memory in patients with frontal lobe involvement, other aspects of memory impairment are present. These patients exhibit difficulty with memory tasks which require organization, memory access, metamemory, and spatial-temporal or source memory (Shimamura, 1990), or in other words, difficulty in varying aspects of prospective memory mechanisms.

To demonstrate the effect of frontal lobe lesions on prospective memory, Janowsky, Shimamura, and Squire (1989) presented patients with frontal lobe lesions (N = 7; mean age = 64 years), age-matched control subjects (N = 9; mean age = 62 years), and younger control subjects (N = 6; mean age = 51 years) with facts and then asked the subjects to categorize the information. After a two hour retention interval, subjects were asked to indicate whether or not a fact had been presented and to identify its source. In this experiment, frontal lobe patients recalled as many facts as their age-matched controls and the younger subjects; however, both frontal lobe patients and the older subjects displayed more source errors than younger subjects. These authors (Janowsky et al.,

1989) interpret these results as indicating that the frontal lobes are particularly crucial in associating facts to the context in which they occurred. Unfortunately, the noted age decline in source memory (i.e., a special aspect of prospective memory) was not discussed.

Other neuropsychological evidence suggests frontal lobe functioning is relatively important for prospective memory. For example, Korsakoff's patients are noted to experience diencephalic damage and subsequent impairments in retrospective memory; however, neuroradiologic studies indicate that these patients also experience frontal lobe damage (Shimamura, Jernigan, & Squire, 1988). What is of interest in this context is that individuals with Korsakoff's syndrome display prospective memory impairments in addition to documented retrospective deficiency. Notable impairment is observed, for instance, on tasks of planning, attention, metamemory, organizing, and inferential reasoning (Janowsky, Shimamura, Kritchevsky & Squire, 1989; Oscar-Berman, 1980).

Furthermore, Huppert and Beardsall (1993), as previously mentioned, conducted a study in which the results suggest that prospective memory impairment is a sensitive, early indicator of dementia. Normal control (N = 27), normal subjects with slightly lower scores on the MMSE (N = 26), individuals with a minimal level of dementia (N = 12), and mildly/moderately demented subjects (N = 5) were administered the Rivermead Behavioral Memory Test (Wilson et al., 1985). A battery of retrospective memory tests was also administered. Results indicated that the minimally demented group was significantly impaired on the prospective memory component of the memory tasks and this impairment was noted to be greater than that shown on the retrospective components of the battery. These authors surmise that prospective memory requires the integration of a number of cortical structures and their respective processes and the integrative aspect may fail prior to individual components. Such an argument is consistent with a frontal lobe explanation of prospective memory function given this neurostructural region's extensive interconnections with other cortical regions (Luria, 1966).

It should be noted that specified memory dysfunction which is associated with frontal lobe dysfunction has been observed in other clinical populations as well including individuals with multiple sclerosis (Beatty, Goodkin, Beatty, & Monson, 1989) and individuals with closed head injuries (Sohlberg, White, Evans & Mateer, 1992). For example, sequelae of head injuries are considered to differentially effect the dorsolateral convexity of the frontal lobes and therefore, ubiquitous difficulties with prospective memory have been observed in this population (Sohlberg et al., 1992). Of clinical interest, is that these observed prospective memory deficits have been shown to be amenable to remediation through cognitive rehabilitative efforts (Sohlberg, Mateer, & Stuss, 1993).

Prospective Memory and Frontal Lobe Functioning: Aging Investigations. A review of the literature suggests empirical emphasis has been given to aging and prospective memory or conversely, aging and frontal lobe functioning, but little has been done in the memory and aging field to consider these three domains concurrently. Consequently, only a few studies were found that addressed aging, prospective memory, and frontal lobe functioning even indirectly.

For example, McIntyre and Craik (1987) assessed source amnesia in younger and older individuals by presenting fictitious facts using one of two speakers (male or female), and then asking subjects not only to recall the facts themselves, but also to recall the sources of the fact (i.e., which speaker presented the information). Older adults proved to be significantly impaired in recalling who presented the fact. These authors were also able to show that memory for source information was correlated with performance on the WCST (Heaton, 1981), suggesting a parallel between age-related deficits and frontal lobe efficiency.

Failures to remember the last spatial-temporal context in which a behavior was enacted could lead one to repeat actions inappropriately (e.g., taking one's medication twice in the course of a day). Such memory deficits have been observed in the elderly and are a common complaint in metamemory studies of older individuals' perceptions of their memory functioning (Larrabee & Crook, 1989). This deficiency in monitoring of actions already performed was observed in Koriat et al.'s (1988) study of an elderly population. Specifically, young (mean age = 24.5; N = 40) and old (mean age = 71.2; N = 40) persons were asked to classify words according to whether or not they had *appeared* on a previous study list (input monitoring) and whether or not they had been *recalled* following a previous word list presentation (output monitoring). Older individuals were found to be deficient in both types of monitoring; the noted declines, however, were significantly greater for output monitoring which was considered to rely more heavily on the contextual cues of the learning situation and, therefore, to draw upon skills mediated by frontal lobe integrity.

Craik, Morris, Morris, and Loewen (1990) specifically assessed the interaction between normal aging, source amnesia, and frontal lobe functioning. Elderly community residents (mean age = 71; N = 24) were asked to recall where they had learned new factual information. Performance on this measure was correlated with measures of frontal lobe functioning (WCST; Heaton, 1981) and verbal fluency (Thurstone & Thurstone, 1949). Results confirmed the hypothesis that source amnesia in a normal elderly population is related to frontal lobe functioning. In particular, analyses revealed that source memory correlated reliably with verbal fluency, number of categories achieved, total errors, and perseverative errors on the WCST. Interestingly, source amnesia did not correlate with Performance IQ or with a measure of retrospective memory (e.g., a measure of the recallability of the presented facts). This study supports the notion that an interaction exists between aging, aspects of prospective memory, and frontal lobe integrity.

STATEMENT OF STUDY OBJECTIVES

The major objective of this study is to ascertain if an age-associated decline in prospective memory exists and to delineate the cognitive aspects of this decline. Underlying Craik's (1986) theory of the functional aspects of memory functioning is the hypothesis that older individuals tend to rely more on external memory strategies as internally-generated approaches become less efficient. Prospective memory, or remembering to remember, is considered to require a greater degree of self-initiation and to eventually decline over the life span. Dobbs and Rule (1987) and Cockburn and Smith (1991) both controlled for the use of mnemonic aids and found prospective memory to decline with increasing age. No study to date, however, has considered the comparison of cued and uncued prospective memory performance measured under the same experimental conditions. The present investigation will attempt to determine if age differences exist for intentional memory capabilities, and if so, are the differences present to a greater degree in conditions in which external memory aids are not employed. Individuals will also be assessed according to their performance on retrospective memory tasks given that such abilities are implicit in the successful completion of prospective memory tasks. It will be necessary to experimentally differentiate performance in these domains in order to draw definitive conclusions about age-associated decline in prospective memory.

Furthermore, in an attempt to understand the relationship between age and prospective memory from a neuropsychological perspective, frontal lobe functioning as it relates to memory will also be assessed. It is hypothesized that frontal lobe performance will account for the observed variance between age and intentional memory capabilities. In other words, it is argued that intact frontal lobe functioning contributes to efficient prospective memory functioning and this association may decline across the life span. Given the outlined review of frontal lobe functioning and memory, it is hypothesized that interference effects will be greatest for prospective memory items which have the longest delay period. In other words, prospective memory will deteriorate to a greater extent during longer intervals between task assignment and execution of the intention. This discrepancy will be greatest for uncued items.

An additional aspect of the present investigation will be to explore the relationship between prospective memory performance (aided vs. unaided) and self-assessment of these abilities on a metamemory questionnaire. It is hypothesized that external memory aids may be employed by the elderly to compensate for an underlying decline in prospective memory and, subsequently, an older cohort may perceive their memory in this domain as improved. Therefore, self-rating of intentional memory abilities and actual performance will be discrepant, especially when prospective memory is assessed without the benefit of cues.

Finally, a second experiment will be conducted to determine if subjects show improvement in prospective memory function after participating in an intervention designed to enhance their memory capabilities by providing training in individual memory strategies. This is considered to be a pilot study because it will not offer specific training in prospective memory. Its focus is to ascertain if concentrating on specific memory strategies and practicing information organizing techniques increases prospective memory capability. It is hypothesized that prospective memory will improve from pre-intervention to post-intervention and this improvement will be greatest for unaided prospective memory. The purpose of this study is to determine if this domain of memory function is amenable to remediation. The clinical utility of focusing on improving prospective memory capabilities for the elderly is reflected in the potential consequences for daily living and functional adjustment. Beyond practical implications (e.g., not taking medications more than once on a given day), being able to carry out future intentions enhances an individual's sense of self-efficacy in day-to-day living and strengthens a future-time perspective.

METHOD: EXPERIMENT ONE

Participants. A cohort of healthy, elderly individuals were recruited through their response to advertisements in a local paper to participate in a larger project addressing mood, memory, and aging. Each subject received a pre-assessment of their abilities in a number of relevant domains including memory, attention, executive functioning, and mood. Subjects then participated in a seven session workshop to teach cognitive strategies and relaxation to improve memory skills and relieve emotional symptomatology (e.g., anxiety, depression) contributing to memory difficulties. A power analysis conducted prior to beginning the study (Cohen, 1992), suggested 102 subjects would be needed in order to obtain a medium effect size (α = .05) and statistical power equal to .80 using a multiple regression statistic with seven predictor variables. A cohort of 115 participants completed the assessment thus exceeding the recommended sample size. Subjects ranged in age from 55 to 90 years old ($\bar{x}$ = 67.75; SD = 7.64). Of the 115 participants, 73 were women and 42 were men. The group had a mean education of 15.14 years (SD = 2.83; range = 8-20 years).

Persons who reported a history of neurological or psychiatric illness (e.g., hypertension; Willis, Yeo, Thomas & Garry, 1988) were excluded from the analyses. This information, as well as demographics (e.g., education, occupation), was obtained from a self-report version of the Multilevel Assessment Inventory (MAI; Lawton, Moss, Fulcomer, & Kleban, 1982). In addition, subjects who obtained a score of less than or equal to 24 on the Folstein Mini Mental Status Examination (MMSE; Folstein, Folstein &

McHugh, 1975) or greater than or equal to +.50 on the Storandt Brief Dementia Battery (Storandt, Botwinick, Danziger, Berg, & Hughes, 1984) were excluded from the analyses. Persons scoring 20 or more on either the Beck Depression Inventory (BDI; Beck, 1987) or the Geriatric Depression Scale (GDS; Yesavage, Brink, Rose, Lum, Huang, Adey & Leirer, 1983) were also omitted from data analysis since moderate to severe levels of depression have been known to deleteriously effect memory performance (Lamberty & Bieliauskas, 1993; O'Connor, Pollitt, Roth, Brook & Reiss, 1990).

Experimental Measures. The following measures which were employed to assess identified dependent variables. These have been divided according to the cognitive domain addressed including prospective memory, retrospective memory, metamemory, and executive functioning. A number of additional measures were also included to assess the potential effect of certain moderating variables such as intelligence, attentional capacity, depression, and mental status.

Prospective Memory Experimental Measures

The Rivermead Behavioral Memory Test. Three items from the Rivermead Behavioral Memory Test (RBMT; Wilson, Cockburn, & Baddeley, 1985) were used to assess prospective memory. The RBMT is a laboratory measure which includes three prospective memory items within a series of everyday memory tasks:

(1) *Remembering a belonging*. This RBMT item entails remembering to ask for the return of a personal item of the subject's choosing (e.g., comb, pencil) which the interviewer places out of sight. The subject is instructed to ask for it to be

returned at the end of the session as well as identify the location in which it was hidden. There is no specific cue to prompt the execution of the action, although the experimenter states "That is the end of the testing session." If the subject does not spontaneously request the belonging, the interviewer gives a prompt (e.g., "Was there something you were going to ask me for?").

(2) *Remembering an appointment*. This item involves remembering to ask about an appointment which is initiated by an alarm ringing after 20 minutes. Subjects are instructed to ask the experimenter something to the effect of "When will I see you again?" This task involves an experimenter-generated nonspecific cue for the execution of the required action. If the subject does not respond spontaneously when the alarm sounds, a prompt is given such as "What were you going to do when the alarm rang?"

(3) *Remembering to deliver a message*. This item requires remembering to pick up and deliver a message. This task is embedded within the sequence of another task. The experimenter asks the subject to observe while he/she traces a path around the room. The interviewer goes from a chair to a table, picks up an envelope marked "MESSAGE", then walks to a window, then to the door and then back to the table where the envelope is placed, and then returns to the chair. The experimenter subsequently asks the subject to carry out the sequence. Points are provided for picking up the envelope and delivering it to the appropriate

location without a prompt. Recall is assessed both immediately and following a 20 minute delay.

The RBMT has been found to discriminate between the everyday memory capabilities of high- and low-functioning neurologic patients with the former group performing significantly better (Wilson, 1989). In that study, 176 persons with brain-damage (age range = 14-69 years) were administered the RBMT. RBMT scores were correlated with performance on existing tests, subjective ratings from patients and caregivers, and observations by therapists of everyday memory lapses. Interrater reliability (i.e., 100% scoring agreement), and test-retest reliability (.85) were considered to be high. In addition, scores on the RBMT correlated highly with other measures of memory (e.g., .63 with the Warrington Recognition Memory Test) and with therapist observations of memory lapses (e.g., -.75 between RBMT and number of memory lapses), suggesting that the instrument is a valid measure of everyday memory. In another study, the RBMT was found to be a valid measure of memory and was able to predict staff assessments of patient's everyday adaptive capabilities (Malec, Zweber, & Depompolo, 1990) or parental assessment's of children's everyday memory skills (.71; Wilson, Ivani-Chalian, Besag, & Bryant, 1993).

The Prospective Memory Screening Test (PROMS; Sohlberg & Mateer, 1993). This measure is designed to assess the ability to initiate and carry out planned actions at designated future times. It was originally designed as a screening measure to assess prospective memory difficulties in a head injured population (Sohlberg, Mateer, & Geyer,

1985) but may be a useful research tool in the present context. The PROMS measures prospective memory ability at one, two, ten and twenty minutes as well as twenty four hours. The target items are simple, one-step commands; although, some items have been modified to accommodate the laboratory setting and the population being studied. PROMS items are listed in Appendix A.

In addition to the time dimension, the screening measure also examines the parameter of cueing as some of the tasks are initiated by the experimenter. Associative cue items require the subject to perform a prospective memory task when another event occurs (e.g., the examiner snaps his/her fingers); whereas, with the time cue, the subject monitors time and initiate an activity at a specified time without the benefit of a cue. This latter set of items is considered to require a greater degree of self-initiation. The PROMS is specifically designed so that the subject is never keeping track of more than two prospective memory tasks at one time. To test the hypotheses stated above, the PROMS differentially assesses performance on cued (i.e., event-based) prospective memory items versus self-timed items and allows for monitoring performance based on the length of the interval between the request and the execution of the intention (e.g., 10 minutes vs. 20 minutes).

Since the PROMS is a relatively new instrument (Sohlberg & Mateer, 1993), only limited data is available on its reliability and validity as a screening instrument. The PROMS has been found to discriminate between normal (N = 34; age = 20-59) and brain-injured (N = 25; age = 21-56) individuals (Sohlberg & Mateer, 1993). Out of a total score of seven, 82% of the normal control subjects scored either 6 or 7, while only 36% of the brain-injured group scored in this range. Therefore, the PROMS appears to have some discriminative validity for prospective memory performance. In this same study, PROMS scores were also compared to other memory measures (e.g., Randt Memory Test). Results indicated that the PROMS was assessing a specific type of memory, as a wide range of PROMS scores were demonstrated in individuals scoring both low and high on a measure of retrospective memory.

Retrospective Memory Experimental Measures

The California Verbal Learning Test. The CVLT (Delis et al., 1988) assesses verbal memory for a list of sixteen grocery items presented in five learning trials. Assessment of memory occurs after each trial. An interference list is presented after the fifth learning trial and both immediate and delayed (30 minutes) recall and recognition of the original list is assessed. Sex and age-adjusted performance norms are provided.

The reliability of the CVLT has been established in a study of 133 subjects from a normal reference group which assessed both internal consistency and test-retest coefficients (Delis, Kramer, Kaplan & Ober, 1987). The authors attempted to address the difficulties in establishing reliability for recall measures given the inherent problems of item interdependency (e.g., repeated items over trials). In doing so, the authors analyzed the total trial scores (i.e., a global indicator of learning and memory) and found a split-half reliability estimate of .92 in the normative sample. As additional measures of reliability, these authors correlated scores on two independent halves of the CVLT. These analyses yielded coefficient alphas of .74 and .69, respectively. In a second study designed to establish test-retest reliability, twenty-one normal adults were re-administered the CVLT after a one year interval. Thirteen of 18 CVLT test-retest scores were found to be significant including total immediate recall of List A across the five trials, percent primacy region recall, learning slope, semantic-clustering score, Short- and Long-Delay cued Recall, Long-Delay Free Recall, number of recall errors, and hits/false positives on recognition testing. Significant correlations ranged from .47 to .79.

A factor analysis of the CVLT has also been conducted to determine its components as a measure of the memory construct (Delis et al., 1988). To ascertain if the various CVLT indices clustered in linearly independent performance domains that paralleled experimental constructs, or whether a single learning factor would emerge, it was administered to 399 normal subjects and neurological patients. A varimax rotation yielded a six factor structure for CVLT indices that were consistent for normal as well as neurological subjects by either age-residualized or age-uncorrected scores. These six factors include general verbal learning, response discrimination, serial position effect, learning strategy, and retroactive/short-delay effect.

In the same studies, Delis and his colleagues (1987) also found support for the CVLT's criterion-related validity. In this aspect of the studies, the CVLT was correlated with various scores on the Wechsler Memory Scale (WMS; Wechsler, 1945). The total immediate recall of List A for five trials correlated .66 with the WMS Memory Quotient and in this same range with several additional WMS variables. Validity has also been established for the CVLT by determining patterns of scores for various neurological and clinical groups including chronic alcoholics as well as individuals with Parkinson's disease, multiple sclerosis, Huntington's disease, and Alzheimer's disease (Delis et al., 1987).

Experimental Measures of Metamemory

Memory Assessment Clinic Self-Report Scale (MAC-S; Crook & Larrabee, 1990). The MAC-S is a self-rating scale of everyday-memory abilities which contains an Ability scale, a Frequency of Memory Failure scale, and four global-memory rating items. The Ability scale contains 21 items (rated on a 5-point Likert scale ranging from very poor to very good) concerning one's overall ability to remember things such as verbal directions to a geographic location given minutes earlier. On the other hand, the Frequency scale contains 24 items (rated on a 5-point Likert scale ranging from very often to very rarely) concerning the subject's frequency of memory failure for such things as forgetting the name of a familiar object. For both scales, only those items which reflect prospective memory situations (e.g., *#11 "To write letters you intend to write or make telephone calls you intend to make."*) will be used in assessing the relationship between judgments of prospective memory and actual performance. These items are listed in Appendix C.

Test-retest reliabilities of the various self-rating factors on the MAC-S exceeded .80 in a normative study of 1,106 subjects (Crook & Larrabee, 1992). In their original test-retest reliability study, Crook and Larrabee (1989) tested 52 subjects on four occasions, each separated by three weeks. For the Ability and Frequency measures, the reliability coefficients were uniformly high (i.e., the majority falling in the range of .80). The reliability coefficients were notably lower for global rating items, due to restriction in the range of measurement.

The factor structure of the MAC-S was assessed in two related investigations, Winterling, Crook, Slama and Gobert (1986) and Crook and Larrabee (1990). The factor structures were reported to be equivalent across these studies and include five orthogonal "Ability to Remember" and five orthogonal "Frequency of Occurrence" factors. The five Ability factors include remote personal memory, numeric recall, everyday task-oriented memory, word recall/semantic memory, and spatial/topographic memory. The five Frequency factors include word/fact recall (i.e., semantic memory), attention/concentration, everyday task-oriented memory, general forgetfulness, and facial recognition. This factor structure appeared unaffected by age or sex. In addition, concurrent validity has been established between memory self-ratings on the MAC-S and objective computer-simulated everyday memory performance (Larrabee, West & Crook, 1991). In this study, 125 normal adults were administered the MAC-S and concurrently, completed several other measures of objective memory performance. A canonical correlational analyses revealed that both types of measures shared 28% to 29% of common variance.

Executive Functioning Experimental Measures

Daugneault, Braun, and Whitaker (1992) identified several measures believed to measure prefrontal functions and associated with normal aging after 60-70 years. These include perseverative errors on the WCST (Heaton, 1981), performance on the Category Test (Halstead, 1947), verbal fluency (Thurstone & Thurstone, 1949), nonverbal fluency, judgments of recency, and interference effects. Several of these measures were employed in the present study including the WCST and nonverbal fluency in an attempt to explore the relationship between aging, frontal lobe efficiency, and prospective memory. Three measures were used to assess executive functioning in the experimental sample. These were then be covaried with prospective memory performance in a multiple regression analysis.

The Ruff Figural Fluency Test. The assessment of nonverbal fluency was first extended from verbal productivity by Jones-Gotman and Milner (1977). The design fluency measure used in the present investigation was the Ruff Figural Fluency Test (RFFT; Ruff, Light & Evans, 1987), a measure of speed of productivity, visuospatial creativity, and the ability to monitor ongoing activity. Performance on this measure is enhanced by the use of strategies. This test consists of five trials, each on a page with 40 contiguous squares printed in a 5 x 8 array. Each square on the page contains five identically arranged dots. The page for each trial differs in that the dots in the first three trials are symmetrically arranged; however, interference patterns are included on trials two and three. The remaining trials (i.e., four and five) are arranged in an asymmetrical pattern. The subject is instructed to make as many different patterns or figures as possible within a 60 second time period for each trial. This is accomplished by connecting any two or more dots with straight lines without repeating any pattern. This measure is scored for both the number of unique patterns and the number of repetitions of a pattern (i.e., perseverations). The RFFT has been found to be differentially sensitive to right frontal lobe dysfunction (Ruff, Allen, Farrow & Neiman, 1994).

The test-retest reliability of the RFFT was demonstrated using one-third (N = 95) of the original normative sample who were retested following a six month interval (Ruff, Light & Evans, 1987). On initial testing, this subgroup generated an average of 100.6 designs (sd = 21.8) while on retesting the group averaged 108.6 designs (sd = 22.0). The correlation coefficient was .76. On the other hand, perseveration scores were found to differ only slightly from the first to second administration; however, a greater degree of variability (i.e., less stable scores) was observed on retesting (initial: 6.53, sd = 5.8; second: 7.76, sd = 4.8). This pattern resulted in a correlational coefficient of .36.

The RFFT has been factor analyzed to assess its validity as a measure of planning, initiation, and divergent reasoning (Baser & Ruff, 1987). Baser and Ruff (1987) explored the factor structure of the RFFT in a group of normal subjects and in a head-injured population. Their analysis revealed that total unique designs loaded moderately on two factors including initiation and complex intelligence. In addition, the ratio of errors to unique designs loaded on a planning factor. Similar factors emerged for both samples with the exception that the RFFT failed to reveal a complex intelligence factor in the clinical sample; however, a planning flexibility factor did emerge instead.

The Wisconsin Card Sorting Test (WCST; Grant & Berg, 1948; Heaton, 1981). This test involves "working memory" and the ability to adapt behavior based on performance feedback (Lezak, 1983). The WCST is considered to be one of the most useful measures of executive function integrity and recently, the performance on the test was found to correlate with increased regional cerebral blood flow (i.e., a neuroimaging technique) in the dorsolateral and medial prefrontal cortex (Marenco, Coppola, Daniel, Zigun & Weinberger, 1993).

In the WCST, the subject is provided with a deck of sixty-four cards on which are printed one to four symbols (e.g., triangle, star, cross, circle) in various colors (e.g., red, green, yellow, blue). No two cards in the deck are identical. The subject's task is to place them one by one under four stimulus cards (i.e., one red triangle, two green stars, three yellow crosses, and four blue circles) according to a principle that the subject must infer from the pattern of the examiner's response to the subject's placement of the cards. After a series of ten consecutive correct responses, the examiner shifts the sorting principle, indicating the shift only in the changed pattern of his/her "right" and "wrong" statements to the subject. The test continues until the subject has made six runs of ten correct placements or gone through two decks of sixty-four cards each. Relevant measures of executive functioning include the number of categories completed, the number of perseverative responses and errors as well as the number of "failures to maintain set." This measure has been associated with declines in normal aging after the age of 60-70 years (Daigneault et al., 1992; Haaland, Vranes, Goodwin & Garry, 1987; Whelihan & Lesher, 1985).

In establishing the reliability of the WCST, Heaton and his colleagues (Heaton, Chelune, Talley, Kay & Curtiss, 1993) employed generalizability coefficients rather than reliability coefficients. Generalizability coefficients reflect how well the instrument measures a subject's true score whereas traditional reliability coefficients might focus on the similarity of test-item content. In a sample of 46 children and adolescents who were administered the WCST on two separate occasions (i.e., approximately one month apart), the average generalizability coefficient fell at .57 (range = .39-.72). This suggests that the WCST has good scale reliability as a measure of executive function.

This instrument has been studied in a wide variety of clinical populations including seizure disorder, multiple sclerosis, Parkinson's disease, brain lesions of other etiologies, and schizophrenia. In each case, impaired performance has been found relative to normal control subjects (Heaton et al., 1993), thus supporting the WCST's validity as a measure of executive functioning. Furthermore, physiological studies of WCST performance indicate that this measure is sensitive to executive functioning in particular. Recent regional cerebral blood flow investigations have found that blood flow increases during the WCST to the right anterior dorsolateral prefrontal cortex as well a the medial prefrontal cortex (Marenco et al., 1993). In another investigation, a SPECT analysis of regional cerebral blood flow was found to increase during WCST performance for both neuroleptic-treated schizophrenic patients and healthy controls to the left lateral prefrontal region (Kawasaki, Yoshiki, Michio, & Katsumi, 1993). It should be noted that some authorities question the validity of the WCST as a measure of frontal lobe function (Reitan, 1993; Axelrod, Goldman, Heaton, Curtiss, Thompson, Chelune, & Kay, 1996).

Trails B. Trails B is a test of visual conceptual and visuomotor tracking which is considered to be sensitive to the effects of frontal lobe integrity (Uchiyama et al., 1994) since it requires that the subject be able to shift mental sets. It has been described as a measure of visual search, attention, mental flexibility, and motor function (Spreen & Strauss, 1991). The subject is instructed to draw lines which connect consecutively numbered and lettered circles on a work sheet by alternating between the two sequences. Subjects are encouraged to complete the test "as fast as you can."

Lezak (1983) reported a moderate reliability coefficient of concordance of .67 for Trails B and found that practice effects were not noted over the course of three administrations (i.e., at six month intervals). In addition, Snow, Tierney, Zorzitto, Fisher, and Reid (1988) in a sample of 100 elderly subjects reported a one-year retest reliability of .72 for Trails B. Similarly, Goldstein and Watson (1989) found reliability coefficients of .66-.86 for various neurological groups and .63 for schizophrenics.

A factor analysis of Trails B found the instrument to load on both "rapid visual search" and a "visuospatial sequencing" factors (desRosiers & Kavanagh, 1987). Construct validity for visual search has been established by correlating performance on Trails B with an object finding test and a hidden pattern test obtained for aphasic and nonaphasic individuals (N = 92, correlations ranging from .36 to .93; Ehrenstein, Heister & Cohen, 1982). In addition, Alekoumbides, Charter, Adkins and Seacat (1987) reported significant differences on Trails B between normal control subjects and three clinical groups (i.e., Korsakoff's syndrome, diffuse lesions, and focal lesions) with respect to correct classification rates. As further evidence of the measures validity as a neuropsychological instrument, several authors have found Trails B to be highly sensitive to brain damage (desRosiers & Kavanagh, 1987; Dodrill, 1978; O'Donnell, 1983).

Experimental Measures of Potential Moderating Variables

Several additional measures will be included in the neuropsychological test battery to assess potential factors which might contribute to final outcomes. These include intellectual functioning, attention, depression, and mental status. Measures for each will be briefly described here.

The American Version of the Nelson Adult Reading Test. Intellectual functioning was assessed using the American Version of the Nelson Adult Reading Test (AMNART; Nelson & O'Connell, 1978). The AMNART is a test of the ability to pronounce a list of fifty phonetically irregular words. Measures of verbal ability are considered to be the best predictor of intellectual levels since vocabulary correlates best with overall ability level and tends to resist the effects of brain impairment more than any other intellectual capacity (Lezak, 1983). The AMNART authors developed regression-based formulas which estimated concurrent scores on intellectual measures such as the Wechsler Adult Intelligence Scale-Revised (WAIS-R). AMNART scores have been found to correlate fairly well with obtained WAIS-R Full Scale IQ scores in older individuals ($r = .70$; Berry, Carpenter, Campbell, Schmitt, Helton & Lipke-Molby, 1994).

The AMNART is considered to have high internal and test-retest reliability and does provide a better estimate of WAIS-R IQ than Vocabulary subtest scores (Crawford, 1992). Furthermore, Blair and Spreen (1989) reported a coefficient alpha (i.e., a measure of internal consistency) of .94. In this same normative sample, correlations between actual WAIS-R VIQ, PIQ, and FSIQ, and predicted IQs on the basis of AMNART scores were .83, .40, and .75, respectively (Blair & Spreen, 1989). From this data, it appears that the AMNART is a good predictor of VIQ and FSIQ, but is a relatively poor predictor of PIQ. Other authors report that deterioration in reading performance does occur with cerebral dysfunction and the AMNART is, therefore, best regarded as providing an estimate of the lower level of premorbid functioning (Stebbins, Giley, Wilson, Bernard & Fox, 1990).

Wechsler Adult Intelligence Scale-Revised Digit Span Subtest. WAIS-R Digit Span (Wechsler, 1981) is considered to be a test of short-term auditory memory and attention/concentration (Spreen & Strauss, 1991). Digit Span requires the subject to recall and repeat auditory information in a proper sequence. The task consists of two parts: Digits Forward requires the subject to repeat sequences of 3-9 digits while Digits Backwards sequences are 2-8 numbers long and the subject must say them in the reverse order.

Digit Span is considered to load heavily on a "memory/freedom from distractibility" factor (Kaufman, 1979; Sattler, 1988; Spruill, 1984). This measure is also considered to be one of the most sensitive tests to brain damage, mental retardation, and learning disabilities (Mishra, Ferguson & King, 1985). In addition, Wielkiewicz (1990) has suggested that the factor which this task measures may reflect executive and short-term memory processes including monitoring and evaluating task performance.

Beck Depression Inventory and the Geriatric Depression Scale. Two self-report measures of depression were completed by the subjects including the Beck Depression Inventory (BDI; Beck, 1987) and the Geriatric Depression Scale (GDS; Yesavage, Brink, Rose, Lum, Huang, Adey & Leirer, 1983). While both measures assess the general construct of depression, the BDI is considered to be more sensitive to somatic correlates of dysphoric mood while the GDS is considered to more sensitive to the behavioral and cognitive symptoms of depression. Individuals scoring greater than 20 on either of these measures were excluded from the current analyses.

The test-retest reliability of the BDI in a sample of 38 patients was found to be greater than .90 (Beck, 1970). In addition, Spearman-Brown reliability has been demonstrated to fall at a level of .93 and internal consistency for test items at .86 (Reynolds & Gould, 1981). With regard to validity, the BDI has been show to yield concurrent validity coefficients of .38-.50 with Lubin's Depression Adjective Checklist for psychiatric patients and .66 in normal control subjects; and .79 in psychiatric patients and .54 in college students for the Zung Self-Rating Depression scale (Kerner & Jacobs, 1983).

Mini-Mental Status Examination. The Mini-Mental Status Examination (MMSE; Folstein, Folstein & McHugh, 1975) was designed to test cognitive functions in an efficient and accurate manner. This measure is useful in providing gross estimates of cognitive functioning (Spreen & Strauss, 1991). The test is comprised of eleven questions and concentrates on cognitive aspects of mental functions, and specifically excludes questions regarding mood, abnormal mental experiences and the form of thinking.

Reliability and validity were established in the original standardization sample (Folstein et al., 1975). Test-retest reliability coefficients were found to fall at .89 for a 24 hour retest administration by a single examiner and .83 when separate examiners readministered the test. A 28 day retest of elderly depressed and demented subjects yielded a correlation of .98. With a maximum obtainable score of 30, the elderly control subjects and younger patients with functional psychiatric disorders achieved scores in the 25 to 28 range. Scores of several groups of senile patients ranged form 9.6 to 12.2. No overlap between the aged control subjects and the senile patients was observed. For purposes of the present study, no subject scoring less than 24 on the MMSE was included in the analyses.

Procedure. Controlling for the use of external mnemonic devices addresses the first requirement outlined by Kvavilashvili (1992) for the experimental study of remembering intentions. Besides the necessity of monitoring the employment of assisted memory strategies (Maylor, 1993), the experimenter can also ensure that all subjects are exposed to a standardized set of procedures and activities during the interval between the formation of an intention and its completion at a later point in time. Secondly, Kvavilashvili (1992) suggested that experiments in remembering intentions must minimize the chances that an intention will be remembered without undermining the possibility that the intention will be carried out. In the present investigation, subjects were provided with a timer so they could monitor and complete the action at the requested time; however, the intervening period was filled with other neuropsychological measures (none of which had a prospective component) to simulate everyday memory situations (i.e., other activities filling time before an action needs to be completed). In this way, activities during the interval were consistent across subjects and ceiling effects could be avoided (Kvavilashvili, 1992; Maylor, 1993). Ceiling effects were also avoided in this study by employing a number of items of prospective memory, some of which were considered to be more difficult since they rely entirely on self-initiated execution by the subject. In addition, all subjects were assumed to have the same level of motivation since each had responded to a newspaper ad in order to participate in the project. Lastly, the experimental procedure was considered to be ecologically valid given that prospective memory items were representative of real-life situations; although, nuances of everyday functioning cannot entirely be reproduced in the laboratory and to this extent, prospective memory items were considered to be artificial.

The current investigation was part of a larger project assessing memory and mood in the elderly. Incentive was provided by offering subjects the opportunity to participate in workshops aimed at enhancing memory functioning through training in specific memory strategies. This intervention component was the focus of Experiment Two. Interested subjects were initially contacted by phone during which the purpose of the investigation was explained and assignment to an intervention group was determined. For the purposes of Experiment One, subjects were asked to participate in an approximately 2.5 hour pre-testing session in which they completed the experimental measures described above. Informed consent was obtained and subjects were provided with a copy. Subjects then spent approximately one-half hour in a group setting completing self-report measures. Following these initial steps, subjects were then individually assigned to an experimenter who was an advanced clinical psychology student in the Ph.D. program at Michigan State University. Examiners were trained by peers who observed the administration of each test in the battery. The tests were administered in a standardized order so that each subject was exposed to the same activities during delay periods. Breaks were offered to subjects as needed.

Subjects were provided with a timer placed in front of them on the testing surface so that they could monitor delay periods for self-timed prospective memory tasks. Additional testing materials were provided for subjects as needed (i.e., pencil and paper). At the end of the PROMS, subjects were provided with an addressed and stamped postcard to be mailed the next day in order to obtain a 24 hour measure of prospective memory. The use of external memory aids for this task was not controlled for; however, the completion of the task does contribute to an overall prospective memory score. Subjects were contacted at a later date by the examiner to provide them with feedback regarding their performance on assessment measures. Feedback was general so as not to confound post-testing.

RESULTS: EXPERIMENT ONE

Statement of Hypotheses and Statistical Analysis. The present investigation sought to determine if prospective memory decreases across the life span. In fact, an age-associated decline in prospective memory was observed ($\underline{r} = -.29$, $\underline{p} < .01$). This study then addressed three related questions with regard to prospective memory and aging.

Hypothesis 1A. The first hypothesis focused on whether or not prospective memory performance would be affected by subject performance on retrospective measures. Results confirmed that retrospective memory performance accounted for a significant portion of the variance in prospective memory performance above and beyond the variance accounted for by age. Zero order correlations are listed in Table 1A. As expected, age and retrospective memory were significantly correlated with prospective memory performance.

The major question was whether or not retrospective memory would account for the variance in prospective memory performance above and beyond that accounted for by age. Age and retrospective memory (i.e., CVLT raw score) were entered into a hierarchical regression equation to determine if prospective memory performance (e.g., RBMT, PROMS) declined as a function of these variables. In the first step, Age was used to predict Prospective Memory. Consonant with the significant correlation, Age predicted 9% of the variance in Prospective Memory performance ($R^2 = .09$, $\underline{F}\,(1, 111) = 10.50$, $\underline{p} < .01$). In the second step, Retrospective Memory was added to the equation. By adding Retrospective Memory, the equation then was able to predict 20% of the variance in

Prospective Memory performance, which was a significant increase (difference F (1, 110) $= 15.25$, $p < .05$). These results suggest that Retrospective Memory performance provided additional information above and beyond the effects observed for Age alone in predicting Prospective Memory performance.

Hypothesis 1B. The next objective of the study was determine if measures of executive functioning would account for the observed performance in prospective memory beyond the effects of a set of proposed control variables including age, attention (e.g., total Digit Span score) and retrospective memory. The hypothesis that executive functions contribute to successful prospective memory performance above and beyond the control variables was confirmed; however, only one of the four executive function measures contributed significantly to prospective memory performance.

All of the control variables correlated with the outcome. Specifically, the correlations amongst the variables revealed Age, Attention and Retrospective Memory were significantly correlated with Prospective Memory. Executive Function variables included total number of categories on the WCST, Failure to Maintain Set on the WCST, total number of designs on the RFFT, and Trails B. With the exception of Failure to Maintain Set on the WCST, all of the Executive Function variables correlated with Prospective Memory (refer to Table 1B). The Failure to Maintain Set variable was not retained in subsequent analyses as the nonsignificant correlation was considered sufficient indication that it did not *contribute* to Prospective Memory performance. The correlations amongst the variables are presented in Table 1B.

A hierarchical regression was employed to determine if the addition of performance on measures of Executive Functioning improved prediction of Prospective Memory performance beyond that afforded to the contribution of Age, Attention and Retrospective Memory. In the first step, the three covariates were used to predict Prospective Memory Performance. The three variables combined (i.e., Age, Attention, and Retrospective) predicted 21% of the variance ($R^2 = .21$, $F\ (3, 102) = 9.09$, $p < .01$). It should be noted that the majority of this effect was attributable to Retrospective Memory (beta = .07, $t = 3.42$, $p < .01$) as both of the beta weights for Age and Attention were nonsignificant (Age beta = -.05, $t = -1.67$, n.s.; Attention beta = .06, $t = .87$, n.s.). Again, the latter two variables were retained for the analysis given that the theoretical question was whether the predictors would explain variance above and beyond all three covariates.

In the second step, three Executive Functioning variables were added to the control variables in predicting Prospective Memory performance. The full model including all three Executive Functioning variables (i.e., WCST Categories, RFFT Number of Designs, and Trails B) and all three control variables (i.e., Age, Attention, and Retrospective Memory) accounted for 28% of the variance in Prospective Memory performance ($R^2 = .28$, $F\ (6, 99) = 6.31$, $p < .001$). Most importantly, the increase in R^2 over the control variable model was significant (difference $F\ (3, 99) = 3.00$, $p < .05$), suggesting that Executive Functioning abilities contributed significantly to Prospective Memory performance above and beyond that accounted for by the three control variables.

Given the established reliability and validity of the Wisconsin Card Sort, it seemed possible that the additional Executive Functioning (e.g., RFFT Number of Designs and

Trails B) variables could simply be redundant with the Wisconsin Card Sort Test. Therefore, it was important to establish whether or not the Wisconsin Card Sort alone explained the variance in the Prospective Memory performance beyond the control variables (i.e., Age, Attention, and Retrospective Memory) and, if not, determine which additional Executive Functioning variables explained variance above and beyond that accounted for by the Wisconsin Card Sort. The decision to enter the WCST first in the hierarchical regression was made in a post-hoc manner. The WCST did not explain a significant portion of the variance above and beyond the control variables (difference F (1, 101) = 2.85, $p < .10$). Given that there were no theoretical expectations about which of the remaining two Executive Functioning variables were most important, they were entered together into a regression equation including all variables. The beta weights were then considered to determine which of the remaining Executive Functioning variables contributed a significant and unique portion to the variance in Prospective Memory performance after controlling for all the other variables in the equation. The total number of designs on the Ruff Figural Fluency Test did produce a significant beta weight (beta = .04, $t = 2.42$, $p < .05$); however, the other measure, Trails B, was not significant. In addition, the beta weight for the WCST in the full model was nonsignificant. The results of these analyses suggest that Executive Functions do explain variance in Prospective Memory performance above and beyond the effects of Age, Attention, and Retrospective Memory. Specifically, the Ruff Figural Fluency is related to Prospective Memory performance after controlling for the effects of Age, Attention, and Retrospective Memory. The WCST Number of Categories and Trails B, on the other hand, were correlated with Prospective Memory performance but these correlations were largely redundant with the information provided by the other Executive Function variable (i.e., RFFT). And finally, the Failure to Maintain Set variable was not significantly correlated with Prospective Memory performance and therefore, did not add any useful information to understanding the variance.

Hypothesis Two. A second objective of the current investigation was to explore the effect of cued and uncued performance on prospective memory. In other words, this study attempted to determine if the use of external memory aids would enhance prospective memory performance. Furthermore, prospective memory items were also divided according to the length of the interval between the request and the execution of the intention to determine if indeed, this type of memory is susceptible to the interference effects described in connection with executive functioning. Therefore, it was hypothesized that older individuals would perform poorest on uncued prospective memory tasks initiated after the longest time interval (i.e., 20 minutes). This hypothesis was confirmed in a significant interaction between the variables of Cue and Time and a separate main effect for the Age variable; however, a three way interaction between the variables of Age, Cue, and Time was not observed.

To accommodate the specific statistical properties of this analysis including repeated measurements of both categorical (e.g., binary outcomes; performed the prospective memory task or not) and continuous (i.e., age) variables, a Generalized Estimating Equation (GEE; Stokes, Davis & Koch, 1995) was used. Solving the GEE is the same as fitting the usual regression models for independent data by treating the correlations among a subject's observations over time as a nuisance variable and partialling this factor out. Cue (cued vs. uncued), Time (10 minutes vs. 20 minutes), and Age were entered into the GEE. The analyses did not reveal a significant three-way interaction among the variables. The two-way interactions among the variables were then investigated and these variables converged after six iterations. The Cue x Time interaction term was meaningful (β = -1.90, p = .00) suggesting that uncued tasks requiring greater self-initiation and longer intervals leading to more interference effects contribute to poorer performance on prospective memory. The solved generalized estimating equation is depicted in Table 2 and in Figure 1 which show that the effect of Cue decreases across time. In addition, the analyses revealed a main effect for Age (β = -.04; p = .02); however, this variable did not interact with either Cue or Time. These results suggest that age does effect prospective memory performance (i.e., as age increases, prospective memory performance declines) but it does so regardless of the effects of cueing or time interval.

Hypothesis Three. A third objective of the current study was to explore the relationship between prospective memory performance and self-assessment of these abilities on a metamemory questionnaire (i.e., The Memory Assessment Clinic Self-Report Scale, MAC-S; Crook & Larrabee, 1990). A review of the literature suggested that individuals typically rate themselves as performing well in situations which involve intention memory (Cohen & Faulkner, 1984; Martin, 1986). However, self-reports of memory failures were considered to be diminished due to the effective use of memory aids in everyday life (e.g., calendars, lists). Little has been done to link self-reported prospective memory to actual performance. Therefore, it was hypothesized that when older individuals rated themselves as high on prospective memory performance that such ratings would be negatively correlated with time-based (i.e., self-initiated, unaided) prospective memory tasks only. This hypothesis was also confirmed in that a relationship did not emerge between subjective reports of prospective memory ability and actual performance on measures of prospective memory.

First, an inter-item reliability check, using Cronbach's (1951) alpha, was conducted to determine if adequate reliability existed to justify combining thirteen items from the MAC-S which reflected subject's self-report of their prospective memory capabilities. These thirteen items are listed in Appendix C. Analysis revealed an internal consistency coefficient (alpha = .84) which suggested that there was adequate reliability to support combining this series of items from the MAC-S into a prospective memory factor.

As with the previous analysis, a Generalized Estimating Equation (GEE) was also appropriate for this analysis given that it involved repeated measures data as well as categorical (cued vs. uncued) and continuous (age and self-report of prospective memory abilities) variables. To analyze the hypothesis regarding the relationship between self-report of prospective memory and actual performance on cued/uncued prospective memory tasks, Self-report, Cue, and Age were entered into the GEE. The analyses did not reveal significant findings for either the three-way or the two-way interaction terms. Main effects were then investigated and the variables converged after nine iterations. As with the previous analysis, a main effect for Age emerged ($\beta = -.05$; $\underline{p} = .02$). In addition, results revealed a main effect for Cue ($\beta = .88$; $\underline{p} = .00$) but no main effect for Self-

Report. These results suggest that a relationship does not exist between self-assessment of prospective memory capability and actual performance on cued and uncued prospective memory performance.

METHOD AND RESULTS: EXPERIMENT TWO

The purpose of the second experiment was to determine if subjects would show improvements in prospective memory function after participating in an intervention designed to enhance their memory capabilities by providing training in specific memory strategies. It is rarely sufficient to say that age-associated cognitive decline exists in the elderly without offering potential efforts at remediation. Much clinical and experimental literature has been generated with regard to memory assessment of the elderly, whereas limited resources have been allocated for treating assessed deficits. One reason is the lack of developed programs with proven efficacy. Much of the available information on the remediation of prospective memory deficits is anecdotal and relies on the use of such common sense strategies as making lists or using a diary to record activities (Cockburn, 1996). Additionally, limited treatment availability is based on the assumption that underlying organicity is irreversible. However, the sparse available research suggests that when targeted, documented declines can be improved through individualized training sessions (Perlmutter, 1978; Schaie & Willis, 1986; Weingartner, Cohen, Murphy, Martello & Gerdt, 1981).

For example, Schaie and Willis (1986) found that individual training sessions can reverse documented declines (e.g., over a 14 year period) in the areas of inductive reasoning and spatial orientation. Training was offered to both those who had remained stable and those who had displayed cognitive decline. While both groups improved, the most significant gains were in those who had experienced decline (i.e., 39% and 55%

improvement, respectively, for the spatial-orientation training). Based on findings such as these, the area of cognitive rehabilitation is rapidly expanding.

Sohlberg and Mateer (1993) recently developed a training program for individuals with head injuries that was specifically designed to improve prospective memory dysfunction and alleviate impaired adjustment in everyday living. Initial results have been very promising (Sohlberg, White, Evans & Mateer, 1992). In addition, a host of alternative treatments have been developed which focus on the remediation of executive control deficits (Sohlberg, Mateer & Stuss, 1993) which have been shown to impair memory functions in various dimensions (Luria, 1973; Stuss & Benson, 1986) outlined in the literature review above.

Participants. A power analysis conducted prior to the experiment using the method outlined by Cohen (1992) suggests that for a medium effect size ($\alpha = .05$), 67 subjects would be needed to obtain statistical power equal to .80. Of the 115 subjects who participated in Experiment One, 68 completed a seven session workshop designed to teach cognitive strategies and relaxation in order to improve memory functioning and alleviate mood symptomatology (e.g., anxiety, depression) which potentially contributed to memory difficulties. Those participants who completed the memory workshops ranged in age from 55 to 81 years ($\bar{x} = 67.37$; SD = 7.39). Of the 68 participants to complete the curriculum, 41 were female and 27 were male. The group had a mean education of 15.16 years (SD = 2.74). Thirty-eight were randomly assigned to a group intervention which employed ecologically valid stimuli while the remaining 30 participated in a group which utilized lab-generated stimuli.

Of course, attrition was expected from pre- to post-testing; consequently, an analysis of various demographic variables was conducted to determine if noncompleters differed in any way from completers. Forty-seven individuals or 41% of the sample dropped out of the study prior to participating in the workshop. Seven of these individuals attended all seven sessions, but did not complete post-testing. Four attended between one and four sessions and the remaining thirty-six did not attend any sessions. Thirteen dropped out after being assigned to the Everyday Group, 15 were assigned to the Lab Group, and 19 dropped out before they were assigned to either of the two intervention groups. Of the noncompleters, 16 were male and 31 were female. The mean age of those who dropped out was 68.30 years ($\underline{SD}$ = 8.05) and the mean education level was 15.15 years ($\underline{SD}$ = 3.01). A series of independent samples t-tests between the two groups on a number of variables indicated that completers did not differ significantly from noncompleters. Analyzed variables included age, education, and performance on measures of estimated intelligence and mental status. The analysis of these latter measures suggests that those subjects who remained in the group did not have significantly different cognitive capacities (i.e., greater or lesser) than those subjects who chose not to receive the intervention.

Experimental Measures. The same measures were employed for Experiment Two. Alternate forms of the RBMT were available and used during post-testing. The identical prospective memory items were utilized during both testing sessions for the RBMT and the PROMS. Items from these two measures were combined to form a single measure of prospective memory performance. Practice effects may have occurred to the extent that subjects were aware of the experimental demands of these measures; however, specific prospective memory tasks are often repeated in activities of daily living (e.g., remembering to attend a regular appointment) in analogous or very similar form. Therefore, using the same items from pre- to post-assessment was not considered to be an artificial representation of everyday memory.

Procedure. Following pre-assessment, subjects participated in a seven session training group which was designed to enhance memory. Subjects received information on several memory strategies including strategies for remembering discrete pieces of information (e.g., lists), text material, and names. The use of mental imagery and the value of using internal memory strategies in combination or in lieu of external memory strategies was communicated throughout the curriculum. Furthermore, subjects were given information on how to improve attention and concentration skills and on how mood related symptomatology might affect memory performance. In addition to the educative component, participants were guided through a relaxation and mental imagery exercise during each session to facilitate the development of these abilities as well as emphasize the importance of relaxation as a means of improving memory capabilities. Group attendance was monitored and subject feedback was obtained to evaluate participant perspectives of the intervention. Post-testing, as described above, followed delivery of the memory enhancement curriculum and subjects were again given feedback about their performance.

Two distinct memory enhancement workshops were offered. While the information and strategies taught in each group remained consistent, they differed in whether teaching examples and homework assignments employed ecologically-valid (e.g., grocery lists, newspaper articles) or laboratory-generated (e.g., random lists of words, stories from a text recall task) stimuli. Groups were conducted by advanced clinical psychology students in the Ph.D. program at Michigan State University. Each group leader was trained by a peer and observed four sessions conducted by an experienced group leader. This same group of experimenters conducted the post-assessment once the intervention was completed.

Statement of Hypotheses and Statistical Analysis. For the purposes of Experiment Two, it was hypothesized that subjects would improve in prospective memory after participating in an intervention designed to build memory skills. Due to this educative component and focus on memory building, subjects would become more focused on their individual memory skills (i.e., enhanced metamemory), rely to a greater extent on internally generated memory processes, and have more available memory strategies in problem solving situations. It was hypothesized that improvements would be greater for older individuals participating in the group whose content was ecologically valid as opposed to laboratory generated. Results revealed a significant improvement in prospective memory performance from pre- to post-testing; however, no differences were observed in the Group (Everyday vs. Lab) condition.

A repeated measures ANOVA was conducted in order to determine if differences on prospective memory performance from pre- to post-testing (Time) were present and to determine the significance of group assignment (Everyday vs. Lab) intervention. In this instance, Time served as a within subject factor, while Group Assignment served as a between subjects independent variable. Analyses did not reveal a Time by Group interaction or a main effect for the Group intervention. However, analyses did reveal that Prospective Memory performance did improve from pre- to post-testing (F (1,65) = 10.05, $p < .01$). Given the lack of an appropriate control group, it is difficult to say if it was the group intervention or the demand characteristics of the testing situation which accounted for the improvement in prospective memory performance; however, it is apparent from these data that declines in prospective memory capacity are reversible in the able elderly. Means and standard deviations for prospective memory performance at pre- and post-testing and for each of the two groups are presented in Table 3.

DISCUSSION

Age and Prospective Memory. Results in this study revealed a significant negative relationship between prospective memory and age. The aging and memory literature has definitively demonstrated that memory declines with age (Light, 1991); however, these age-related deficits are likely to be larger on some tasks than others. Craik (1986) theorized that older individuals have greater difficulty on self-initiated memory tasks and that prospective memory relies extensively on self-initiated retrieval processes. It has further been hypothesized that older individuals have fewer attention resources (Salthouse, 1991) and working memory capacities (Moscovitch & Winocur, 1992) to devote to the dual task requirements necessary in prospective memory tasks (i.e., carrying out other activities while needing to remember to perform a future action). In addition, the cognition literature has demonstrated that older individuals are also prone to make other types of errors which might lead to prospective memory failures. These include both errors in *reality monitoring* (i.e., mistaking the memory of the intention for the action itself; Johnson & Raye, 1981) and in *output monitoring* (i.e., remembering that a planned action has already been performed so as not to repeat it; Koriat, Ben-Zur, & Sheffer, 1988). These cognitive failures could potentially lead to both errors of omission and commission, respectively, in carrying out a future intention.

Despite these potential changes in cognitive processing in the elderly, it should be noted that the elderly possess other information processing capacities which might contribute to successful prospective memory performance. For example, the accumulation of experience often results in an awareness of one's errors and the subsequent development of compensatory strategies and environmental/cognitive support systems (Salthouse, 1990; Backman, 1989) to overcome possible deficits in ability.

The Impact of Retrospective Memory on Prospective Memory Performance. Several studies have failed to find correlations between performance on retrospective and prospective memory tasks (Einstein & McDaniel, 1990; Huppert & Beardsall, ,1993; Maylor, 1990) suggesting that the processes involved in the two types of tasks are different. On the other hand, the construct of prospective memory as a distinct entity has been criticized as entailing little more than retrospective memory capabilities. The present analyses revealed that retrospective memory is a necessary component of prospective memory performance, but is not entirely sufficient for successful completion of prospective memory tasks. The results of this investigation revealed a significant positive correlation between prospective memory and retrospective memory performance. In addition, the results indicated that retrospective memory accounted for a substantial portion of the variance in prospective memory performance above and beyond that accounted for by age. These data support the supposition that prospective memory tasks, at least to some degree, rely on retrospective memory capabilities. Specifically, one cannot carry out an intention in the future without remembering the content of that intention (the retrospective component). For example, Einstein and colleagues (Einstein, Holland, McDaniel, & Guynn, 1992) found that when prospective memory performance was made dependent on retrospective memory for the target events, an age deficit disappeared. In other words, age-related differences for the prospective memory tasks were attributed to poorer retrospective memory for the target events.

The present results suggest that retrospective memory ability is an important component of prospective memory but certainly does not account fully for the variance associated with intention memory tasks. Both types of memory were important in the present sample for functioning adequately. The contrast between the two is often thought of as memory for intention (e.g., remembering to pass a message onto a friend, remembering to pay a bill or take one's medication) versus memory for content (e.g., recalling a list of words previously learned, recalling the state capitols). Some have suggested that prospective memory tasks may be encoded more elaborately than to-be-recalled tasks. For example, prospective memory tasks, since they have different retrieval requirements than their retrospective memory counterpart (i.e., subjects need to "remember to remember" on their own), may be held in a state of heightened activation to keep them accessible for potential use (Glisky, 1996). The two types of tasks also differ in the attention which is allocated for retrieval. Usually during retrospective memory recall, full attention can be allocated to the task while in prospective memory, recall occurs while other activities are occurring simultaneously. In addition, retrospective memory is usually elicited by an external prompt, while in prospective memory retrieval is begun when a flow of thoughts of the prospective memory task interrupts ongoing activities and comes to mind (i.e., prospective memory retrieval occurs as a result of time and context monitoring). For example, a teacher can prompt students to remember the content of a seminar, but they cannot rely on this type of prompting when needing to return a library book or attend an appointment. The former is a direct type of remembering that involves consciously controlled processes while the latter type of remembering is more spontaneous and arises into consciousness involuntarily (Ste-Marie & Jacoby, 1993).

Furthermore, some authors have suggested that prospective memory and retrospective memory may rely on different encoding and storage processes which effect subsequent retrieval requirements. For example, Koriat, Ben-Zur and Nussbaum (1990) theorized that encoding and rehearsal for prospective memory tasks relies on an internal visualization process (i.e., an enactment of the task) to create a multimodal representation (i.e., visual and motor code in addition to verbal coding) which makes it more likely that the memory representation will be activated during retrieval conditions. As will be demonstrated in the next section, prospective memory is a multidimensional cognitive process which is "more than memory" and may be distinguished from retrospective memory by its reliance on executive functions and the integrity of the frontal lobes (Glisky, 1996).

The Impact of Executive Functioning on Prospective Memory Performance. Prospective memory requires such skills such as planning, organizing, and self-initiation that may not be present in various types of retrospective memory searches. For instance, demands on the executive functions of the frontal lobes are likely to be present "when demands on working memory are considerable, when preliminary planning is necessary, when tasks are not routine, when temporal tracking or time estimation is required, when ongoing behaviors have to be interrupted and when environmental or contextual stimuli need to be monitored" (Glisky, 1996, p. 258). Many prospective memory tasks require these executive skills.

In the present study, the entire group of executive function measures contributed a substantial portion to the variance associated with prospective memory beyond the effects associated with the other variables of age, attention, and retrospective memory. This analysis was considered to be a conservative measure of the contribution of executive functions given that the control variables already accounted for a significant portion of variance in prospective memory. However, not all of the measures included in the regression equation contributed significantly in predicting prospective memory performance. Executive function measures which assessed the ability to shift and maintain a mental set (i.e., WCST Total Number of Categories and Failure to Maintain Set) or the ability for visuospatial sequencing and mental flexibility (i.e., Trails B) did not predict successful prospective memory performance despite being significantly correlated with the outcome variable. Indeed, the only executive function measure which contributed significantly to the variance in prospective memory was a measure of visuospatial creativity, speed of productivity and the ability to monitor ongoing activity. In addition, this executive function measure has been shown to load heavily on an "initiation" factor (Baser & Ruff, 1987). In the Ruff Figural Fluency Task, monitoring is an important component as subjects are instructed to produce "as many designs as possible that are all different." Therefore, subjects must "monitor" what designs have already been produced (background activity) while creating new designs (foreground activity). This measure of executive function is similar to what is required during prospective memory tasks in which other activities are being carried out during the interval prior to the completion of the intention.

The monitoring component appears to be a central feature in completing prospective memory tasks successfully. This process of monitoring can also be thought of as "behavioral inhibition" in that the effects of other competing, distracting processes over a delay period must be ignored and a task must be avoided until a certain time interval has passed. Studies have shown that the prefrontal cortex is implicated in these types of working memory tasks (Cohen & O'Reilly, 1996) given that they require delayed responses to stimuli as well as inhibition of competing information (Stuss, Eskes, & Foster, 1994).

Dobbs and Reeves (1996) have identified monitoring as one of a number of prospective memory components necessary in the completing these types of tasks. These authors also differentiated between monitoring behaviors (i.e., implicit and explicit checking to determine if the appropriate circumstances to act are present) and monitoring accuracy (i.e., knowing when to respond regardless of whether or not one can remember the content of the intended action or whether they wish to comply with the task demands). Harris and Wilkins (1982) proposed a test-wait-test-exit model to explain monitoring behavior during a prospective memory task. While waiting to perform a future action, a person must check to see if the critical period for carrying out the intention has arrived. If not, the person continues to wait; however, if the critical period has arrived a person must "exit" the waiting period and perform the activity. Some studies have specifically considered external indicators of monitoring behavior and their influence on successful task completion. Ceci and Bronfenbrenner (1985) have observed how individuals check time on a clock and found that subjects used both linear and U-shaped patterns of checking, the latter being more efficient. Similarly, Einstein and McDaniel (1996) have observed that clock-checking increases in the one minute preceding the completion of the prospective memory task and that monitoring frequency was strongly correlated with successful memory performance.

Therefore, the present results would seem to suggest that the cognitive requirements of planning and monitoring are unique aspects of prospective memory which differentiate it from its retrospective counterpart. This set of data supports current theoretical explanations of the construct of prospective memory (Craik & Kerr, 1996). In addition, Biasiacchi (1996) discusses the role of prefrontal cognitive capacities and prospective memory. He refers to the executive functions of planning as a type of temporal organization which entails going over potential actions as well as evaluating and selecting the optimal strategy and optimal order in which to execute them in the prospective memory task. In addition, he indicates that planning also involves a control mechanism which entails switching between different actions and permitting the inhibition of one task in favor of another. This would entail switching between two or more different tasks or responses (i.e., cognitive flexibility).

Why the present investigation did not find measures of cognitive flexibility to significantly predict prospective memory performance remains open to question. One possibility is that event-based and time-based prospective memory tasks were combined and the role of executive functions in these two types of tasks were not considered separately. One might assume that time-based tasks require a greater degree of monitoring than event based tasks. For event-based tasks, subjects would not have to engage in switching mental sets between monitoring the clock and engaging in the current activity given their only requirement was to wait for an environmental cue to initiate the prospective memory task. Another possibility to explain the apparent lack of influence of cognitive flexibility on prospective memory tasks may be that it is redundant with the predictive information provided by the attention factor in the regression equation. The attentional requirements of the other ongoing activities during the retention intervals were not specifically assessed in this study. These conditions were held constant for all participants, but a more careful exploration of the role of monitoring in foreground and background tasks can be a fruitful area for future investigation.

An additional dimension of the Ruff Figural Fluency Test (i.e., RFFT) which may contribute to prospective memory performance is that of perceptual fluency. Jacoby and Kelley (1991) have indicated that perceptual fluency and context recognition can evoke feelings of familiarity which can be followed by controlled retrieval processes which attempt to connect the familiarity to a source. For example, as a subject is constructing a new design on the RFFT, he/she must "notice" if the design is familiar which may subsequently direct a search to determine if the design has been constructed before. The RFFT requires that a subject maintain a constant awareness of contextual and perceptual information and the quicker and more efficiently one can carry out this search activity the more optimal his/her performance.

The data from the present investigation suggest that both retrospective memory and executive functions are significant predictors of successful prospective memory performance. From a neurostructural perspective, Cohen & O'Reilly (1996) postulate an interactive system between processes localized in the prefrontal cortex and the hippocampus as contributing to different facets of prospective memory performance. Specifically, they speculate that the prefrontal cortex is important in directing attention to task-relevant representations and inhibiting task-irrelevant ones. The hippocampus, on the other hand, serves to recall the intention prior to the initiation of its completion. The role of hippocampal function is to "bind" together and mediate novel associations (e.g., build stimulus-response associations) until they can be encoded in the mnemonic system. In this manner, hippocampal processes serve or complement frontal lobe processes (Shallice, 1996) in completing prospective memory tasks. These neurostructural areas share numerous cortical connections (Luria, 1966) between themselves and with other cortical substrates (e.g., diencephalon, basal ganglia) which may also have a role in prospective memory performance (Bisiacchi, 1996; Eslinger & Grattan, 1993).

The Role of Environmental Support and Trace Memory Decay Over Time in Prospective Memory Performance. This portion of the investigation considered the effect of external cueing and the interval between the request and the initiation of the to-be-remembered action on prospective memory performance. The results revealed a Cue x Time interaction indicating that older individuals performed more poorly on prospective memory tasks with little environmental support (e.g., less cues) and which had to be initiated after longer intervals. These analyses revealed that both the effects of cueing and time interval have a significant impact on prospective memory performance, apparently to a greater extent than the effects associated with age itself. In other words, prospective memory deteriorated during longer intervals between task assignment and execution of the intention and this discrepancy was greatest for uncued items. These data support the hypothesis that older individuals have greater difficulty on tasks in which the need for self-initiated activity is high and when the potential for interference is greater.

In the present study, two types of cues were given. The subjects were either provided with an external, associative cue or were provided with a clock and required to monitor time (e.g., an internal cue was needed).[3] In addition, prospective memory tasks were carried out after 10 and 20 minute intervals. One preliminary study which investigated prospective memory in older adults and the use of cues found that reliance on external cues does increase with age, but may depend on the type of task to be carried out (Reeves & Dobbs, 1992). Specifically, these authors found that older subjects were significantly more likely than younger subjects to use external cues for tasks which occurred infrequently and for tasks which were "habitual" (e.g., occur with a regular time interval) but did not have an environmental cue. Therefore, older subjects adopted an external cueing system for those tasks under which their prospective memory was likely to deteriorate. In effect, these subjects converted time-based tasks into event-based tasks in order to assist in remembering the future intention.

Maylor (1990) conducted one of the largest "naturalistic" studies of prospective memory in the elderly in which she assessed influences on performance for a telephone task (i.e., subjects were asked to phone the experimenter once per day Monday through

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It should be noted that any cue may have both internal and external characteristics. For instance, activity required to construct an external cue may influence a cognitive (i.e., internal) representation of the intention (Itons-Peterson & Fournier, 1986).

Friday). Those subjects who relied on internal cues to remember the task (e.g., "I tried to condition myself to remember without any aid) showed the worst performance. Subjects who chose a "conjunction cue" (e.g., telephoned in conjunction with another routine event such as breakfast) carried out the task in the most consistent manner, while those who used an external cue (e.g., reminder note) performed in between the other two groups. Maylor (1990) also noted positive effects of age such that older subjects appeared better at using external or conjunction cues than were younger subjects, possibly because they had more experience in using them.

Cue type appears to be an important factor in completing prospective memory tasks successfully. For example, recent research has demonstrated that performance is better with unfamiliar rather than familiar cues (Einstein & McDaniel, 1990), specific rather than general cues, distinctive rather than nondistinctive cues (McDaniel & Einstein, 1993), and elaborate rather than simple cues (Loftus, 1971). Dobbs and Reeves (1996) have also reported that subjects perform better on prospective memory tasks which follow cues related to the task rather than unrelated cues and which follow perceptual cues rather than semantic cues.

The effects of the twenty-minute retention interval on prospective memory performance can best be explained by executive functioning and monitoring ability discussed in the previous section. The twenty-minute retention interval between the request to carry out the prospective memory task and the execution of the intention can be regarded as a "divided attention" task given that the subjects are asked to perform other activities during the time interval while also remembering to perform the task in the future.

These types of attentional and monitoring cognitive tasks require greater processing resources (Salthouse, 1991; Moscovitch & Winocur, 1992) and research has indicated that memory traces decay more quickly over time in working memory of the elderly due to the inability to inhibit competing, distracting stimuli (Hasher & Zacks, 1988). These factors make it difficult to switch from the intervening activity to the prospective memory task. Therefore, prospective memory performance is influenced by the requirements of tasks carried out between the formation of the intention and its initiation (Brandimonte & Passolunghi, 1994). While it was not explored explicitly in this study, individuals may vary on their susceptibility to the influence of the intervening activity on the intended action due to such factors as personality and motivation.

The Correspondence Between Self-Reported Prospective Memory Capabilities and Actual Performance. As discussed in the previous section, the present study revealed that when the use of cues was controlled for, a decline in prospective memory ability emerged. The results from the present study also revealed that a relationship does not exist between self-assessment of prospective memory capability and actual performance on cued or uncued prospective memory performance. The use of external memory aids may conceal actual prospective memory deficits. As a matter of fact, when subjects have been asked to rate themselves on various prospective memory tasks (e.g., "How often do you forget to take your medication?"; "How often do you forget to write letters you intended to write or make telephone calls you intended to make?"), evidence for age-related declines in prospective memory do not emerge (Maylor, 1993). Some studies that have measured self-reports of prospective memory have even demonstrated improvement in prospective memory (Harris, 1984; Martin, 1986). However, other studies show that as individuals age, they have poor metamemory or insight into their own memory capabilities (Cavanaugh, 1988; McGlynn, 1993).

Few studies have simultaneously considered self-perceptions of prospective memory and actual performance. Dobbs and Rule (1987) did not find a correspondence between rated ability and actual performance in any of the adult groups studied. Furthermore, the same null result was obtained when comparing self-rated ability and performance in groups of mildly head injured individuals (Dobbs, Reeves & Rule, 1995). However, neither of these studies asked subjects to rate their performance on the prospective memory task to be carried out in the study, but instead asked them to rate their potential performance in hypothetical prospective memory tasks. This was also true for the present study. Conversely, one study conducted by Devolder, Brigham and Pressley (1990) did find that older adults were able to accurately rate their performance on a prospective memory task, and were better at predicting than younger adults. It is possible that this study found a correspondence between self-rated ability and performance because the hypothetical task in the rating and the task to be carried out in the experiment were one and the same.

The most likely explanation for the present data is that outside of the laboratory, older individuals rely on external memory aids to a greater extent and therefore, do not notice potential deficits in prospective memory ability. The other side of this argument is that older individuals who have little insight or awareness into their memory capabilities will be unable to implement appropriate memory strategies (Janowsky, Shimamura, &

Squire, 1989) or fail to acknowledge memory lapses. External cues for completion of prospective memory tasks, in addition to reminding one to complete the intention, also function to cue an awareness that one has forgotten. Such external supports for remembering do not provide the opportunity for individuals to make an accurate assessment of memory capabilities. Of course, other interpretations are likely including the inherent difficulties in using questionnaires to assess competency in aging (Rabbitt & Abson, 1990), including a heightened need in the elderly to respond in a socially desirable manner.

Individual differences also might account for whether or not people can accurately assess their prospective memory ability and whether or not they can complete intention memory tasks in their everyday environment. As people age, they often have the benefit of experience which can lead to improved problem-solving abilities and thus successful prospective memory (Andrzejewski, Moore, Corvette & Herrmann, 1991). The subjects in the present sample may have had a great deal of experience with the types of prospective memory situations outlined in the self-report measure, but none with types of tasks with which they were presented during the assessment. Research regarding other individual difference variables has shown that Type B personalities tend to be less accurate in remembering intentions than Type A personalities (Searleman & Gaydusek, 1989) and that a heightened emotional state, such as seen in anxiety, has been shown to have a deleterious effect on prospective memory (Meacham & Kushner, 1980). Finally, individuals may vary in the extent to which they ruminate about "unfulfilled intentions" (Zeigarnik-effect; Goschke & Kuhl, 1996) keeping the intention in a heightened state of activation. Again, subjects may have been more ambitious about the types of prospective memory tasks outlined in the self-report measure while the laboratory prospective memory tasks may not have carried the same psychological valence.

Remediation of Prospective Memory Declines in the Able Elderly. Few studies to date have systematically investigated the remediation of prospective memory in the elderly despite the fact that adaptive prospective memory ability has a significant impact on daily functioning. The clinical importance of remediating cognitive declines associated with prospective memory was demonstrated by Huppert and Beardsall (1993) in a study which revealed that prospective memory declines are an early indicator of dementia. Furthermore, cognitive declines can be part of normal aging and, therefore, not part of a disease process, with prevalence rates in the able elderly ranging from 45% to 86% for persons over the age of 80 years old (Crook, 1993). Interventions have proven efficacious in reversing cognitive changes in old age (Crook, 1993) and may potentially contribute to circumventing a more serious disease process.

Our intervention was designed to enhance prospective memory performance by training group participants in information-organizing techniques as well as strategies to increase attention/concentration abilities. In addition, procedures aimed at decreasing the impact of mood-related symptomatology (e.g., depression, anxiety, stress) were provided as the literature has shown that these can increase certain types of prospective memory errors (Cockburn & Smith, 1994, 1996; Meacham & Kushner, 1980). In our sample, a significant increase in prospective memory capacity was observed following the group intervention. However, no differences were observed between the group employing ecologically valid stimuli and the group using laboratory stimuli. The overall intervention appeared to have an impact on prospective memory performance; however, the Everyday and Lab group intervention may not have been distinctive enough to yield significant differences.

A strong component of the training paradigm was to encourage subjects to supplement external memory aids with internally generated strategies which provided a structure for subjects to cognitively rehearse to-be-remembered material. For example, many of the techniques (both relaxation and memory strategies) involved the use of visual imagery. Subject's prospective memory performance may have improved with the development of the ability to imagine oneself performing the intended action in the context where it is supposed to occur (i.e., increased rehearsal during a retention interval).

Dobbs and Reeves (1996) have developed a heuristic which delineates various qualitative aspects of prospective remembering. They have labeled six steps in prospective remembering which include *metaknowledge* (i.e., knowing the specific demand of the task; being able to know one's own abilities), *planning* (i.e., formulating a plan of how to remember a future intention), *monitoring* (i.e., periodically recalling when the task needs to be completed and evaluating whether or not the requirements for recall are currently met), *content recall* (i.e., remembering what the prospective memory task is; retrospective memory component), and *output monitoring* (i.e., recalling that the task has already been carried out).

Some authors have indicated that the most important aspects of prospective memory tasks are the monitoring and planning components (Craik & Kerr, 1996).

Planning and monitoring has been the focus in several studies which trained intention memory capabilities. For example, Stevens and colleagues (1992) trained Alzheimer's disease patients to consult a calendar and to carry out the activities identified for that day. In effect, individuals were trained to use a "good strategy" to increase the likelihood of completing prospective memory tasks. Similarly, Park and Kidder (1996) have developed a sequence of memory aids which they use to increase medication adherence in the elderly (e.g., organizational charts, reminders, calendars). In addition, Camp and his colleagues (1996) focused on the monitoring component of prospective remembering when they used a spaced retrieval technique to successfully train a group of subjects with Alzheimer's Disease to improve their prospective memory performance. Their techniques involved a shaping procedure for memory in which subjects are trained to recall information over increasingly longer periods of time.

As opposed to the studies just mentioned, the group training paradigm in this study did not focus on specific aspects of prospective remembering. Prospective memory is a multidimensional task which involves a variety of processes such as planning capabilities (e.g., appropriate setting of environmental cues; planning how to remember), attention abilities needed for time monitoring and holding intentions in working memory, and the memory component itself (e.g., remembering the intention and the action to be performed). Future training groups in prospective memory might specifically define these aspects of memory for intentions and then develop individually tailored programs to compensate for whichever aspect is problematic. For example, if an individual is able to assess which aspect of the prospective memory task he/she is likely to fail, then steps can be taken to change the nature of the task (e.g., using a clock alarm to circumvent prospective memory failures arising out of time monitoring deficits). However, this approach is confounded by the fact that individuals often are unable to accurately assess their prospective memory ability in order to plan for specific deficit areas.

Limitations of the Present Study and Future Directions

Methodological

The present findings should be considered in the context of the sample which was studied. There was no way to determine the unique characteristics of those who responded to the advertisement to participate in the study and those who did not. The present sample was highly educated and may, therefore, have been more "psychologically minded" than those who chose not to respond to the advertisement. The present sample might have also differed on factors such as social relatedness, personality, and psychological well-being factors. The workshop provided participants with the opportunity to interact with peers who may have been experiencing similar adjustment reactions to the aging process. Those who did not respond to the advertisement may have had an adequate social support network or, on the other extreme, have been isolated with limited contact with others. In addition, the present sample was predominantly female and racially homogeneous (i.e., the majority of the sample being Caucasian). Therefore, the results from the present sample cannot be generalized to groups that differed from the present sample. Furthermore, 58% of the original sample remained in the study to participate in the seven session workshop which was offered to participants. This group did not differ significantly from the other 42% on the variables of age, education, and performance on measures of estimated intelligence and mental status. Again, other variables which were not analyzed might have accounted for those individuals who dropped out of the study including personality (e.g., depression, anxiety) and cognitive factors (e.g., differences in memory capacity).

The findings associated with the intervention component of the present investigation should also be interpreted with caution due to reasons of sampling. The present study did not include a waiting-list control group so that pre- and post-measures of performance might be compared to those who received the seven session training group. Given the lack of an appropriate control group, conclusions cannot be drawn about whether or not the intervention contributed to improvements in prospective memory performance beyond changes which might have been due to practice effects with repeated assessment or simple demand characteristics of the testing situation.

Another methodological limitation of the present investigation refers specifically to the prediction that self-report measures of prospective memory would not correspond to actual abilities as measured in the laboratory. In this case, the null hypothesis of no differences was being predicted. The results supported the null hypothesis of no difference; however, this should be interpreted with caution since from a statistical standpoint, hypothesis testing is biased toward finding a null result. Frick (1995) outlines the interpretive bias that exists in predicting the null hypothesis.

Measures

The present findings must also be considered in the context of the measures used to assess various facets of prospective memory, retrospective memory, and executive functions. There is a difficulty in designing tasks which provide pure measures of prospective memory and which are uncontaminated by other factors such as compliance and motivation. Prospective memory failures could occur for any number of reasons. For example, poor performance could be due either to a lack of compliance, lack of motivation (e.g., needing to pay a bill, but not having the money), or to a retrospective memory failure. Measures were not taken in the present sample to assess how much importance subjects attributed to the assessment process. Subjects may have accurately monitored when tasks were to be completed and recalled the content of the intended action but not have been motivated or willing to complete tasks. Oftentimes, when people fail to remember something in the future, there is some kind of social obligation that has been neglected. People may attribute retrospective memory failures to a deficit in one's memory while prospective memory failures are attributed to personal preference (i.e., intention). It was assumed in the present investigation, but not specifically explored, that subjects were motivated to complete the tasks given their self-initiated participation and expressed interest in completing the workshops provided.

Furthermore, the significant positive correlation between prospective memory tasks and retrospective memory tasks should be interpreted with caution since these tasks were not comparable in the encoding demands necessary for each nor in the retention interval which occurred prior to recall. Retrospective memory was assessed by using the CVLT Raw Score for which encoding occurs over five trials and recall is assessed immediately after encoding. Many of the prospective memory tasks required encoding after only one presentation and were recalled after retention intervals of up to 20 minutes.

In addition, the cognitive and attentional demands of the interfering activities and tasks (i.e., those occurring between formation of a prospective memory intention and the completion of the intention) were not assessed. This issue was partially addressed by ensuring the same testing sequence for each subject; however, some prospective memory tasks may have followed high demands for attentional and information processing resources while others may not have. One strength of the present investigation was that it considered multiple subgoals for prospective memory tasks which is more reflective of real world situations for intention memory. Most studies of prospective memory utilize a single instruction or procedure for prospective memory. Using multiple subgoals of prospective memory increased the predictive power in assessing intention memory functions; however, specific conclusions cannot be drawn about the different kinds and amounts of demands that apparently similar tasks make on working memory.

Future Research

Prospective memory is pervasive in everyday life and has important implications for adequate functioning in daily living. Delineating the nature of prospective memory failures appears to be important in understanding memory processes in the elderly and how they affect overall adjustment. Future research might specifically focus on the reasons for prospective memory failures including both errors of omission and commission and whether or not retrospective memory, time monitoring, or motivation was responsible to instances of forgetting.

However, as some have stated prospective remembering is "more than memory" (Dobbs & Reeves, 1996; Maylor, 1996) since it entails a set of abilities that depend on a broad range of underlying processes involving the timely performance of planned actions. It is surprising that the WCST Number of Categories and Trails B were not distinguishing features in predicting successful prospective memory performance completion given that such tasks require mental flexibility and the ability to switch mental sets. Future research might focus more specifically on the interaction of attentional and executive functions in predicting prospective memory performance. The fact that monitoring as a specific cognitive requirement of the RFFT emerged as an important predictor in successful prospective memory completion is an important contribution to the literature on prospective memory. However, the behavioral dimensions of monitoring in the prospective memory task were not correlated with monitoring behaviors required in the RFFT in order to confirm the validity of this finding.

Finally, future research will consider which specific components of the intervention led to improved performance and how participants compare to a waiting-list control group. A workshop designed with interventions more specifically geared to prospective memory functioning would certainly provide information beyond that garnered from the present preliminary investigation. Ideally, the present data might have been more informative if considered in the context of a control group of younger cohorts to more clearly delineate the nature of the age-associated decline in prospective memory.

TABLES

Table 1A
Means, Standard Deviations and Correlations For Prospective Memory, Age, and Retrospective Memory

Variables	Prospective Memory (DV)	Age	CVLT
AGE	-.29*		
CVLT	.42*	-.40*	
Means	14.90	67.71	45.49
SD	2.56	7.71	11.49

N = 113
*p < .01

Table 1B
Means, Standard Deviations and Correlations For Prospective Memory, Age, Attention, Retrospective Memory and Executive Function Measures

Variables	Pros. Mem. (DV)	Age	Attn	Retro	Cat.	FTMS	Des	TrB
AGE	-.31*							
ATTENTION	.22*	-.23*						
RETROSPECTIVE	.43*	-.39*	.31*					
WCST CAT	.35*	-.48*	.45*	.35*				
WCST FTMS	-.08	.16**	-.29*	-.10	-.40*			
RFFT DES	.40*	-.34*	.42*	.36*	.40*	-.15		
TRAILS B	-.25*	.43*	-.37*	-.30*	-.42*	.15	-.54*	
Means	14.83	67.48	14.48	45.37	4.88	.85	67.84	108.35
SD	2.59	7.67	3.70	11.99	1.60	1.06	19.65	65.00

N = 106
*$p \leq .01$; **$p < .05$
(WCST CAT = total number of categories on the WCST; WCST FTMS = failure to maintain set on WCST; RFFT DES = total number of designs on the RFFT)

Table 2
Prospective Memory Score Values for the Solved Generalized Estimating Equation: Hypothesis Two

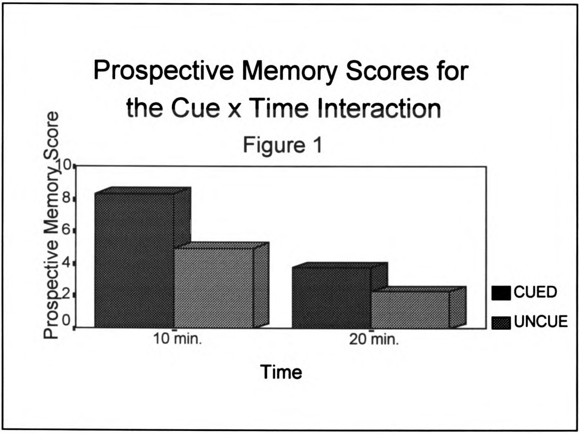
	Length of Delay	
	10 Minutes	**20 Minutes**
Uncued	4.97	2.30
Cued	8.35	3.78

N = 115

Table 3
Descriptive Statistics for Prospective Memory Performance for the Everyday and Lab Groups in the Sample

Group	N	Pre-Test Prospective Memory		Post-Test Prospective Memory	
		Mean	SD	Mean	SD
Everyday	38	14.97	2.31	16.16	1.59
Lab	30	15.45	2.81	16.17	1.93

FIGURES


Prospective Memory Scores for
the Cue x Time Interaction
Figure 1
Prospective Memory Score
10
8
6
4
2
0
10 min.
20 min.
Time
CUED
UNCUE

APPENDICES

Appendix A

Prospective Memory Screening (PROMS) Items

1) Twenty minute prospect memory task with associative cue.
   Directions: *"The first thing I want you to remember is to make a fist (examiner models) when I show you a picture of a boat sometime during the next hour."*

2) Two minute prospective memory task with time cue.
   Directions: *"From when I say "begin", wait exactly two minutes, then write your name on this paper."*

3) One minute prospective memory task with associative cue.
   Directions: *"This time, I want you to draw a square on the paper when you see me clap my hands."* (Examiner claps hands in 60 seconds)

4) Ten minute prospective memory task with time cue.
   Directions: *"In exactly ten minutes from right now, I would like you to put this letter in this envelope. While you are waiting, we are going to do a couple of other tasks."*

5) Ten minute prospective memory task with associative cue.
   Directions: *"OK, now I'd like for you to remember to stop and tap the table (examiner models) when I snap my fingers. While you are waiting, we are going to work on some other tasks."*

6) Twenty minute prospective memory task with time cue.
   Directions: *"In twenty minutes from right now, I want you to stand up. While you are waiting, we will work on some other tasks."*

7) Twenty four hour prospective memory task.
   Directions: *"The next task you need to remember is to mail this postcard. I want you to put it in the mail tomorrow. I will look at the postmark date to see when it was mailed. It already has the address and stamp. All you need to do is drop it in the mail tomorrow."*

Appendix B

Cued and Uncued Prospective Memory Items

I) Cued Prospective Memory Items:

Immediate:

1) PROMS Item #3--Examinee remembers to draw a square when examiner claps hand (cue) after one minute interval

10 minute interval:

1) PROMS Item #4--Examinee taps table when examiner snaps fingers (cue) after 10 minute interval

20 minute interval:

1) RBMT "Remembering an Appointment": Cue: Alarm ringing after 20 minute interval
2) PROMS Item #1--Examinee makes a fist when presented with a picture of a boat 20 minutes after instruction

II) Uncued Prospective Memory Items:

Immediate:

1) PROMS Item #2--Examinee remembers to write name after two minute interval

10 minute interval:

1) PROMS Item #4--Examinee places letter in envelope after self-timed 10 minute interval

20 minute interval:

1) RBMT "Remembering a Belonging"--Examinee remembers to ask for a belonging at the end of the test
2) PROMS Item #6--Examinee stands up after self-timed 20 minute interval

III) Uncategorized Prospective Memory Items:

1) PROMS Item #7--Examinee is instructed to mail postcard after 24 hour interval--external aids not controlled.
2) RBMT "Remembering to Deliver a Message"--Embedded in a sequence
3) RBMT Delay of "Remembering to Deliver a Message"

Appendix C

MAC-S Prospective Memory Items

I) Ability Items:

Item #4: To turn out lights, turn off appliances, and lock doors when leaving home.

Item #11: To write letters you intend to write or make telephone calls you intend to make.

Item #16: To take along, when leaving the home or office, any items that you intended to take (for instance, an umbrella or a letter to mail).

II) Frequency Items:

Item #23: Go into a room to get something and forget what you are after.

Item #24: Forget to bring up an important point you had intended to mention during a conversation.

Item #25: Forget that you told someone something and tell that person the same thing again.

Item #30: Feel that a word or name you want to remember is "on the tip of your tongue" but cannot be recalled.

Item #34: Dial a number and forget who you were calling before the phone is answered.

Item #35: Forget an appointment or other event that is very important to you.

Item #38: Forget which waiter took your order in a restaurant.

Item #40: Pass the point where you intended to exit while driving a car or taking public transportation.

Item #43: Arrive at the grocery store or pharmacy and forget what you intended to buy.

Item #46: Store an important item in a place where it will be safe and then forget where it is.

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