1997

The role of activity level for memory in the elderly

Lori Ann Johnson

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THE ROLE OF ACTIVITY LEVEL FOR MEMORY IN THE ELDERLY

A Thesis
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Psychology

by
Lori Ann Johnson
December 1997
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2 December 1997
A common complaint of people over 60 involves the decline in memory performance. Although memory problems can be an indication of serious health problems (e.g., senility or Alzheimer's disease) not all memory loss is inevitable. This study looks at whether leisure activity can improve memory performance. In particular, this thesis examined the influence of activity level on higher forms of memory; prospective memory, implicit memory, and source memory. The hypothesis tested was that more active participants would have better memory performance. A sample of 60 men and women (average age 73.92) was divided into groups using a combined activity score, which was based on the number of activities a subject participates in and the time spent engaged in each one. The most active performed better on several measures of memory performance, including implicit memory and source memory. No significant differences were found between the three groups on recognition memory and prospective memory. Several demographic variables were examined to determine which, if any influenced activity participation. Results indicated that education, age, and source of participant all affected activity participation to varying degrees. A potentially confounding variable to memory performance proved to be age, but this factor was discounted on theoretical grounds. The overall conclusion
from this study is that memory performance is affected by level of activity, and the more active a subject is, the better his or her performance. Future research on this issue needs to determine if something so simple as activity level could affect other types of memory. Additional research is also needed to examine which types of leisure activity are most beneficial.
ACKNOWLEDGMENTS

I would like to thank Dr. Riefer for his time and help in getting me through this thesis. I would also like to thank Steve for being generous with his time and computer.
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INTRODUCTION

The population is aging; in just 34 years the number of older adults will actually outnumber the number of children in the United States. It is safe to say that advancements in science and medicine have contributed to the fact that we are living longer and healthier lives. Furthermore, the baby-boomer phenomenon supports the prediction that by the year 2000, 12.7% and by 2050, 20.5% of the population in the United States will be over 65 (Kalish, 1982). Because of these trends, a large body of literature exists that explores aging and problems of the aged.

A large portion of this literature looks at older persons in long-term care facilities. For example, Kane and Kane (1987) found the risk of entering long-term care to be high; almost one-half of the men and over one-half of the women who turned 65 in 1990 are expected to enter long-term care at least one time before they die. We might ask ourselves why we should bother looking for ways to prolong or enhance the quality of life outside of the long-term care facility. Quite simply, by 2035, a large percentage of these older persons over 65 will still be living
independently. The fact that they enter a nursing home at least once before they die does not mean they will spend the majority of the years after age 65 there.

Memory performance in older persons has been a particularly important area of focus, including age differences in memory performance (Craik, 1977), the effect of physical activity on memory (Boothby, Tungatt, & Townsend, 1981), physiological explanations of decline in memory performance (Mitrushina & Satz, 1991), implicit and explicit memory (Graf & Schacter, 1985), and prospective and retrospective memory tasks (Maylor, 1993).

Experimental research has largely confirmed that a reduction in memory is an inescapable part of the normal aging process (Craik & McDowd, 1987; Hasher & Zacks, 1979). Chiarello and Hoyer (1988) have stated “that to understand the nature of age-related memory changes, it is necessary to specify the conditions under which preserved, as well as impaired performances are found” (pp. 358). Clearly, this is an important area for research.

Traditionally, memory research has focused on the differences found between young and old subjects. The problem with this methodology is that it tends to lump all of the older persons into one group, and focuses only on
differences. Current belief is that life is a series of developmental stages throughout the life span, and old age is no exception. Based on personal observation and supported by a large amount of research (e.g., Birren, Woods, & Williams, 1980; Rabbitt, 1989; Schaie, 1979) there are far more individual differences among older persons than sameness, and if samples of older subjects are compared, these differences would become evident. For example, Stoner (1982) found individual differences in older samples when measuring fluid intelligence (cognitive flexibility, which includes problem solving abilities) and crystallized intelligence (learning or knowledge gained by study).

The research in this thesis focuses on the relationship between activity level and memory performance. Specifically, the current study examined the relationship between levels of activity (sedentary, moderate, and active) as defined by Kozma, Stones, and Hannah (1991) and memory performance. The study evaluated memory performance using three global, high-level, types of memory: prospective memory, which is the ability to remember to do something at a later time; implicit memory, the use of unconscious memories to facilitate performance; and source
monitoring, the ability to distinguish from what source information was acquired. It was hypothesized that a lifestyle that involves a high level of activity will result in better performance on these memory tasks.

Physiological Activity and Cognitive Performance

In the past, researchers have broadly defined the concept of activity, and two large bodies of literature exist that use activity as an independent variable. The first body examines activity's effect on physiological measurements (e.g., heart rate, cardiac output, and left ventricular ejection during exercise) and the second body looks at life satisfaction. The physiological research shows a measurable decline in later adulthood (Port, Cobb, Coleman & Jones, 1980; Strandell, 1976). There is, in addition, a significant decline in cardiorespiratory fitness (i.e., aerobic capacity). This type of research reveals that the more physically active an older person is, the better his or her reaction time performance on memory tasks will be.

It has been well documented that exercise training improves cardiovascular functioning in older adult populations. These beneficial effects have been found for
older persons in long-term care (Clark, Wade, Massey & Van Dyke, 1975), as well as healthy community-dwelling older adults (Cunningham, Rechnitzer, Howard & Donner, 1987). Studies of older participants have examined the relationship between exercise and cognitive functions, and have done so in several ways: 1) comparison of older competing athletes with those who are inactive, 2) comparison of physiological measurements based on self-reported activity participation, and 3) comparison of subjects involved in experimenter controlled training programs. All three of these methodologies produce results that support the idea that level of activity significantly affects cognitive performance.

Clarkson and Kroll (1978) explored the first methodology. Their research suggests that athletes tend to perform better than non-athletes on speeded tasks of cognitive function. Athletes were defined as those who lifestyle involved a 30-year period of competing at least three times a week. Measures of performance included strength, endurance, flexibility, and speed (cf. Kozma, Stones, & Hannah, 1991). Using these measures, participants were assessed on their performance on simple and choice reaction tasks. The athletes' superior
performance supported the idea that the lifestyle of an individual that includes high levels of continuous activity has an effect on tasks that involve a psychomotor component.

The second methodology involves looking at the relationship between cognition and physical expenditures of energy during activity. The idea is that the decline in cognitive abilities is governed by physical conditioning as well as age. In this type of research, individuals are compared in terms of how much physical exertion is expended. Performance is based on the average number of kilocalories expended per week (Kcal/wk) in daily activities using standardized tables. Clarkson-Smith and Hartley (1989) demonstrated better performance for working memory and reaction time in individuals expending at least 3,100 Kcal/wk compared with those expending 1,900 Kcal/wk.

The third methodology compares subjects involved in experimenter controlled training programs. This type of research examines the effects of long-term intensive aerobic training on basic measures of cognitive functioning (e.g., reaction time). In a study by Blumenthal, Emery, Madden, George, Coleman, Riddle, Reasoner, Mckee, and Williams (1989) nonactive older adults were randomly placed
into one of four experimental groups: aerobic exercise, yoga, flexibility training, or a wait-list control group. Of interest was the aerobic exercise group, who trained three times a week for 16 weeks. Exercise consisted of a combination of stationary cycling, walking, and jogging. But after 16 weeks, there was no improvement in cognitive test performance. It was theorized that an extension in the length of training would improve performance, but at the end of 28 months, there were few, if any improvements. Blumenthal et al. (1989) concluded that although memory performance was not improved, the findings suggested that if exercise does affect psychological functioning, it might do so through an improved sense of well being and quality of life. This is an important idea, because it suggests that there is a relationship between exercise and life-satisfaction.

Despite mixed results, there appears to be a general consensus that cardiovascular benefits derived from physical exercise may help to forestall degenerative changes in the brain associated with normal aging (LaRue & Jarvick, 1982). However, people tend to curtail physical activity when they reach a certain age. The literature has examined several demographics in older adults to determine
what variables are associated with this decline in physical activity. For example, Clarke (1974) looked at the amount of formal education. The National Adult Fitness Survey (Clarke, 1973) confirmed that the more education subjects have, the more likely they are to be currently involved in physical activity. Additionally, the greater the amount of education, the greater the knowledge of the importance of fitness and activity participation. Factors such as occupation, income, and geographical area also affect the level and duration of physical activity participation across the life span (Hobart, 1975).

Boothby, Tungatt, and Townsend (1981) identified five broad dimensions that they believed accounted, in part, for the termination of activity participation in a sample of 244 older adults. The five dimensions are: 1) decline in physical ability, 2) loss of interest, 3) social constraints and commitments, 4) limited access to facilities, and 5) breakdown of social contacts and networks. The variables found to influence activity are diverse and complex, and this makes it difficult to explain the relationship between activity level and cognitive decline in the older adult.
The body of literature that examines physiological benefits (cardiovascular measurements) has focused on physical activity. Cognitive performance in these studies has typically been measured using reaction time tasks (Clarkson-Smith & Kroll, 1978) or working memory (Clarkson-Smith & Hartley, 1989). But what about higher-order memory performance? Very few studies (e.g., Clarkson-Smith & Hartley, 1989; Clarkson-Smith & Hartley, 1990) address this issue in relationship to physical activity level when looking at older subjects. The presence of intact higher-order memory processes could account for the large number of older adults who function independently.

Leisure Activity and Life Satisfaction

Previous research has demonstrated the importance of a physically active lifestyle in cognitive functioning. But the fact remains that there is a known decline in physical activity as we age (Boothby et al., 1981). A second body of literature examines the relationship between leisure activity and social interaction. In these studies, life satisfaction has been a common dependent variable. Caspi and Elder (1986) define life satisfaction as the positive appraisal of one's life. Atchley (1971) stresses the
importance of gathering information about leisure activity and its relationship to aging because individuals gradually expand the amount of time spent in leisure activity as they age, thereby theoretically influencing life satisfaction. Thomae (1976), found that life satisfaction is dependent on the amount of time spent pursuing and balancing social relationships, offers a different view of life satisfaction. From the viewpoint of developmental psychologists, the task is to balance the amount of time spent alone and with others to ensure optimal life satisfaction.

Scribner and Beach (1993) theorize that all activity, such as work, play, and education (among others), have one thing in common, characteristics that call for the integration of mental and behavioral processes directed at satisfying goals. Turner (1992) describes social interaction as the goal we strive for, and believes that the process of integrating mental and behavioral processes is an antecedent to life satisfaction.

Steinkamp and Kelly (1987) also have concluded that leisure activity contributes to life satisfaction if it provides an opportunity for self-determined leisure activity. It appears that before age 65, non-determined
types of social activity for example, frequency of visits with adult children, frequency of visits with family and frequency of visits with friends are the important social activities that determine life satisfaction. However, after 65, self-determined social activities that are inspired by variables such as loneliness, sense of belonging, having enough friends, and relating to others are important in determining the choice of leisure activity and subsequent life satisfaction.

What is interesting about Steinkamp and Kelly's (1987) research is that around age 65, the role of leisure activity undergoes a developmental change. A possible explanation for this change could be the fact that older adults retire from paid work around this time. This view is supported by additional research that describes activities as filling in this "work" void by providing older persons with new roles and concept of self, but cautions that if leisure activity is to provide genuinely new roles, retired persons must engage in meaningful activity appropriate in terms of cultural values and personal needs that will afford them a rationale for a social identity and a concept of self. Atchley (1976) agrees that activity is valuable at this stage in life
because it provides an arena to experience achievement and recognition.

There appears to be a consensus in the literature that social interaction as a result of activity participation is an important variable in older adults' life satisfaction. DeCarlo (1974) looked at leisure activity patterns and successful aging and found that active participation, particularly after 60, offers substantial rewards to the aging individual. He examined the reported relationship between the number of activities and frequency of participation and concluded that leisure activity could be one factor that influences physical and mental health during later life.

What do activities entail? Apparently, activity as a construct seems to be subjectively defined in the literature. Atchley (1971) views activities as being aimed primarily at relaxation, entertainment, and personal development. Dumazedier (1967) and Kelly (1975) see leisure as much more than organized groups, games, community programs, and use of special facilities. Much leisure is informal, some is alone, and most is around the home. Kelly (1978), who emphasizes the twofold value of activity, defines it as having two components: 1) the
process of being involved in doing something, involving either the expenditure of energy or physical movement and 2) cognitive, affective, or social aspects. The present research defined leisure activity as an activity that is engaged in on a regular basis (at least once a week) and included activities that were social, solitary, physical, or sedentary in nature.

Steinkamp and Kelly (1987) suggested that there is a lack of consensus in definitions because it is the social interaction and not the activity itself that contributes to life satisfaction. Their viewpoint offers an explanation as to why there has been an effort to develop a classification system for activities. Havighurst (1961) grouped activities into lifestyles: community-centered, home-centered high, home-centered medium, and home-centered low. Tinsley, Teaff, Colbs, and Kaufman (1985) developed a classification of leisure activities in terms of psychological benefits: self-expression, companionship, power, compensation, security, service, intellectual/aestheticism, and solitude.

Additionally, some studies did not attempt to categorize activities but merely presented a list to subjects and collected data about participation patterns:
how often, time spent, and how long, in terms of days, weeks, and months they have participated in an activity (e.g., DeCarlo, 1974; Kelly, 1978; Kozma et al., 1985; & Steinkamp and Kelly, 1987). The rationale for this methodology is the idea that the benefit of leisure activity (physical or social) comes from degree of participation rather from the nature of the specific activity. It is possible that this variable is related to memory performance in that there is a circular effect: activity means social contact; social contact means greater life satisfaction; greater life satisfaction means the individual will participate in more activities; and a higher activity level is reflected in better memory performance.

It appears from the literature that both physical and leisure activity are beneficial to the older adult, and that both contribute to life satisfaction and memory performance. However, the focus of this thesis is on the link between leisure activity and memory performance, an area in cognitive aging that has received little attention. Accordingly, one goal of the present research is to fill in some missing information by examining relations between the two constructs.
Prospective Memory

Prospective memory is memory for a future act. Cohen (1989) proposed that prospective tasks can be categorized as self-imposed, imposed by someone else, routine, novel, a single action, or a whole network of related plans, specific or general. The differences between the various types of prospective memory are significant because they are likely to affect the ability of the individual to remember to perform the task. It is generally thought that novel, high priority tasks are most likely to be remembered (Cohen, 1989).

Maylor (1993) believed that there are four things that must be done to successfully complete a prospective memory task: remembering that something has to be done, remembering what has to be done, performing the task, and remembering that it has been performed. In most cases, this action must be performed at a specified time or within some time limit (e.g., taking medicine, visiting the doctor, or paying a bill).

The strategy that people use in prospective memory consists of setting up a cue to remind them of the task. The typical procedure used to study prospective memory has involved participants performing some action in a
naturalistic setting at some specified time in the future. West (1988) asked young and old participants to call the experimenter on the phone at a specified time, and also to send a postcard on a specific day. For both of these tasks no reliable differences between old and young were found.

Another important factor in prospective memory is motivation. This operates in two ways, on both compliance and memory. For a task to be performed, people must not only remember to perform it, but they must be also willing to perform it. Meacham and Singer (1977) gave subjects postcards to mail back once a week for eight weeks. One group was offered a cash incentive for posting on time, which produced a small improvement in performance.

Another variable that has been studied experimentally is timing, such as the length of the retention interval (Cohen, 1989). Wilkens and Baddeley (1978) designed a study to simulate remembering to take a pill at specified times. Subjects were required to press a button on a box at 8:30 a.m., 1:00 p.m., 5:30 p.m., and 10:00 p.m. each day for one week. A device in the box recorded the time of each button press. Lateness of response increased across the seven days and across each day, with the 8:30 a.m. responses being more accurate than later ones. Wilkens and
Baddeley speculated that the time-of-day effect must be due to competing activities later in the day, which could be problematic for older persons.

Prospective memory also involves time monitoring as well as content of plan. Completion of the task is dependent on whether it must be completed at a specific or indefinite time. Einstein and McDaniel (1990) designed a laboratory paradigm that involved asking participants to remember to perform some future activity while busily engaged in another task. Young and old participants were instructed to perform an action whenever target words occurred during a short memory task. The difficulty of the task was manipulated by varying the delay preceding the occurrence of the target event and by varying the number of different target events. Age-related performance differences emerged when there were several different target events, but not when one target event was presented several times. Einstein, Holland, McDaniel, and Guynn (1992) found age differences between young and old participants only when they were presented with a complex prospective memory task in which they had to perform an action whenever any one of the four possible target events occurred.
Einstein and McDaniel (1990) believed that although naturalistic studies have yielded some suggestive data, they suffer from control problems associated with measuring and controlling subjects' behavior, e.g., the strategies that are used to remember. Naturalistic studies also fail to address failure to complete the task: is it a problem with memory or compliance? Cohen (1989) suggested that the differences lie in the extent to which people devise external and internal reminders (e.g., object placement, written reminders or tying a string around their finger), and use them efficiently.

As one goes through the day, it becomes obvious how often we rely on prospective memory. This reliance underscores the importance of this type of memory for older adults' attempt to maintain independence. Craik (1986) theorized that prospective memory might be problematic for older persons because remembering involves recreating prior states, and the reinstatement of these can be prompted from internal and/or external cues. External cues (e.g., clocks, notes, or visual reminders) guide reconstruction, but not always. In their absence, we rely on self-initiated cues or processes. Craik's (1986) research indicates that the aging process interferes mainly with
self-initiated retrieval processes. The degree to which age differences occur may depend on the nature of the prospective memory task. Cohen (1989) attributed the failure of prospective memory to age, completely forgetting to do something, slips of action, or doing the wrong thing. Inconsistency of findings in the literature, as to why an older person fails at prospective memory tasks, continues to remind us of the need for future research.

**Implicit Memory**

In recent years, there have been many proposals for two or more functionally distinct memory systems (Snodgrass & Corwin, 1988). These divisions include procedural vs. declarative knowledge (Cohen & Squire, 1980), automatic vs. effortful memory (Hirst & Volpe, 1982), semantic vs. episodic memory (Tulving, 1985), unconscious vs. conscious processing (Kihlstrom, 1987), data-driven vs. conceptually driven tasks (Roediger & Blaxton, 1987), and implicit vs. explicit memory stores (Graf & Schacter, 1985). For the purpose of this thesis, Graf and Schacter's (1985) distinction between implicit and explicit memory was examined. Graf and Schacter differentiated the two proposed memory systems as follows: implicit memory is the
performance on a task which is facilitated in the absence of conscious recollection and explicit memory is revealed when performance on a task requires the conscious recollection of a previous experience. Tasks that measure implicit memory vary in their stimuli and presentation, but they always require that the subject utilize unconscious memories. Such tasks include recognition of a briefly presented stimuli, lexical decisions, reading transformed text, solving anagrams, and recognition of fragmented stimuli.

Much of the theoretical interest displayed by researchers has focused on whether the two separate memory systems exist. Experimental evidence has been sought from research with anterograde amnesiacs, and there is a separate body of work performed with normals. The first line of evidence supporting the explicit/implicit memory distinction deals with subjects who are thought to be incapable of learning anything new. Recent studies show that although amnesiacs exhibit little evidence of learning when asked to recall or recognize new information (explicit memory), their performance is normal when asked to perform a non-memory task in which the effect of prior experience (implicit memory) may be used. Specifically, they may show
the effects of prior experience on subsequent performance in terms of reduced latency or greater probability of a particular response, even though they have no conscious awareness of the experience.

One task in which amnesiacs exhibit implicit memory is repetition priming (Squire & Cohen, 1984). Priming in this context refers to situations in which subjects are given an opportunity to study stimuli and then show improvement on a second presentation. For example, Warrington and Weiskrantz (1974) found that patients with anterograde amnesia displayed low levels of retention of word lists when tested by recall or recognition, but performed normally when given either fragmented words as cues or the first three letters of previously presented words and asked to complete them with the first word that came to mind. Similar results have been found for spelling of low-frequency members of homophone pairs (Jacoby & Witherspoon, 1982), generating category instances (Graf, Shimamura, & Squire, 1985), and producing idioms in a word association task (Schacter, 1985).

Additional evidence for implicit memory is based on priming effects in normals. Priming can be measured by a variety of tasks, including stem completion, fragment
completion, and perceptual identification. For instance, Feenan and Snodgrass (1990) used a fragment completion task, in which subjects were shown different sets of pictures consisting of common objects and animals. Each set was made up of a series of eight individual pictures with an increasing amount of detail. The first picture was 8% complete and displayed the least amount of detail. The amount of detail increased until the eighth picture, which was 100% complete. The subject’s task was to identify each picture as quickly as possible. The set of pictures were presented on two different trials, and Snodgrass and Feenan reasoned that if implicit memory is utilized because of priming, identification of the picture would be faster on the second trial. The difference between the first and second trials is referred to as savings time.

Feenan and Snodgrass (1990) found that experiencing a stimulus during a study session could have a profound effect on how easily that stimulus is identified during a completion test. Furthermore, any kind of experience is beneficial, including the presentation of an extremely fragmented image from a different fragmented series than the one to be shown during the test. Nonetheless, Feenan and Snodgrass found that priming conditions varied widely
in their effectiveness. The most effective priming stimulus was a fragmented image that was just identifiable. In their experiments, this was a fragment at level four that, on the average, was identified 60 percent of the time. These findings support a perceptual closure hypothesis, which asserts that the optimal priming stimulus is the one that contains the minimum amount of information needed to produce this closure. These findings emphasize Graf and Schacter's viewpoint that these two memory systems differ on the element of awareness (e.g., unconscious recollection vs. conscious recollection).

Overall, the evidence has been persuasive that there is a functional dissociation between implicit and explicit memory systems. Both experimental and subject variables have been examined and are thought to account for this dissociation. Experimental variables such as length of retention interval, semantic encoding, and modality shifts between study and test have been proven to influence this dissociation (Hirshman, Snodgrass, Mindes, & Feenan, 1990). There have been many reports indicating that forgetting on implicit memory tasks is slower than forgetting on explicit memory tasks, and that priming can last as long as a year (Mitchell & Brown, 1988).
Level or type of processing is another variable that produces a differential effect on implicit and explicit memory tests. Although semantic processing produces better recognition and recall than does surface processing (Craik & Tulving, 1975) levels of processing do not seem to affect implicit memory performance. For example, Jacoby and Dallas (1981) demonstrated that a levels-of-processing manipulation had no effect on perceptual identification. Similarly, Caroll, Byrne, and Kirshner (1985) found no effects of levels of processing on picture naming in adults. In addition, other researchers have demonstrated only small and non-significant effects of levels of processing on other implicit memories, such as stem completion and fragment completion (Light & Singh, 1987).

Another dissociation concerns the effects of modality shifts (i.e., presentation of stimuli in one modality and testing in another). Although explicit memory displays small or no modality dependence, there is evidence that implicit memory is completely modality dependent (see Clarke & Morton, 1983; Jacoby & Dallas, 1981).

Relevant to the current study, age is a subject variable that produces different effects on implicit and explicit memory tasks. Light and Singh (1987) demonstrated
that although young people tend to perform better on recall and recognition, the two groups performed equally well on implicit memory tasks. Age differences are likely to occur when subjects are asked to engage in deliberate attempts to remember, but not on implicit memory tasks which, include priming in lexical decision, semantic categorization, reading transformed text, word fragment completion, perceptual identification, and picture naming. Results such as these suggest that the elderly are deficient in processes involving elaboration, but their activation processes function normally, which is characteristic of amnesiacs' use of unconscious recollections. Light and Singh (1987) concluded that it is not merely what is on the memory test, but what the subjects are asked to do with the test material that is critical as to whether age differences are obtained. These differences in performance underlie the disassociation between what Graf and Schacter define as implicit and explicit memory.

Source Monitoring

In research, source monitoring is the ability to recall the origin of a piece of information e.g., self-produced vs. experimenter-produced items or list one vs. list two
(Batchelder & Riefer, 1990). Cohen (1989) stated that failures of source monitoring are not confined to abnormal (Harvey, 1985) or immature individuals (Foley & Johnson, 1985). Imperfect source monitoring is common in normal intelligent adults and is an important source of errors in judgments, action, or belief.

Johnson and Raye (1981) developed a model that explains source monitoring. The model describes the processes that we use to discriminate between externally derived memories, that originate from perception, and internal memories, that originate from imagination. External memories represent events that really occurred, objects that were perceived, actions that were performed, or words that were spoken or written. Internal memories are of events that have only been imagined, actions that were planned, considered, or intended, or words that were thought but never said. This process is referred to as reality monitoring.

According to the model, there are two ways in which external memories can be distinguished from internally generated ones: 1) the evaluation of qualitative attributes, and 2) awareness of cognitive operations. Johnson and Raye (1981) propose that internally generated
memories differ from externally generated memories along specific dimensions. First, externally generated memories are real and therefore possess a greater amount of attributes, such as spatial and temporal dimensions coded in the memory trace of the event. Second, external memories should have more sensory attributes, although some evidence exists that imaging processes also generate a limited amount of sensory information (Finke, 1979; Kosslyn, 1976). Finally, it is believed that externally generated memories contain more specific information than internally generated memories.

Internal memories are of events that have only been imagined and are thought to be more reliant on cognitive operations, e.g., reasoning, inferring, or imagining. Johnson and Raye (1981) worked on two assumptions: 1) that the more difficult an item is to generate in thought, the greater the amount of cognitive operations that will be present in the memory trace, and 2) the greater the amount of cognitive operations in the trace, the more easily it will be recognized as self-generated. When a plan or imagined act is mistaken for the memory of a real act, the result is an omission error (e.g., if you think that you have locked the door, but upon checking, it is unlocked).
If, on the other hand, the memory of a performed action is mistaken for the memory of a plan, the result is a repetition error (e.g., going to lock the door and it is already locked). Reasons (1979) suggested that errors are more commonly associated with routine, frequently performed actions (e.g., taking medications). With these actions, the difficulty lies in deciding whether a memory of performing an action is today’s memory or yesterday’s.

Johnson and Raye’s (1981) reality monitoring theory has generated an enormous amount of research. Hashtrudi, Chrosniak, and Johnson (1989) expanded the basic premise when they used the model to determine if subjects could distinguish between different dimensions of internally and externally generated information. Specifically, their research addressed the question of whether older adults display a general problem remembering the source of information or whether the problem is limited to specific types of source monitoring. Three types of source monitoring tasks were examined: between two externally derived and internally generated memories, between two types of internally generated memories, and between two types of externally generated memories. Young and old subjects were assigned to one of four conditions and were
presented with a list of words originating from different sources: say/listen (external/external), think/listen (internal/external), say/think (external/internal), and listen/listen (internal/internal). The results supported their hypothesis that older adults have a specific rather than a general problem remembering the source of information. No differences were found between the say/listen and think/listen conditions. The differences found in the say/think and listen/listen conditions supported the idea that there are greater age differences in memory from sensory/perceptual sources than in memory for material from self-generated sources.

In other research, Backman (1985) found that memory for simple actions are spared from normal aging. However, when lists longer than those used by Backman (12 items) were presented, Cohen, Sandler, and Schroeder (1987) found age differences in memory for simple items. Guttentag, Hunt, and Reed (1988) further explored the question of age differences in memory by examining both self-performed and imagined actions. These researchers questioned the extent that motor activity automatically produces a rich recall-supportive, multi-modal memory trace in subjects of all ages (Backman, 1985). Based on this reasoning and the
finding that performance on memory for simple actions does not decline with age, one would predict smaller age differences in memory for performed rather then imagined actions. Guttentag, Hunt, and Reed presented old and young participants with a list of 24 simple actions from Foley and Johnson’s (1985) study. Subjects performed a random half of the actions on the list and imagined performing the remaining actions. After all the actions had been presented, subjects were given an unexpected discrimination test for actions and were asked to indicate whether each item had been performed, imagined, or was a new item.

The age differences in discrimination performance were consistent with the findings of Cohen, Sandler, and Schroeder (1987), suggesting a recall deficiency on the part of the older adults for a longer list of actions. Furthermore, the Guttentag et al. (1988) findings provided no support for Backman’s (1985) hypothesis that motor activity automatically produces a rich, multidimensional encoding by subjects of all ages. On the average, the older adults were poorer than young adults at identifying whether an action was performed or imagined, an effect that cannot be attributed to differences in action recall per se. This particular finding was consistent with Craik’s
(1986) context encoding deficiency hypothesis and provided further evidence for age differences in remembering the source of information presentation.

The importance source monitoring plays in our lives is evident every time a distinction is made as to where information was attained. Guttentags' et al. (1988) research on real and imagined actions is especially relevant for older persons because distinctions are made on the basis of how real actions appear to be. It is reasonable to assume that novel information would be easier to trace back to the original source, but life is full of routine actions (e.g., taking medications, personal hygiene, eating). Life and death decisions are based on whether our memory of taking medicine was today's or yesterday's. Consequences, such as death, underscore the importance of continuing research on variables that influence ability to successfully perform source monitoring tasks.

Overview of the Current Study

Based on the literature, it appears that with a few notable exceptions (recall of remote information, Poon, 1985; recognition memory, Salthouse, 1982; and implicit
memory, Graf, 1990), most types of memory are not spared by the normal aging process. However, the extent of continued loss once old age has been reached has not been extensively studied. A majority of the previous research has compared young and old subjects, but what happens when the elderly are compared with each other?

This thesis looks at activity as a lifestyle across old age. Specifically, the construct of leisure activity is examined to determine if it shares a relationship with higher-order memory performance. Previous research has been limited by its focus on physical activity, as opposed to leisure activity, and in examining the relationship to basic cognitive performance. The three methodologies: comparing competing athletes with inactive participants, physiological measurements of self-reported physical activity, and experimenter controlled training programs, fail to take into account the known decline in physical activity. It is important to know how physical activity affects cognitive performance, but what happens as we age and are unable to run, jog, or exercise?

This research attempts to answer this question by looking at leisure activity, which is known to increase as we age. By looking at this construct we acknowledge that
older persons slow down and/or lose interest in physical activity. Therefore, it is important to know how alternate forms of activity affect memory performance.

The measures of cognitive performance examined in previous research (i.e., reaction time and working memory) are important, but they are not the only cognitive functions that could be examined to determine what features of memory performance are crucial to the ability to live independently. It is felt that higher-order memory performance (prospective, implicit, and source monitoring) might also be important variables in independent living.

To determine if leisure activity lifestyle has any influence on higher-order processes, the study used Kozma, Hannah, and Stone's (1991) Frequency of Leisure Activity (FLA) scales to classify the subjects into one of three activity-level groups (sedentary, moderate, or active). The groups were determined by using a self-rated activity participation inventory. The subjects responded to how many times per week they participated in an activity, and for how long each time (minutes, hours) they participated in the activity. Based on this division of lifestyle choices, it was hypothesized that volunteers who participate in a greater number of activities and for a
longer amount of time, should perform better on higher-order memory tasks.
METHOD

Subjects

The 60 subjects were required to be at least 60 years of age, and both male and female volunteers were accepted. Due to the source of volunteers, it was expected that subjects would be retired from paid work. Because of established influences on memory performance, health status was evaluated by a self-report health questionnaire. Four subjects were eliminated because of obvious health problems, and one withdrew after the first viewing of the implicit memory task.

One source of subjects came from retirement communities in the Los Angeles and San Bernardino counties. For our purposes, this type of living establishment is preferable because the individual is provided with opportunities to participate in activities of their choice. Additionally, since the residents were not confined to the retirement community, they were free to pursue outside activities. This source yielded a wide range of subjects, not only in age but activity level as well. Subjects were recruited at the noon meal because it was believed that more residents would be available. Subjects were given the
opportunity to ask questions about the research and what their participation would entail.

Subjects were also recruited from senior citizen centers that are run by the city. As with the retirement communities, permission was obtained in the form of a written letter before any research was performed. It was believed that recruiting from these two different sources would ensure that a wide variety of subjects would be given the opportunity to participate.

Materials

General Questionnaire

This self-report questionnaire inquired about sex, marital status, education, annual income, and sensory (hearing/sight) status (see Appendix A: General Questionnaire).

General Health Questionnaire

This was a self-report instrument designed to assess physical and mental health (see Appendix B: General Health Questionnaire). Subjects were asked to rate their health status during the past year. The questionnaire inquired about alcohol and substance dependence, strokes,
degenerative brain disorders from dementia, alcoholism, or Alzheimer's disease, high blood pressure, brain damage, problems with their endocrine, pulmonary, liver, kidney, vascular, or circulatory systems and what medication they were currently taking. In the physical exercise literature it is common practice to exclude subjects with any one of these health problems. The presence of these self-reported health problems may indicate an inability to perform physical exercise (Blumenthal & Madden, 1988; Roger, Meyers, & Mortel, 1990; Stevenson & Topp, 1990).

Activity Scale

Three existing activity scales were combined to measure the present concept of activity. The subject was presented with a combined list of 43 activities from Kelly (1978), Steinkamp and Kelly (1987), and Tinsley, Teaff, Colbs, and Kaufman (1985). The activities were either solitary or social in nature, and are typically engaged in by people of all ages. Due to the fact that the list of activities was compiled from three different sources, care was taken not to duplicate similar activities. To make the self-reporting easier, the activities were grouped into broad categories: physical activity, socializing, hobbies,
cultural, and service activities (See Appendix C: Activity Questionnaire).

The participant’s task was to indicate whether they participate in each activity. This was measured by two questions: do they engage in the activity and how many times per week do they engage in the activity? The FLA (Kozma, Hannah, & Stones, 1991) was used to obtain an activity score for each subject.

The questionnaire asked about social aspects of each activity and life satisfaction. To evaluate the social aspect of each activity, participants were asked if they perform the activity alone or with other people. To indicate life satisfaction, each subject was asked to report on a seven-point Likert Scale how satisfied they are with their life. Both of these measures were self-report and no other formal measures were given.

Implicit Memory

The task consisted of 30 fragmented pictures designed and normed by Snodgrass and Vanderwart (1980), and Snodgrass, Smith, Feenan, & Corwin, (1987). Those selected were pictures of common animals, articles of clothing,
furniture, household items, tools, and transportation vehicles. Each picture comprised a series of fragmented images at eight levels of completion, in which level one was the most fragmented (8% visible) and level eight was the complete picture (100% visible). Figure 1 is an example of a series of fragmented pictures (1-8) that make up one test picture.

Snodgrass and Vanderwart (1980) rated the percentage of name agreement in the identification of an animal or object. Participants were instructed to identify each picture as briefly and unambiguously as possible by writing only one name, the first name that came to mind in response to the picture. Name agreement (H-value) ranged from .00 (100% agreement) to 2.55 (36% agreement). Items with higher H-values enjoyed less name agreement, while lower H-values were higher in recognition. The H-values for the current study ranged from .92 (67% agreement) to .00 (100% agreement). The four groups of thirty pictures ranged from 89.8% agreement to 94.8% agreement.

Source Monitoring

Thirty actions taken from Foley and Johnson's (1985) developmental study on children were selected for inclusion
FIGURE 1. Example of a Series of Fragmented Pictures (1-8) that Make-up One Test Picture
in the study. The actions were classified into five categories: 1) communicative gestures, 2) touching body parts, 3) tracing exercises, 4) extending body parts, and 5) looking at objects. For each participant, the actions were randomly assigned to one of three categories: physically performing the action, imagining themselves performing the action, or distracters. There were four different randomly ordered presentations of the actions. This ensured that only one-fourth of the subjects in any activity group would receive the same ordering (see Appendix D: Source Monitoring Presentation Orders).

**Procedure**

The session started with the volunteers filling in the general, health, and activity questionnaires. Obvious health problems did not mean automatic exclusion from the study; the experimenter proceeded with the experiment until it was clear that the participant was unable to contribute to the data. The four questionable participants were asked a few demographic questions and shown five pictures from the implicit memory task. The subjects were then thanked for their time and effort.
The second part of the session began with the participant receiving the white poker chip with their participant number on it. Then, in an off-hand manner, the researcher said, "please put the chip away in your purse or pocket for safe keeping. You will be required to give the poker chip back when the research is complete. In fact, here's what I would like you to do. When your involvement in the research is completed, I will thank you for your participation. At that time, please return the chip to me, OK?"

The participants then proceeded to the implicit memory task. They were seated facing the researcher and were shown 34 sets of pictures. The first four were practice pictures and the remaining 30 constituted the memory task. The researcher displayed eight pictures, one at a time, starting at level one (8% complete) and proceeding to level eight (100% complete). The participant’s task was to identify each picture at the lowest level of completion (i.e., the highest level of fragmentation) as early in the sequence as possible. The participant saw each fragmented picture for three seconds, and if at the end of the time period a correct identification had not been made, the next picture in the series was displayed. The participant
indicated recognition by verbally naming the object or animal depicted in the picture. Once the identification had been confirmed, the participant was shown the complete picture for three seconds, and after an additional five second delay, they began the next picture series. The task proceeded in the same manner until all 30 pictures had been identified. Each participant saw one of the four randomly selected orders, and the order of the pictures was the same for both presentations.

After a five-minute break, the participants did the source monitoring task. The objective was whether a participant could distinguish between an action that they had actually performed and one that they imagined themselves performing. The task consisted of 20 actions from a set of 30: ten were randomly selected to be physically performed, ten were randomly selected to be imagined performing and the remaining ten actions were the distracter items on the final memory test. Four different presentations of 20 actions were randomly ordered for this task.

Participants were shown a stack of index cards, which the experimenter turned over. After three seconds, the researcher asked them to perform the action on the card or
imagine themselves performing it. The task proceeded in the same manner until all 20 cards were gone.

After the actions were presented, performance was evaluated by an unannounced memory test. On the recognition test, all thirty actions were presented to the subject, and their task was to indicate if it was an action that they performed, an action that they imagined themselves performing, or a new action that they neither performed nor imagined themselves performing. An example of the Source Monitoring Response Sheet, which includes a list of the thirty actions, can be found in Appendix E.

After a five-minute break, they proceeded to the second part of the implicit memory task. They were shown the original 30 pictures a second time. The procedure was the same as before.

When the participant had completed the implicit memory task, the experiment was completed. At this time, the researcher thanked them for their participation. This cue was supposed to remind the subject that he or she was expected to return the poker chip. At this time the subject was given a final one-minute break. If after the break they failed to return the chip, the researcher
reminded them by saying, "By the way, could you please return the chip now?" The subjects were then debriefed, and notified of the true nature and purpose of the experiment and how these types of memory are used in everyday life.

Level of Activity

Activity participation was determined by modifying the FLA. The original study by Kozma, Hannah, and Stones (1990) examined physical measures (e.g., aerobic power, grip strength, flexibility, sit-ups, and pushups) and their relationship with length of time spent engaged in long-term physical activity. Two measures were examined in the current study. The first was a combined activity (CA) score which was calculated by adding the total hours a subject participated in activities per week, and multiplying this score by the number of activities participated in per week. For example, if a subject spent 72 hours participating in 9 activities, their CA score would equal 648 hours. The subject's total score (648) then became the criterion for inclusion in an activity group; the top twenty scores represented the active group (average 1949.76 hours); subjects with the middle twenty
scores were the moderate group (average 954.6 hours); and the lowest twenty scores the sedentary group (average 492.5 hours).

The two variables used to form the CA score (hours of activity and number of activities) were combined to yield a comprehensive representation of a subject's activity participation. It was believed that both of these measures are equally important, and when examined together, provide an accurate measure of a subject's activity level (e.g., active, moderate, or sedentary). Activity participation for this study was considered to be a twofold concept, and since no method was found in the literature that examines the combined influence for these two variables, the CA score was devised.

The second measure separately examined one component of the CA score: hours per week spent in activity. This was calculated by adding all the time spent in each activity. The second component of the CA score: number of different activities a subject participated in per week, was calculated by counting the number of activities. The argument can be made that activity level is best measured by the total amount of activity, regardless of the number of different activities. For this reason, we defined a
different set of three activity groups based only on total hours active. Subjects were divided into groups by assigning the top twenty scores to the active group, the next twenty scores to the moderate group, and the lowest twenty scores to the sedentary group.

To determine if the two sets of groups (groups based on their CA score and those based on total hours active) were similar, we looked at the number of subjects that changed activity groups when total hours of activity was used as criterion for inclusion in a group as opposed to the CA score. When the subjects were divided into groups based on the total amount of hours active, 80% of the sedentary group, 75% of the moderate group, and 90% of the active group remained the same. Furthermore, no subject moved more than one group, either up or down. These differences can be considered minor and explain how both measures produce activity groups that are similar. For this reason, the pattern of results presented below are generally the same regardless of what measure is used to define the activity group. We will present the results for the activity groups based on the CA score, and will note any different results found when the activity groups were based on hours active.
The primary interest of the present research is whether leisure activity affects memory performance. Specifically, it is believed that a high level of activity enhances cognitive performance. All statistical tests of significance were run at the $p = .05$ level (except where stated) and Tukey's Honestly Significant Difference test was the post hoc test used.

**Memory Tasks**

The three types of tasks examined were 1) prospective memory, which is the ability to remember to do something at a later time, 2) implicit memory, which involves using unconscious memories to facilitate future performance, and 3) source monitoring, which is the ability to distinguish a source of information. Performance on these tasks for each activity group is presented in Table 1. Memory Performance for the Three Activity Groups.

**Prospective Memory**

At the onset of the experiment, participants were given a white poker chip with their subject number on it

RESULTS
TABLE 1. Memory Performance for the Three Activity Groups

<table>
<thead>
<tr>
<th></th>
<th>SEDENTARY</th>
<th>MODERATE</th>
<th>ACTIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROSPECTIVE MEMORY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Percent returned)</td>
<td>35%</td>
<td>15%</td>
<td>45%</td>
</tr>
<tr>
<td><strong>IMPLICIT MEMORY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Average number of pictures)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First viewing</td>
<td>5.57</td>
<td>5.34</td>
<td>5.25</td>
</tr>
<tr>
<td>Second viewing*</td>
<td>4.31</td>
<td>3.93</td>
<td>3.51</td>
</tr>
<tr>
<td>Item saving score*</td>
<td>1.26</td>
<td>1.41</td>
<td>1.74</td>
</tr>
<tr>
<td><strong>Source Monitoring</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall proportion correct</td>
<td>.86</td>
<td>.88</td>
<td>.89</td>
</tr>
<tr>
<td>Proportion correct</td>
<td>.92</td>
<td>.97</td>
<td>.96</td>
</tr>
<tr>
<td>(performed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion correct</td>
<td>.81</td>
<td>.80</td>
<td>.82</td>
</tr>
<tr>
<td>(imagined)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identification of Origin*</td>
<td>.78</td>
<td>.85</td>
<td>.89</td>
</tr>
<tr>
<td>Identification of Origin (performed)</td>
<td>.90</td>
<td>.93</td>
<td>.91</td>
</tr>
<tr>
<td>Identification of Origin (imagined)*</td>
<td>.66</td>
<td>.74</td>
<td>.85</td>
</tr>
<tr>
<td>False Alarms*</td>
<td>.26</td>
<td>.24</td>
<td>.08</td>
</tr>
</tbody>
</table>

Note: *p = .05.
and were asked to return it when the experimenter thanked them for their participation. The information gathered was whether the poker chip was returned at that time. It was hypothesized that the most active participants would remember to return the poker chip more often than those with sedentary or moderate lifestyles. Although active participants returned the chip with the highest frequency, differences between the groups were not significant $\chi^2 (2, N = 60) = 4.31$.

Implicit Memory

Performance on the implicit memory task was evaluated by item savings. This score was measured by calculating the difference between the average number of fragmented pictures needed to make an identification between the first and second viewing. For example, if a participant needed an average of six pictures to make an identification during the first viewing, and needed an average of only four on the second viewing pictures, the item savings score equaled two. It was hypothesized that participants who lead an active lifestyle would display a greater item savings score.
Table 1 presents the average number of pictures required to identify the picture for both the first and second viewing. Also presented is the item savings score, which is simply the difference between the two averages. Differences between the means of the three groups were significantly different. The sedentary activity group improved by an average of 1.26 pictures, the moderate activity group saved an average of 1.41 pictures, and the active group improved by an average of 1.74 pictures, $F(2, 57) = 5.75$. Post-hoc tests revealed a significant difference between the sedentary vs. both the moderate and active group, with no significant differences between the moderate and active groups.

Individual ANOVA's were also performed on the data for the first and second viewing separately. The three activity groups did not significantly differ on the first viewing, $F(2, 57) = 2.43$. This implies that the groups started out similarly on the number of pictures needed to make an identification. Mean differences for the second viewing supported the hypothesis that active participants required fewer pictures to make an identification, $F(2, 57) = 5.67$. The post hoc test supported the finding that
the active group was significantly different than the sedentary and moderate groups on the second viewing.

Source Monitoring

Source monitoring is the ability to recall the source of information. Performance is evaluated by whether the participants remember if they physically performed an action, or only imagined themselves performing an action. One common measure in the source monitoring literature is overall proportion correct, which calculates the proportion of items correctly identified as old, regardless of correct source identification. As seen in Table 1, the three activity groups did not significantly differ on this measure, $F(2, 57) = 0.30$. This indicates that activity had little effect on whether the subject remembered an action as old or new (distracter). Proportion correct was also calculated separately for the performed and imagined items; however, no significant differences were found for either of these measures, $F(2, 57) = 0.98$ and $F(2, 57) = 0.07$, respectively.

The thesis also examined identification-of-origin (IDO) scores, which measures source memory performance (see Batchelder & Riefer, 1990). The total number of actions
attributed to the correct source were divided by the total number of actions correctly identified as old. When the IDO score was examined in relation to activity groups, significant differences between the means were found, $F(2, 57) = 4.06$. Post-hoc tests revealed that there were significant differences between the active group compared to both the moderate and sedentary groups. Additionally, when the IDO score was calculated separately for the performed and imagined items, the active group was significantly better in the imagined condition, $F(2, 57) = 3.50$, but not the performed condition, $F(2, 57) = 0.56$.

An additional measure that was examined was the false alarm rate. False alarms occur when subjects state that an item is old (either performed or imagined) when it is actually a new item. When the CA score was used to define the three groups, the measure revealed only marginally significant differences between the means, $F(2, 57) = 2.77$, $p = .07$. When hours spent per week in activity was used to divide the participants into groups, the mean false alarm rate between the groups was significantly different, $F(2, 57) = 4.11$. An examination of Table 1 shows that the most active group had fewer false alarms than did the other two groups.
Demographic Variables

Activity is a complicated concept, and previous research has found that several variables affect participation. In addition to memory measures, this research also examined a number of demographic variables, including education, age, annual income, source of participants, gender, marital status, life satisfaction, and health. We also examined time taken to complete the experiment as an additional variable. The purpose was to determine if any or all of these variables play a role in memory or activity participation. Table 2 presents demographic information for the three activity groups.

Education

One variable thought to influence activity participation is education. Education was measured in months from the first grade on. There was a significant difference between the means on education for each group, which indicates that the three activity groups differed on their levels of education, $F(2, 57) = 5.80$. Post-hoc tests revealed that the sedentary group had less education than the moderate or active group. The sedentary group averaged 11.3 years of education, while the moderate and
<table>
<thead>
<tr>
<th>TABLE 2. Demographic Information for the Three Activity Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEDENTARY</td>
</tr>
<tr>
<td>ACTIVITY LEVEL* (in hours)</td>
</tr>
<tr>
<td>EDUCATION* (in months)</td>
</tr>
<tr>
<td>AGE* (in months)</td>
</tr>
<tr>
<td>ANNUAL INCOME</td>
</tr>
<tr>
<td>1= less than $10,000</td>
</tr>
<tr>
<td>2= $10,000- $19,999</td>
</tr>
<tr>
<td>3= $20,000- $29,000</td>
</tr>
<tr>
<td>4= $30,000- $39,999</td>
</tr>
<tr>
<td>5= over $40,000</td>
</tr>
<tr>
<td>SOURCE OF PARTICIPANT*</td>
</tr>
<tr>
<td>Senior centers</td>
</tr>
<tr>
<td>Retirement communities</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>PERCENT MALE</td>
</tr>
<tr>
<td>PERCENT MARRIED</td>
</tr>
<tr>
<td>TIME (in minutes)</td>
</tr>
</tbody>
</table>

Note: $p = .05.$
the active group averaged 14.0 and 13.9 years, respectively. However, when activities groups were defined by the total number of hours active, the results did not indicate a difference between the groups means on education, $F(2, 57) = .33$. One measure, the CA score, indicated that the amount of education influenced activity participation, but did not influence the total number of hours active. This is an interesting finding, because there is little indication as to what is causing this difference.

Years of education proved to be an influential variable in activity participation when examined with the CA score and provides the basis for inclusion in an activity group. In addition, level of education may have an influence on various memory tasks. To examine the extent of education's influence, an analysis of covariance (ANCOVA) was run on each of the original ANOVA results, using education as a covariate.

The initial ANOVA indicated that the activity group a subject belonged to influenced his or her IDG score, $F(2, 57) = 4.06$. When education was used as a covariate, the results remained significant, $F(2, 56) = 5.32$. This indicates that education is not a confounding variable in
the difference between the groups recalling the source of an action. An initial ANOVA was calculated separately on the performed and imagined conditions, and the results indicated that the active group was better than the other groups in recalling an action as imagined, $F(2, 57) = 3.50$. When the effects of education were controlled by the ANCOVA, the results remained significant, $F(2, 56) = 5.52$. This also indicates that education is not a confounding factor in the activity differences on remembering an action as imagined. An additional measure that was examined was the false alarm rate, which is when a participant responds that a new item is old. The original ANOVA's yielded different results when the two activity scores were used to divide the subjects into groups. When the total amount of hours was used to divide the participants into groups, the results were significant, but when the CA score was used, the results were only marginally significant. Furthermore, to determine if specific variables in the present study influenced this measurement, ANCOVA's were run for the two activity groups using education as a covariate. The ANCOVA that was run using the division of participants based on their CA score indicated that the group differences remained marginally significant, $F(2, 56) = 2.70$ $p = .07$. 57
Finally, the ANCOVA examining the groups based on the total number or hours active indicated that there were still significant differences between the groups, $F(2, 56) = 4.03$.

Age

Another variable that may influence activity participation is age, which was measured in months. Participants in the three activity groups significantly differed on age, $F(2, 57) = 11.55$. The average age in years for the sedentary group was 80.1, 73.6 for the moderate group, and 68.2 for the active group. In addition, age is well known from prior research to affect memory measures. For this reason, a series of ANCOVA’s were calculated that reanalyzed the effect of activity level on the various memory measures using age as a covariate.

The original ANOVA performed on the implicit memory data indicated that the activity group a participant belonged to was a contributing factor in his or her ability to identify the pictures faster on the second viewing, $F(2, 57) = 5.75$. To the extent age may affect memory performance, therefore covary, the ANCOVA results were no
longer significant, $F(2, 56) = 1.47$. Similar findings were found for the source monitoring tasks. The IDO score with age factored out as a covariate was no longer significant, $F(2, 56) = 0.99$. Also, active participants recalled more imagined actions than the other two groups, but when age was used as a covariate these differences were no longer significant, $F(2, 56) = 1.20$. These results imply that age is a contributing factor and may account for the differences between the activity groups on these measures.

The original ANOVA's run on the false alarm data yielded different results when the two activity scores were used to divide the participants into groups. When the total amount of hours was used to divide the participants into groups, the results were significant, but when the CA score was used, the results were only marginally significant. To determine if age influenced this measurement, ANCOVA's were run for the two activity scores using age as a covariate. The ANCOVA run with the participants divided into groups based on the CA score and age as a covariate indicted that there were no significant differences between the three groups, $F(2, 56) = .71$. Finally, the ANCOVA run on the groups based on the total
number of hours active and age as a covariate indicated that there were no longer significant differences between the three groups, $F(2, 56) = 1.37$. These results indicate that age is a contributing factor in subjects' ability to distinguish new from old actions in this study.

Annual Income

Subjects were asked to state their income and were given a choice of five categories: 1= under $10,000, 2= $10,000-19,999, 3= $20,000-29,000, 4= $30,000-39,999, and 5= over $40,000. In previous research, income has had a significant influence on activity participation in that subjects with a higher income were more active; however, in the current study, income did not have this effect. Statistical analysis using an ANOVA did not indicate that income was a significant factor as to which activity group the subject belonged to, $F(2, 57) = 1.21$.

Source of Participants

Participants were recruited from three sources: senior citizen centers, retirement communities, and other sources: (friends etc.). Statistical analysis indicated that activity level and source of participants were not
significantly associated $\chi^2 (4, N = 60) = 7.12$. However, when the source of participants and the activity groups based on hours of activity were examined, the analysis implied that these two variables were significantly associated $\chi^2 (4, N = 60) = 10.64$. Based on this measure, subjects from community centers and other sources appear to spend more time participating in activities than do subjects from retirement communities.

Marital Status

The participants were asked about their current marital status and were divided into those who were married vs. those who were not. Using these categories, statistical analysis revealed that marital status marginally influenced activity participation, $\chi^2 (4, N = 60) = 5.90 \ p. < .10$. As seen in Table 2, sedentary participants were more likely to be unmarried than participants in the other two activity groups.

Gender

We also explored whether sex of participants influenced activity participation. Results indicated that
the three activity groups did not significantly differ with regard to gender, \( \chi^2 \) (4, \( N = 60 \)) = 0.42 (see Table 2).

Health

The participant's current health status was evaluated by asking a series of questions about recent illness and/or conditions and included alcoholism/drug dependence, heart attack, chronic conditions of major systems, depression, stroke, high blood pressure, cancer, Alzheimer's disease or Korsakoff's disease. Each participant started out with a total of 22 points (perfect health), and for each "yes" answer, one point was subtracted from the total. Previous research has indicated that certain health problems may be an indication of an inability to participate in activities and that certain medication (i.e., blood pressure) may cause memory impairment. However, in this thesis, the three activity groups did not significantly differ on their health status, \( F \) (2, 57) = 2.13. The thesis also examined the effects of high blood pressure alone and as before, found no significant differences between the means of the three groups, \( F \) (2, 57) = 2.17.
Time

The amount of time need to complete the experiment was examined. Table 2 presents the average time (in minutes) taken to complete the experiment for each activity group. The difference between the three means was not significant, indicating that the time taken was not influenced by what activity group the participant belonged to, $F (2, 57) = 2.18$.

Life Satisfaction

Life satisfaction was determined by asking the participant to indicate on a seven-point Likert scale how satisfied he/she was with their life. Statistical analysis implied that life satisfaction was not an influential factor in a subject's activity participation, $F (2, 57) = .80$.

Correlations

Participants were divided into one of three activity groups based on their CA score. However, valuable information about each participant's individual score was lost when they were divided into groups. Also, because this measure is a combined score and does not consider the CA score's separate components, correlation analyses were
run on both the total number of hours active and the number of different activities. Both demographic and memory variables were examined, including age, education, IDO score, false alarms, item savings score, health, and life satisfaction. The overall results examining each measure individually were similar to the correlations using the combined CA score, and any differences will be noted below. Generally, the correlation data supported what was found by the ANOVA's. For example, the variable of age was significantly correlated with the subject's CA score, $r (58) = -.59$, as well as the number of activities engaged in per week $r (58) = -.40$ and the number of hours spent participating per week, $r (58) = -.60$. All of these correlations show that the older participants were significantly less active. We examined the CA score and its correlation with memory tasks and found that activity correlated with performance on the implicit memory task, $r (58) = .45$, memory for imagined actions in the source monitoring task, $r (58) = .35$, and the false alarm rate, $r (58) = -.36$. The number of activities engaged in per week and the number of hours spent in participation were significantly correlated with the false alarm rate, $r (58) = -.27$ and $r (58) = -.35$ respectively. These results
indicate that the least active participants took longer to make an identification in the implicit memory task, recalled fewer actions correctly as imagined in the source monitoring task, and incorrectly identified more old items as new. Furthermore, consistent with the ANOVA results, activity was not correlated with the overall proportion of items remembered as old in the source monitoring task [r (58) = .11], nor with time [r (58) = -.16], or education [r (58) = .24, p = .07]. The additional variable, number of activities engaged in per week, was significantly correlated with the amount of time per week spent engaging in activities [r (58) = .43], time taken to complete the experiment [r (58) = -.26], health [r (58) = .34], and life satisfaction [r (58) = .32].

Additionally, we examined age and its correlation with the memory tasks and found that age correlated with the implicit task, r (58) = -.48, performance on the imagined actions in the source monitoring task, r (58) = -.39, the overall proportion of items remembered as old, and finally, the false alarm rate, r (58) = .43. These results indicate that the oldest participants took longer to make an identification in the implicit memory task, recalled fewer actions as imagined in the source monitoring task, and were
more likely to identify an old item as new. Age also was significantly correlated with education $r (58) = -.39$, and health $r (58) = -.27$. This indicates that older participants had fewer years of education and poorer health. Furthermore, age was correlated with the overall proportion of items remembered as old in the source monitoring task $r (58) = -.39$, but not the time taken to complete the experiment $r (58) = .25$, $p. = .057$. 
DISCUSSION

Does leisure activity share a relationship with cognitive performance, as does physical activity? It was hypothesized that, based on a division of lifestyle choices, subjects who participated in a greater number of activities and for a longer amount of time would perform better on higher-order memory tasks. One body of literature has examined physical activity using physiological measurements and how this effects simple memory tasks (i.e., choice reaction and working memory). A second body of literature has examined leisure activity and life satisfaction and has found that happier people are more socially active.

The present study acknowledges that the areas of research in both bodies of literature are important, but some aspects may not be beneficial to an older population. For instance, the first body examines only simple memory tasks, but functioning higher-memory performance is also a crucial aspect of daily functioning. If a variable is found to influence cognitive performance, this could improve the quality of life by suggesting appropriate intervention. The second body of literature has examined
leisure activity. This could be a pertinent variable to examine, because physical activity tends to decline as we age. Physical activity has been extensively studied in the lab by monitoring and assessing the benefits of the extent and length of physical exercise and how it affects the quality of life.

Although results have generally agreed that exercise is beneficial for subjects of a certain age, we are left with the question: Does physical activity as well as age influence memory performance in older participants? Unfortunately, in an older population, this may not be the measure of choice. Boothby et al. (1981) found that adults (65+) decrease their level of physical exercise for various reasons, including loss of interest, ability, opportunity etc. Physical exercise may offer physical fitness, but the more diverse leisure activity can have more of a cerebral effect, which could affect cognitive performance. So it seems reasonable to examine leisure activity, which is known to increase with age.

Memory Tasks

The present study examined leisure activity and its relationship with three types of memory performance, two of
which are known to decline with age (prospective memory and source monitoring) and one that remains stable (implicit memory) as they are measured in research that compares young and old subjects. It was decided to examine these memory tasks across old age (60+) to determine if these patterns existed in older populations.

Prospective Memory

In the prospective memory task, participants were asked to put the poker chip in their pocket or purse and return it at a specified point later in the experiment. The results showed that participants’ total activity level did not influence whether they remembered to return the poker chip. Simply put, their failure to return the poker chip did not support the hypothesis that active participants would remember to return the chip more often than the sedentary or moderate groups.

Why did 68% of the participants fail at this seemingly easy task? There are a number of reasons as to why over 2/3 of the participants failed to return the poker chip. For example, Cohen (1989) felt that incentive and motivation are important to the successful completion of the task. Furthermore, tasks that are self-imposed, novel,
or high-priority are known to influence prospective memory, but none of these factors was present in the present study. Another reason could be one of compliance. Einstein and McDaniel (1990) felt that the willingness to complete a task was important. This did not apply to the current study because subjects agreed to participate and did not withdraw; compliance was implied. If intrinsic factors are not present to facilitate memory, the failure to return the chip becomes an issue of remembering to do so.

Cohen (1989) found that most people use a cue to remind themselves that a task must be completed, for example, writing a note or circling a date on the calendar. Furthermore, for a cue to be effective, it must be used efficiently. The participants in this experiment did not have an opportunity to establish and use a cue to remember to return the poker chip. The participants were asked to place the poker chip out of sight, but approximately six participants would not or could not put the poker chip away and left it on the table. Surprisingly, none of the six returned the poker chip at the expected time. In this instance, a visual clue was not a guarantee that the participant would remember to return the poker chip. Could it be a problem with modality? Would the participant have
been more likely to remember the task if they had read the
directions instead of hearing them? It would be
interesting to explore this in future research.

An additional possibility was that some participants
only appeared to be listening to what was asked of them,
despite the fact that everything possible was done to
ensure that each participant understood what was expected
of them. Each poker chip was labeled with a number (to
disguise its real purpose) and participants were told it
was for identification purposes. At the end of the
experiment, several participants recited their number at
the time they were expected to return the poker chip. It
seemed that they were so sure that this is what they were
asked to do that they forgot to return the chip.

Finally, a possible explanation as to why there was
not a significant difference between the three activity
groups is that this type of memory may not be maintained or
improved by level of activity. What is interesting about
this study is that the results might represent one of the
few memory patterns that are resistant to factors that are
known to help other types of memory (i.e., physical
exercise or mnemonics).
Implicit Memory

For the implicit memory task, participants were shown two viewings of the fragmented pictures and were asked to try and identify each picture at the lowest level of completion for each viewing. Graf and Schacter (1985) defined implicit memory as the use of unconscious memories to facilitate future memory performance. In other words, participants used memories of the first viewing to help them identify the pictures earlier during the second viewing. Significant differences on the item savings score were found between the three activity groups and thereby support the hypothesis that the more active a subject is, the better his or her performance on the implicit memory task. To determine the source of this effect the scores on the first and second responses were examined. The number of pictures needed to identify the object or animal was not significantly different between the three groups on the first response, which demonstrates that the three groups started out equally. It was with the second response that the differences were found, and this supports the hypothesis that the most active participants needed fewer pictures to make an identification on the second viewing.
These results support Snodgrass and Feenang's (1990) view that if priming (the first viewing) facilitates implicit memory performance, then picture identification will be faster on the second viewing. This is exactly what happened; all three groups exhibited some priming in that they all improved to a certain degree. The sedentary group's savings score improved an average of 1.26 pictures per set, the moderate group saved an average of 1.41 pictures per set, and the active group saved an average of 1.74 picture per set, so the active group required fewer pictures to make an identification. So at first glance, the amount of activity participation per week and the total number of activities engaged in per week had an effect on priming and ultimately implicit memory performance.

To determine what variables influenced the significant differences between the groups, a series of ANCOVA's were conducted which examined income, education, and age. When income and education were factored out, the results remained significant. This supports the general conclusion that activity level and not these two variables, influences people's performance on the implicit memory task. However, when age was examined as a covariate, the differences between the three groups were no longer statistically
significant. This indicates that age may be a factor in the implicit memory results.

How can the differences found in the current study be explained? At first glance, age and/or activity level appear to be the cause. Previous research has examined age extensively in relation to implicit memory, and has shown that implicit memory does not exhibit characteristic patterns of decline across the life span. For example, both Light and Singh (1987) and Russo and Parkin (1993) compared young and old participants on implicit memory tasks and found little differences between the two groups. Based on results such as these, it is generally believed that age does not affect implicit memory as it does free recall or source monitoring.

In the present study, participants who were the most active were also the youngest, suggesting that age could possibly be a factor in the results. But the above research lends support to the idea that it is not age that is responsible for these differences. It is therefore reasonable to conclude that time spent in leisure activity is the most likely underlying cause of the implicit memory differences between groups. These results suggest that
leisure activity could prove to be an intervention that forestalls any possible decline of implicit memory.

Source Monitoring

Source monitoring is the ability to recall the source of information. For the present study, participants' task was to determine whether actions were performed, imagined, or new. The thesis examined two standard measures in source monitoring, overall proportion correct and the IDO score.

Overall Proportion Correct

The overall proportion correct calculates the proportion of items correctly identified as old, regardless of the correct source identification. There were no significant differences between the three groups on this measure, which indicates activity level has no effect on whether a subject identifies an action as old.

It was hypothesized that the more active a participant is, the better he or she would perform on the source monitoring task. However, the three activity groups did not statistically differ on their overall proportion correct. As seen in Table 1, all of the three activity groups actually did quite well on this measure, with even
the sedentary group correctly identifying 86% of the actions. This suggests that there may have been a ceiling effect, which suppressed any possible difference between the groups.

The measure of the overall proportion correct is measured by recognition memory and is employed when a participant identifies the correct answer because it appears familiar. There are three possible explanations as to why our results were not significant. First, it is possible that age exerts an influence on this type of memory performance. However, this is not supported by the literature, as it appears that recognition memory generally does not decrease as we age (Craik, Byrd, & Swanson, 1987; Perlmutter, 1979). The fact that most previous researchers found that older participants perform as well as young subjects is an indication that age is probably not a factor that contributed to the recognition performance for the three groups.

But age has been a factor in recognition memory in at least one prior study. Hashtrudi et al., (1989) found that age had an effect on performance when they examined a measure of recognition memory. However, in this thesis a significant factor of age could be a cause of the non-
significant differences in activity level only if it
counteracts a significant effect of activity. Therefore, a
second possible explanation is that both age and activity
level affect this type of memory, but in opposite
directions. The net effect would be no significant
differences across the three groups, which was in fact
observed. However, this possibility is not feasible for
the following reason. If activity level has a significant
affect on recognition performance, we would expect the most
active group to have the highest score and the sedentary to
have the lowest score. But the most active participants
were also the youngest and the least active participants
were the oldest. Therefore, for age to have the opposite
effect as activity, the youngest would have to perform
poorly, while the oldest would have to have the best
performance. This is an illogical, and hence unlikely,
pattern of results.

A final possibility is that activity level does not
influence this type of memory. This is the most probable
explanation because, unlike implicit memory, activity level
does not appear to stimulate the processes that enable a
subject to recognize a familiar action. Although our
hypothesis was not supported, it is as important to
discover variables that do not affect memory, as it is to find variables that do. For this study, the variables that contribute to performance on the overall proportion correct remain an enigma. Future research needs to examine different variables and determine if they can forestall the decline of this type of memory.

**IDO Score**

The second measure examined for the source monitoring data was the IDO score. This is a measure of source memory and is the number of actions attributed to the correct source divided by the number of action correctly identified as old. There were significant differences between the three groups on the IDO score and these differences were found in the imagined condition. This indicates that the most active participants were better at remembering an imagined action as opposed to a performed action. As seen in Table 1, all three groups did quite well on the performed component of the IDO score (with scores ranging from .90 to .93). This suggests that there may have been ceiling effects which suppressed any possible differences between the groups on the performed component.
If age was not a factor that produced the differences between the three groups, then what is the underlying factor? These differences could be attributed to group differences in activity level (i.e., the most active group had the highest score on the imagined actions). Although it is not clear from the present study whether this type of memory remains stable throughout the life span, it is possible that leisure activity stimulates the processes that are important to remembering an item that was internally generated.

As before, when age was used as a covariate, there were no significant differences between the three groups. Therefore, we can ask to what degree the variable of age is affecting older participants' source memory in this study. We can do this by looking at previous literature on older participants' ability to recognize performed and imagined action. For example, Johnson and Raye (1981) examined how accurately participants are able to discriminate between externally and internally generated memories. For the present experiment, external memories represent the performed actions while internal memories represent the imagined items. Johnson and Raye (1981) found that participants are more likely to remember internal items
because memory is dependent on easier-to-recall cognitive operations, which include reasoning, inferring, and imagery. Hashtrudi et al. (1989) found that external memories are affected by age (young vs. old) because these memories are based on less memorable sensory/perceptual aspects of an item. These researchers also found that internal memories are not affected by age. However, opposite results occurred in the current study, which examined activity level instead of age on source monitoring performance. Specifically, activity level affected internal memories but not external memories. These opposite results speak against age as a confounding variable, because if age were a confounding variable, the results should be consistent with previous research on age and internally generated memories would not be affected. Therefore, it is reasonable to assume that the significant differences were due to activity level and not age, which supports the hypothesis that the most active participants perform better on this memory task.

**False Alarm Rate**

A final measure of source monitoring that we examined was the false alarm rate. When the participants were
divided into groups using the CA score, the results were only marginally significant. But when the hours spent per week in activity was used to divide the participants into groups, the mean false alarm rate between the three groups was significantly different. This difference represents one of the conflicting results obtained with the measures and indicates that activity level seems to exert some, perhaps weak, influence on the false alarm rate. This also suggests that perhaps the CA score is too complex to predict whether a participant is able to correctly reject old items. However, the direction of this effect was consistent with the hypothesis that the most active subjects would have fewer false alarms.

Demographics and Leisure Activity

It is not enough to discover whether leisure activity influences memory performance; the factors that influence amount of time spent participating in leisure activity should also be explored. This knowledge is valuable when older adults are faced with a decline in ability and/or desire to participate in physical activity, and must therefore find alternatives to this type of activity. In previous research an emphasis has been placed on physical
activity and demographic factors and their impact on participation across the life span (e.g., Hobart, 1975). This thesis examined several of these variables, plus others, to discover if they also impact the amount of time spent in leisure activity.

Education

Education's value lies in the participants' awareness of the benefits derived from activity. Previous literature, which has examined physical activity, found that there is a relationship between the two variables. Does this relationship extend to leisure activity? The CA score indicated that educational background was significantly different across the three activity groups. Correlational analysis was performed on the data and indicated the relationship between education and activity group was not strong and only marginally related to the CA score. This indicates that the amount of education has some, perhaps weak, influence on how active a subject is.

Age

Age appears to be an underlying factor in how active a participant is. Previous research has emphasized the relationship between age and the amount and affects of
physical activity. This trend is also apparent when examining leisure activity. Younger subjects tended to participate in more activities for a longer amount of time. The CA score indicated that age is a significant factor in determining which activity group a participant belonged to. Correlational analysis also indicated that the nature of this relationship plays an important role in the significant differences between the three groups on the memory tasks. These results are supported by the fact that the older participants were the least active, while the younger participants were the most active.

Annual Income

Income is not a variable that has been examined in relation to leisure activity. For the present thesis, it was thought that a participant with a higher annual income would also be the most active, as extra money would allow subjects to participate in more activities that are pleasurable, but also cost money (e.g., travel, hobbies, or sports). This trend was not found when the CA score was used to divide the participants into groups. Correlational results also indicated that there was not a significant relationship between the amount of leisure activity and
income. It is important to discover that this relationship does not extend to leisure activity, as a large percentage of older adults have a lower income when they retire.

Source of Participant

Since this variable has not been examined in relation to physical activity, we hypothesized that participants who had access to planned activities would be more active. Participants were recruited from three sources: retirement communities, community senior citizen centers, and other sources, which included friends, family, and referrals. Participants who live in retirement communities are offered an array of different opportunities to participate in leisure activity as well as socialize. However, when the participants were divided into groups based on hours active, statistical analysis found the contrary; both participants who lived at home and frequented community centers and others who did leisure activities on their own were found to be the most active. The label "retirement community" in some instances may be a misnomer. For example, the residences visited for this thesis could be considered one step above full-time care; not only were the participants in poor health, they also appeared to be on
more medication than those from other participant sources. These personal observations could explain why this source of participants tended to be lower in its activity level. This indicates a need to restructure the activity programs offered by retirement communities so that these older persons who are in poor health can take advantage of the opportunity to increase their activity lifestyle.

Marital Status

It was thought that the married participants would be the most active because of the social aspect of company during activity. The results indicated that marital status marginally influenced how active a participant was. The sedentary group tended to be unmarried while the moderate and active groups were evenly split (half-married, half-unmarried). This analysis could be misleading, because age appears to be an underlying factor. Although unmarried participants had a tendency to be less active, they were also significantly older too.

Gender

Are men or women more active? An interesting observation was made by Stevenson and Topp (1990) that most exercise studies of the older person has focused on male
subjects. This prompted us to examine the differences between the sexes in activity participation. However, based on our sample there were no differences in activity participation between the sexes.

Health

Based on the findings from the physical activity literature, health plays an important role in whether an older adult engages in physical activity. Because our sample consisted of older participants (60+) who are more apt to have a chronic condition, it was thought that traditional age-related medical conditions and their subsequent medication would affect the older adult's activity level, and indirectly affect memory performance. We specifically examined for diseases that affected the circulatory systems (e.g., high blood pressure, chronic heart and/or blood vessels disease, and strokes), because these problems of the circulatory system and/or their medication are thought to impair some memory performance. Participants were asked to rate their recent health for 22 different health-related problems. For each affirmative answer one point was deducted from the total. Each participant's final score was considered a self-reported
indication of their health status. When the CA score was used to divide the participants into groups, the results indicated that there were no significant differences on health status. Conversely, correlational analysis indicated that the number of activities a subject participated in per week was influenced by their health status, but not the amount of time spent engaged in activity. This indicates that health status is more influential when a participant actually decides to go out and do something as opposed to how much time is spent once he or she is engaged in this activity.

Basically, there were no significant differences between the three groups on health status based on their CA scores. This suggests that the health of all three groups started out the same and arguably, equally limited to certain activities. All subjects had health problems of one kind or another; in fact, 55% of the 60 subjects suffered from high blood pressure, heart or blood vessel problems, or suffered a stroke. In much of the physical activity literature, it is preferable that subjects be free of overt cardiovascular diseases (Blumenthal & Madden, 1988). In the current study, subjects were not excluded because of these problems, as it was felt older adults with
these problems are fairly representative of the general population. By allowing these subjects to participate, it was felt that we could get an idea of how these "non-healthy" adults function. Our results indicated that health problems such as these are not necessarily indicative of a memory problem.

Life Satisfaction

A large body of literature looks at life satisfaction and its affect on a participant's life. It is believed that being satisfied with one's life is an important aspect of aging. Researchers who examined life satisfaction found that the more satisfied a person is the more likely he or she is to participate in leisure activities (Atchley, 1971). We found that life satisfaction also shares a relationship with the number of activities a subject participates in, but does not influence how many hours that are spent in activity. This is consistent with the results found using the CA score, which showed no significant differences between the three activity groups on their level of life satisfaction. These results indicate that life satisfaction continues to be an important aspect to successful aging. This knowledge can be applied to
formulate interventions with older adults who may not be happy with their life and wish to improve it.

Activity Measurement

A review of the literature supports the idea that leisure activity is a multidimensional concept and is subject to interpretation. Leisure activity includes a variety of activities and includes, but is not limited to, physical activity. We chose to offer a list of 43 various activities that included physical activity, social activity, family orientated activities, hobbies, and volunteer work. This appeared to be a comprehensive list that included activities that an older adult might participate in.

Previous research has primarily focused on physical activities. In this thesis the primary physical activity that a participant engaged in was walking, as opposed to sports, exercise/aerobics, jogging, etc. A total of 83% of the subjects engaged in some kind of physical activity: 80% of the sedentary group, 90% of the moderate group, and 80% of the active group. This indicates that at least for this population, physical activity was not the deciding factor.
as to whether the participant performed well on the memory tasks.

The primary measurement used in this thesis to divide the participants into three groups was based on Kozma, Hannah, and Stones (1991) FLA, which combines the amount of time spent per week per leisure activity with the number of months active. Because of the FLA's inability to discriminate among activity participation beyond nine months, a long-term effect of leisure activity could not be assessed. For the purpose of this thesis, the focus was on the quantity of leisure activity, how many different activities the subject participated in, and for how long each time (the CA score).

To test the reliability of the CA score, separate statistical analyses were run on the two variables that were combined to create the CA score. Analyses indicated that the results were comparable when looking at the two measures separately. When the total number of hours engaged in activities per week was used to divide the subjects into activity groups, similar trends were found between the means of most of memory tests: the IDO score, performance in the imagined condition of the source monitoring task, and the implicit memory task.
The similar results between the two measures are an indication that the CA score and the two variables measured separately are measuring a similar concept. The CA score is preferable because of its inclusion of how many different activities a subject participates in per week. It is felt that the time active or number of activities alone is not enough to get a sense of the depth of activities that an older adult participates in.

Statistical analyses revealed only a few minor differences. For example, education was not significant when examined with the CA score as it was with both the total hours active and number of activities engaged in per week. This is a puzzling difference, because education is known to influence activity participation. An additional difference is in the false alarm rates; significant results were found for the total hours of participation and number or activities engaged in weekly, but not for the CA score, which was marginally significant. Finally, one demographic variable, the source of the participant, was significant when examined with the total amount of time spent in activities, but not with the number of activities or the CA score.
The replication of the significant results by the CA score in relation to the total number of hours spent in activity and the total number of activities engaged in per week may be an indication of the CA score's reliability and usefulness in this study. These differences can be considered minor and do little to compromise the overall results of the experiment.

There is a need to caution the reader to potential problems inherent in both measurements of activity participation: all the data were self-reported. There is a possibility that some participants may have over or underrated the extent of their participation. For example, the five most active participants each reported a total of more than 168 hours per week (average age 60.04), which is more hours than actually exists in one week. Seventeen participants reported spending 112+ hour per week in activity (average age 68.32). These may be valid numbers if two or three activities are done at the same time, for example, walking and listening to music on a Walkman. In the future, based on these self-reports, the researcher must be able to verify activities reported and not rely solely on participants' reports.
FIML, CONCLUSIONS

A common complaint of older persons involves memory performance. Although memory problems can be an indication of serious health problems (e.g., senility or Alzheimer's disease) not all memory decline is inevitable. Until recently, the focus of similar research has been on physical activity. It is well documented that participation in physical activity declines with age. So it is reasonable to also examine leisure activity, which is known to increase with age. This is the focus of the current thesis and it appears that leisure activity lifestyle does have an effect on some memory performance. This was supported by the fact that amount of leisure activity accounted for the differences found between the three groups on higher-order memory (i.e., implicit memory, the imagined condition of the IDO score, and to a lesser degree the false alarm rate). These types of memory are evident when we use unconscious memories to facilitate performance (implicit memory) or try to remember if a memory is today's or yesterday's (source monitoring).

Historically, a potentially confounding variable to memory performance has been age; although activity level
appears to be an influential variable, when age was used as a covariate these significant results disappear. Therefore, age can not be discounted as the primary cause underlying the differences found between the three activity groups. It was theorized that activity level would be a factor because of the significant differences found between the three groups when age and activity level were examined. This idea was supported by the fact that there were not large differences in the overall range of ages. These thoughts were based on previous studies where age was found to be a significant factor in memory performance. For example, Hashtrudi et al. (1989), examined a large age range (young to old) and found significant differences in performance.

The present study chose not to examine a wide range of young vs. old participants, instead it examined participants exclusively across old age (i.e., 68-80). It can be argued that the narrow age range makes it less likely that age is the primary causes of the observed differences in memory performance. Unfortunately, based on the ANCOVA results, this did not occur and age can not be totally ruled out as a contributing factor. Future research on activity level needs to equate different groups
on age. Furthermore, there is a need for additional research centered on older participants. For example, it would be informative to compare old vs. very old participants in order to create a baseline of memory data comparing different age groups. This information is needed before we can examine the impact of intervention across old age.

Although the present research indicates some exciting and promising results, the question remains: Does leisure activity and memory performance share a relationship? The results indicate that the sedentary older person could benefit from this research, but unfortunately, by this time it is too late. Because of this, it appears that any potential benefits of the present findings must be communicated earlier in the life span through education, providing access to leisure activities, and encouraging people to remain active all of their lives.
APPENDIX A: General Questionnaire

Age: years ____ months ____

Martial Status: married ____ single ____
               divorced ____ widow ____

Education: years ____ months ____
(first grade and up)

Annual Income: under $10,000 ____
               $10,000-19,999 ____
               $20,000-29,000 ____
               $30,000-39,000 ____
               over $40,000 ____

Sex: male ____ female ____

Sensory: hearing: normal ____ impaired ____
         if impaired: corrected ____ not corrected ____
      eyesight: normal ____ impaired ____
         if impaired: corrected ____ not corrected ____
APPENDIX B: General Health Questionnaire

In general how would you describe your present health? Please indicate your answer on the scale below, with 7 being little or no health problems and 1 being many health problems.

poor = many health problems  
excellent = little or no health problems

poor 1  2  3  4  5  6  7  excellent

CURRENT HEALTH STATUS

Please mark all that apply to your current health status. This applies to any condition below that was diagnosed by your doctor within the past year. Please be assured that when answering these questions all of your answers will be kept in the strictest confidence.

<table>
<thead>
<tr>
<th>Condition</th>
<th>yes</th>
<th>no</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Alcoholism/substance dependence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Heart attack</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Chronic heart and/or blood vessels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Cardiovascular accident (stroke)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. Depression
6. Brain damage
7. High blood pressure
8. Cancer
9. Alzheimer's and/or dementia
10. Chronic kidney, lung, liver, and/or hormonal system disease
11. Any illness that affects the body as a whole (blood/vascular, circulatory, endocrine, autonomic, or cardiovascular system)
12. Are you currently taking any medication? *
   * if yes, see question 13.
13. If you answered yes to question 12, please indicate all of the medication that you are currently taking below.
   A. Preventive (vitamin supplement, calcium etc.)


B. Occasional (aspirin, antacids, etc.)
C. Maintenance (prescribed by the doctor for diabetes, heart, blood pressure etc.)
APPENDIX C: Activity Questionnaire

A. In general how active do you consider yourself? Please indicate your answer on the scale below, with 7 being highly involved in activities on a regular basis and 1 not being involved in activities on a regular basis.

1 2 3 4 5 6 7
very inactive 1 2 3 4 5 6 7
very active

SUBJECTIVE LIFE SATISFACTION REPORT

B. In general how satisfied are you with your life, as it is now? Please indicate your answer on the scale below, with 7 being very satisfied and 1 being not very satisfied.

1 2 3 4 5 6 7
not satisfied 1 2 3 4 5 6 7
very satisfied
Below you will see a list of 43 activities that are common leisure pastimes for people of all ages. Please indicate the following:

1. how many times per week do you partake in the activity.

2. when you partake, for what duration do you usually engage in the activity? (hours, minutes).

3. for how long have you participated in the activity (weeks, months, years).

4. do you partake in the activity alone or do you partake in the activity with others? *

* if you partake in the activity, but do so both alone and with others, please mark the category which shows what you do most of the time.

To help you understand how to answer the questions, I have provided an example that you can refer back to at anytime.

**EXAMPLE**

<table>
<thead>
<tr>
<th>Activity</th>
<th>times per week</th>
<th>duration each time</th>
<th>how long doing this</th>
<th>alone</th>
<th>with others</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Hobbies</td>
<td>2</td>
<td>3 hrs.</td>
<td>6 mo.</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>B. Eating out</td>
<td>1</td>
<td>1½ hrs.</td>
<td>6 yrs</td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

101
Please indicate how many times per week, duration each time, and how long you have been doing the listed activity in your leisure time. Please mark all leisure activities that you participate in at least once a week. If there is an activity that you do not partake in at least once a week, please indicate so by putting a zero (0) in the first three columns.

<table>
<thead>
<tr>
<th></th>
<th>times per week</th>
<th>duration each time</th>
<th>how long doing this</th>
<th>alone</th>
<th>with others</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Going for walks</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2. Swimming</td>
<td></td>
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<tr>
<td>3. Golf/tennis</td>
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<tr>
<td>4. Boating</td>
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<tr>
<td>5. Fishing</td>
<td></td>
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<tr>
<td>6. Hunting</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>7. Camping</td>
<td></td>
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<tr>
<td>8. Jogging</td>
<td></td>
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<tr>
<td>9. Bowling</td>
<td></td>
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<tr>
<td>10. Bike rides</td>
<td></td>
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<tr>
<td>11. Exercise</td>
<td></td>
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</tr>
<tr>
<td>12. Weight training</td>
<td></td>
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<tr>
<td>13. Reading</td>
<td></td>
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<tr>
<td>14. Participate in drama/art, music</td>
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<tr>
<td>Activity</td>
<td>times per week</td>
<td>duration each time</td>
<td>how long doing this</td>
<td>alone</td>
<td>with others</td>
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<tr>
<td>15. Going to plays/ concerts/ exhibits</td>
<td></td>
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<tr>
<td>16. Dancing</td>
<td></td>
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<tr>
<td>17. Listen to music</td>
<td></td>
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<tr>
<td>18. Family outings</td>
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<tr>
<td>19. Entertain at home</td>
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<tr>
<td>20. Socialize with friends and family</td>
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<tr>
<td>21. Talking on phone with friends/family</td>
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<tr>
<td>22. Visiting with friends/family</td>
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<tr>
<td>23. Talking with others at home</td>
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<tr>
<td>24. Auto trips and other travel</td>
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<tr>
<td>25. Going to bars/ clubs</td>
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<tr>
<td>26. Eating out</td>
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<tr>
<td>27. Gardening/ plants</td>
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<tr>
<td>Activity</td>
<td>times per week</td>
<td>duration each time</td>
<td>how long doing this</td>
<td>alone</td>
<td>with others</td>
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<tr>
<td>28. Attending sports events</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>29. Knit or sew</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>30. Cards/games/bingo</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
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</tr>
<tr>
<td>31. Ceramics</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>32. Fix or build things</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>33. Hobbies</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>34. Clubs</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>35. Attend school</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
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<tr>
<td>36. Work</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
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<tr>
<td>37. Volunteer service</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>38. Volunteer professional activities</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>39. Child-centered events</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>40. Play with children</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>41. Activity as a couple</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
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</tr>
<tr>
<td>42. Watch TV/videos</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>43. Church</td>
<td>___</td>
<td>___</td>
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</tr>
</tbody>
</table>
APPENDIX D: Source Monitoring Presentation Orders

A. Look at the door behind you
B. Trace over this letter B
C. Stretch your arms out to your sides
D. Touch your elbow
E. Trace over this circle
F. Shake your head yes
G. Look at the light switch
H. Lean way over forward
I. Point your fingers out in front
J. Touch your toes
K. Trace over this triangle
L. Trace over this rectangle
M. Make a happy face
N. Touch your knee
O. Look up at the ceiling
P. Stretch your legs over to the side
Q. Look under the table
R. Shake your head no
S. Lean way over backwards
T. Make a sad face
A. Lean way over backwards
B. Trace over this letter A
C. Look up at the ceiling
D. Trace over this letter B
E. Clap your hands
F. Look at the light switch
G. Look at the book
H. Stretch your legs over to the side
I. Wave goodbye
J. Shake your head yes
K. Make a happy face
L. Trace over this letter C
M. Stretch your arms out to the sides
N. Touch your toes
O. Touch your elbow
P. Touch your stomach
Q. Trace over this circle
R. Look at the door behind you
S. Point your toes out in front
T. Touch your nose
A. Trace over this letter C
B. Look at the light switch
C. Trace over this triangle
D. Make a sad face
E. Point your toes out in front
F. Touch your nose
G. Point your fingers out in front
H. Trace over this letter A
I. Look up at the ceiling
J. Clap your hands
K. Look under the table
L. Touch your shoulder
M. Lean way over backwards
N. Touch your toes
O. Shake your head yes
P. Trace over this rectangle
Q. Stretch your arms out to the sides
R. Stretch your legs over to the side
S. Look at the book
T. Touch your knee
A. Look at the book
B. Clap your hands
C. Wave goodbye
D. Look at the floor
E. Touch your knee
F. Make a sad face
G. Make a happy face
H. Trace over this circle
I. Trace over this letter A
J. Look at the door behind you
K. Trace over this letter C
L. Touch your elbow
M. Shake your head yes
N. Point your toes out in front
O. Touch your toes
P. Touch your shoulder
Q. Trace over this letter B
R. Lean way over backwards
S. Touch your stomach
T. Point your fingers out in front
APPENDIX E: Source Monitoring Response Sheet

Below is a list of thirty actions. Some of these actions were written on the index cards you just saw but some of them are new. After reading each item, please indicate if it was an action that you performed, an action that you imagined yourself performing, or a new action that you neither performed or imagined yourself performing. Indicate this by placing an X in the appropriate column for each action.

<table>
<thead>
<tr>
<th></th>
<th>Performed</th>
<th>Imagined</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Look up at the ceiling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Touch your elbow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Touch your knee</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Shake your head no</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Look at the floor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Look at the light switch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Touch your nose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Touch your shoulder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Touch your toes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Wave goodbye</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Point your toes out in front</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Clap your hands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Trace over this rectangle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>Instruction</td>
<td>Performed</td>
<td>Imagined</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------------------</td>
<td>-----------</td>
<td>----------</td>
</tr>
<tr>
<td>14</td>
<td>Lean way over backwards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Look at the door behind you</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Trace over this letter B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Make a happy face</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Make a sad face</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Point your fingers out</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>in front</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Trace over this triangle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Trace over this letter A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Touch your stomach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Shake your head yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Look under the table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Stretch your legs over</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>to the side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Trace over this circle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Stretch your arms out to</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>the side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Lean way over forward</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Look at the book</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Trace over this letter C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


