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NEUROPSYCHOLOGICAL CORRELATES

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**EXPLICIT AND IMPLICIT MEMORY IN OLDER ADULTS:
NEUROPSYCHOLOGICAL CORRELATES**

By

Michelle Marks Merwin

A DISSERTATION

**Submitted to
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in partial fulfillment of the requirements
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ABSTRACT

EXPLICIT AND IMPLICIT MEMORY IN OLDER ADULTS: NEUROPSYCHOLOGICAL CORRELATES

By

Michelle Marks Merwin

This study involves the investigation of implicit memory, explicit memory and frontal lobe functioning in older adults. Implicit memory entails remembering without awareness, or unconscious memory. Implicit memory involves unconscious encoding and unconscious retrieval. In contrast, explicit memory involves either conscious or unconscious encoding, but always conscious retrieval. Although explicit memory declines have been consistently demonstrated in older adults, clear declines have not been shown for implicit memory. Some research indicates that age-related declines in implicit memory may be dependent on abilities associated with frontal lobe functioning which have been shown to decline in older adults. Some research suggests that declines in implicit memory may be associated to declines in strategic search mechanisms associated with frontal lobe decline.

The present study tested 100 women over the age of 50 on measures of implicit, explicit memory and frontal lobe functioning (as measured by the Wisconsin Card Sorting Test, verbal and non-verbal fluency, intrusion and perseverative errors). The participants were shown words and asked to rate their pleasantness. Next, the same subjects were presented with word stems (i.e., the first 3 letters of words) and were instructed to complete the word stems with the first word that came to mind (implicit memory). The same subjects were shown another set of words and as before asked to rate the

pleasantness. The participants were then presented with word stems and this time they were instructed to use the word stems as cues to try to remember the words they just saw (explicit memory). This same procedure was conducted for an implicit and explicit word fragment completion task. Here, the subjects were shown words and were asked to complete word fragments e.g., shown "humor" and asked to complete the fragment "_um_r".

The results showed that explicit memory word stem completion negatively correlated with age. Implicit word stem, fragment and explicit fragment completions did not significantly correlate with age. An examination of the memory task completions and selected neuropsychological measures indicated that implicit memory word fragment was not related to any neuropsychological measures. Implicit memory stem performance was significantly related to performance on verbal fluency, and measures of attention. Explicit memory fragment performance was associated with verbal and figural fluency and a measure of inhibition. Explicit stem completions were more consistently and strongly related to most measures of executive skills, including attention. Thus, the overall findings suggest that explicit measures were more closely related to frontal lobe measures of executive skills and attention than was implicit measures.

To my patient, loving and generous family.

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INTRODUCTION

Psychologists have long struggled to understand, classify and localize memory or memory systems. In 1890, William James defined memory as "the knowledge of a former state of mind after it has already once dropped from consciousness; or rather it is the knowledge of an event, or fact, of which meantime we have not been thinking, with the additional consciousness that we have thought or experienced it before" (p. 648). In his historical review, Schacter (1987a) observed that over the years, philosophers, psychologists, and neurologists have added the dimension of unconscious memory to the concept of memory described by James. Schacter observed that Descartes was the first to write about how unconscious memory of an event affected behavior. Schacter further noted that the early writings about unconscious memory were described clinically and anecdotally by Freud and Korsakoff. Memory is no longer considered to be a unitary concept. Today, such dichotomous memory conceptualizations include long and short-term memory, declarative and procedural memory, semantic and episodic memory, implicit and explicit memory (Squire, 1987). In the present study, the dichotomous pair, implicit and explicit memory will be examined.

Explicit memory is related to what James described and encompasses the remembrance of facts (semantic) and events (episodic). In contrast, implicit memory involves remembrance of skills, habits, and priming (enhanced performance due to prior exposure, with no conscious recollection of the experience), simple classical conditioning, and nonassociative learning (Squire & Zola-Morgan, 1991; Squire, 1987; Richardson-

Klavehn & Bjork, 1988).

Explicit memory is what is usually assessed in neuropsychological memory testing. An example involves a participant being presented with a list of words and after a delay, being asked to recite the remembered words. Implicit memory in contrast, involves improved performance as a result of prior exposure which does not involve conscious recollection. Schacter defined implicit memory as the "facilitation in the processing of a stimulus as a function of a recent encounter with the same stimulus" (1987a, p. 506). The most recent wave of experimental research of unconscious memory began with the case of H.M. who had profound memory deficits but was able to show learning on motor tasks (Milner, 1962). This was demonstrated in other amnesic patients who showed improved performance on a mirror writing task, but were unable to recall ever having done the task (Corkin, 1968; Milner, Corkin, & Teuber, 1964). In the experimental literature, implicit memory has been demonstrated in amnesic patients (Graf & Schacter, 1985; Graf, Squire & Mandler, 1984; Roediger, 1990; Schacter, 1987a; Squire, 1987), normal subjects (Graf, Mandler, & Haden, 1982; Woods & Piercy, 1974; Parkin, Reid, & Russo, 1990), older adults (to be discussed further below) and patients with neurological diseases (Alzheimer's Disease and Huntington's Disease; Heindel, Salmon, Shults, Walicke, & Butters, 1989; Meiran & Jelicic, 1995).

The contrast between explicit and implicit memory may be better understood by example. In studies with older adults, subjects are asked to judge the "likability" of a word. For example, a participant is exposed to a word by being instructed to judge whether the word "BLOCK" is "pleasant" or "unpleasant." The subject's implicit memory

for the word is later assessed indirectly by asking the subject to complete a word stem with the first word that comes to mind. In this example, the subject would be asked to complete the three-letter word stem, "BLO___." Implicit memory or "priming" accounts for the increase in likelihood that the subject will complete the stem with a word that was seen prior on the "pleasantness" task. In contrast to implicit memory when subjects are instructed to explicitly recall the words, or to use the word stem as a cue to remember the words (cued recall) conscious recollection is reduced, or eliminated as is the case with amnesic patients. In essence, viewing a word previously will facilitate the subject's performance but the subject will not be consciously aware of this. In explicit memory the information may or may not be consciously encoded, but retrieval of the information is always conscious. In contrast, it is purported that with implicit memory the information is always unconsciously encoded, and unconsciously retrieved.

CHAPTER 1

THEORETICAL AND PRACTICAL CONSIDERATIONS

In the literature, implicit memory has been exhibited in a variety of ways. Roediger and Srinivas (1993) described the "standard procedures" in the following manner. Subjects are presented with a long list of words (e.g., shown the word "ELIMINATE" among others). Implicit memory is then assessed in one of three ways. First, as in the previously stated example, the subjects are shown the first three letters of the word and are asked to complete the word with the first word that comes to mind. This is called the "word stem completion task". In a "word fragment completion task" the subjects are shown the word but are asked to complete the fragment "EL_MI_AT_". Implicit memory may be assessed by asking the subjects to read a word that is presented so quickly that it is just below accurate perceptual threshold. This task is called the "word identification task" and in this task as in both word stem and word fragment completion, priming is shown when "a greater proportion of studied words is named, relative to non-studied words" (Roediger & Srinivas, 1993, p. 19). Implicit memory may also be shown by using a "homophone" spelling test (Jacoby & Witherspoon, 1982; Rose, Yesavage, Hill, & Bower, 1986). Here, the subject is first asked a variety of general questions which contain homophones, like "Name a musical instrument that employs a reed". Later, a spelling test is administered and in this example, the subject would be asked to write down the word read/reed. Priming is demonstrated when the homophone presented in the context of the question is spelled by the subject. The lexical decision making task is another assessment of implicit memory in which the subject is very briefly exposed to a

word (below perceptual threshold) and then later asked to determine whether a string of letters is a word. Implicit memory is reflected in the improved performance after prior exposure. This description of implicit tasks is not exhaustive, and there are a variety of nonverbal measures of implicit memory (Roediger & Srinivas, 1993; Schacter & Cooper, 1993).

Delay

Implicit and explicit memory are differentially affected by a number of variables. For example, it has been demonstrated that in explicit memory, recognition declines and false positives increase over a period of 7 days. However, some studies have shown that correct responses on a fragment completion task were maintained up to 7 days after initial encoding (Tulving, Schacter & Stark, 1982). Still others have demonstrated equivalent decay for implicit memory and recognition over time, in as little as 90 minutes for a word stem completion task (Graf & Mandler, 1984). The authors of the latter study believe that the fragment task requires more deliberate effort because there are fewer possible answers, whereas the stem completion task has many possible solutions. Shimamura (1986) agreed that the instructions and the design of the study placed demands on explicit memory by using unique word fragment completions, for example, "AS__A__IN" for "ASSASSIN." Shimamura pointed out that when Squire, Shimamura and Graf (1987) tested amnesics and controls with the same word stimuli at 0 delay, 2 hours and 4 days, results similar to Tulving et al. (1982) were found. Even after 4 days, the control subjects showed good completion, but people with impaired memory performed worse at immediate assessment, and after the 2 hour delay their performance fell below baseline performance. This does

indicate that more elaborate processes may have been used by controls, but not amnesics, possibly because the elaborate processes were not available to them (explicit memory).

Are Implicit Tests Just Easier?

Graf and Schacter (1985) offer three explanations in opposition to the claim that performance on implicit memory tasks is preserved because implicit memory tasks are easier versions of recognition and recall measures. Graf and Schacter exposed people with amnesia and control participants to word pairs. At test, the word stems were paired with words that were either the same or different from the word presented at study. During study the subjects were asked to either generate a relationship for the word pair or compare the number of vowels in the word pair. They found that retention was higher in the generate condition when the stems were paired with the same words from the study condition. For words studied under the vowel condition, whether the word stems came from the same or different word pair did not affect the results. If implicit memory tests were simply easier, then one would expect that all subjects would perform better on the stem completion task than on cued recall, but the results indicated that the student controls actually performed better on the cued recall task than the completion task. The age-matched controls performed equally well on cued recall and the completion task, while amnesics performed worse on the cued recall task. Further, the words given on the cued recall tasks were different words than those given on the completion task. Lastly, the age-matched controls were the only subjects who demonstrated any type of dependence on implicit and explicit measures.

Mechanisms or Nature of Implicit Memory

There has been much debate about the mechanisms underlying implicit memory and the discussion here will not be exhaustive. There are three major explanations for the dissociation or uncorrelated performance on implicit and explicit memory measures. One line of reasoning involves the notion of multiple memory systems; the belief that implicit and explicit memory are actually two different memory systems (Tulving, 1983, 1985). Schacter (1987a) prefers to use the term "implicit memory" as a descriptor, rather than a determinant of what the individual is experiencing. Therefore, he suggests that implicit memory is a "phenomenon" which can be elicited experimentally and does not necessarily connote two separate memory systems. A second explanation for the dissociation between explicit and implicit memory contrasts cognitive processes called "activation" and "elaboration" (Graf & Mandler, 1984; Mandler, 1980). Graf and Mandler's research in normal subjects suggests that implicit memory is a result of the activation of pre-existing mental representations, whereas explicit memory is based upon an elaborative system. Essentially, they suggest that exposure to a word stimulates a semantic network or mental representations of the word. The activation occurs when the subject's attention is focused on the word (judging whether the word is pleasant). The activation of the mental representation is all that is required in order to complete the implicit memory tasks. After viewing, the word is more accessible and is used to complete the word stem (or whatever priming task is used). Graf and Mandler (1984) suggest that activation is an automatic process, requiring no effort. Conversely, when a subject is instructed to explicitly remember a word, an elaborative search is activated; therefore, elaboration is an

intentional process, not automatic. In sum, word stem completion results in increased accessibility; elaboration involves increased accessibility of a word, plus the retrievability of a word.

Recall is determined by the success of the search process which depends on the available paths to the target word . . . free recall and word completion becomes dissociated because the different requirements of the two tasks make it possible for a word to be accessible for word completion without being retrievable for free recall (Graf & Mandler, 1984, p. 554).

Graf and Mandler further postulate that the activation process is spared in amnesics, but the elaboration process or the ability to retrieve the information is impaired. The importance of pre-existing mental representations was demonstrated by Schacter and Graf (1986) when amnesics were not able to show priming after studying pseudowords. In another effort to delineate the mechanisms of implicit memory, Schacter and Graf (1986) compared amnesics to controls on a priming task of associated words pairs. In this study, the amnesics studied unrelated word pairs which involved creating meaningful sentences to link two words together ("WINDOW - REASON"). They were then asked to complete a word stem with "the first word that came to mind." The researchers then compared two sets of word fragments; those fragments that were the same during presentation (same-context condition, e.g., "WINDOW - REA___"), and those that were different from the pair presented during the study time (different context condition, e.g., "RIPE - REA___"). Explicit memory was assessed when they were asked to remember the second word (e.g., "WINDOW - _____"). The results of this study showed that for all subjects, more priming occurred in the same-context condition than in the different-context condition. Therefore, Schacter and Graf concluded that newly formed associations were the primary

influence of implicit memory. The activation view was not supported; preexisting memory representations did not operate alone. Interestingly, when these researchers re-examined their data in light of the severity of memory impairment, they found that those subjects who showed less priming in the same- and different-context conditions tended to have more impaired memory; those people who showed more priming in the same-context condition tended to have milder memory impairments. These results were replicated in a second study (Schacter & Graf, 1986) where it was demonstrated that people with less memory impairment showed more priming in the same-context condition, than those with severe memory impairment. In contrast, the people with severe impairment showed more priming in the different-context condition than those with less impaired memory. These findings led the researchers to conclude that two different types of priming may exist, and that "one type of priming reflects the activation of preexisting structures and is preserved in both mildly and severely amnesic patients; the other type depends on representations that are constructed by elaborative processing and is preserved only in milder cases of amnesia" (Schacter & Graf, 1986, p. 739).

A third explanation for the dissociation between implicit and explicit memory is called the "transfer-appropriate processing framework" (Morris, Bransford, & Franks, 1977) or the "processing account" (Roediger & Blaxton, 1987; Roediger, Weldon, & Challis, 1989; Blaxton, 1989). The processing account places importance on the type of processing used. The processing variables are either "data driven" or "conceptually driven" processes. Data driven processes refers to the processing of the physical features of the word which are tapped by perceptual identification. Conceptually driven processes

refer to more semantically related processes. Blaxton (1989) made comparisons between implicit, explicit, semantic and episodic measures and examined the type of processing used. The memory system (episodic versus semantic) and type of processing (data driven versus conceptually driven) were the important variables examined. In the episodic-data driven condition, graphemic cued recall was assessed; the subjects were given similar looking words for cues (eager as a cue to help recall eagle). In the episodic-conceptually driven condition, semantic cued recall was assessed; the subjects were given semantically related words as cues (falcon as a cue for eagle). In semantic-data driven condition, word fragment completion was assessed (E_G_E for eagle). In the semantic-conceptually driven condition, general knowledge was assessed (What was the name of Armstrong and Aldrin's lunar module? for eagle). The items were studied under three conditions, no context, context (the target word was preceded by a semantically related word), generate condition (subjects generated the target words when given a semantically related word and a single letter cue (e.g., hawk-e). Blaxton found that priming occurred in the general knowledge group; the subjects showed more priming for studied than non-studied words. Also, more priming occurred in the generate than the context, or no-context condition, which were not significantly different. In a second experiment, Blaxton found that performance on conceptually driven tasks was not affected by modality changes, however, data driven tasks were. She concluded that the dissociation was better explained by the type of processing (data driven versus conceptually driven) distinction than by the episodic, semantic, implicit, explicit distinction. The explicit measures were influenced by modality specific and typographic manipulations whereas implicit measures were

influenced by semantic manipulations. The processing mode is more pertinent than the specific memory system.

CHAPTER 2

IMPLICIT MEMORY IN VARIOUS POPULATIONS

Implicit Memory in Normal Subjects

Woods and Piercy (1974) demonstrated implicit memory in normal subjects. The normal subjects were tested immediately and one week after study. This study was designed to simulate a "weak memory trace" in an attempt to make the memory of normal subjects similar to memory performance of amnesic subjects. They were tested on word fragment completion, word stem completion and recognition. The results showed that relative to controls, the subjects' performance on a recognition task declined after one week. After one week the subjects' performance on a fragment completion task (implicit memory) did not decline relative to controls. Although not statistically significant, the subjects' performance on a word stem completion task also did not decline after one week.

Parkin, Reid and Russo (1990) showed that facilitation of a fragment completion task occurred under divided and undivided conditions in normal subjects. The authors concluded that conscious involvement is not necessary for implicit memory to occur. However, subjects recognized more words under undivided conditions. In a second experiment they found that recognition was better when subjects were exposed to the stimuli where intervening variables were introduced (lag 6); however, the presence or absences of lag did not affect implicit memory performance. Facilitation of performance occurred in both divided and undivided conditions.

Implicit Memory in Persons with Amnesia

Implicit memory was first explored in persons with amnesia. Although their

performance on clinical memory measures was severely impaired, these individuals demonstrated learning on procedural and priming tasks. At that time, the research was focusing on whether memory deficits were a reflection of encoding deficits, consolidation or retrieval deficits (Warrington & Weiskrantz, 1974). Warrington and Weiskrantz (1970) portions of words (degraded words) were presented to persons with amnesia and to control subjects. They found that individuals with memory impairment did not differ from controls when they were provided with the proper cues (e.g., after portions of the word were presented at study, and they were given the first 3 letters of that word at test). However, unlike controls, the amnesics were did not recall the words without cues and were did not recognize the words. When compared to controls, the persons with amnesia retained more words from the partial word trials than the recall measures. Because of the discrepancy between unconscious memory, recognition and recall, the researchers concluded that reduced memory in amnesics was caused by a retrieval deficit and not problems transferring information from short-term to long-term storage, or consolidation. Graf, Squire and Mandler (1984) found similar results when they compared people with Korsakoff syndrome to control subjects (people with alcoholism, or people who had been given ECT several years prior). Individuals with amnesia were impaired on all measures of explicit memory, but their performance on implicit memory test did not differ from the controls. In this study, the cued recall task and the word stem completion task differed only with respect to the instructions toward or away from the memory aspects of the task. In the stem completion task, they were asked to complete the word stems with the first word that came to mind (directed away from the memory task) and in the recognition task,

they were requested to actively recall the words using the word stems as cues (toward the memory task).

Implicit Memory in Older Adults

Some researchers have drawn parallels between deficits found in individuals with amnesia and older adults (Moscovitch & Winocur, 1992). For example, older adults, like amnesic patients, show memory deficits but both populations do not experience notable declines in intelligence. Further, in both older adults and amnesics long-term memory is deficient, but short-term memory is intact. Also, new learning is problematic for both populations, but more remote memories are intact. Lastly, older adults and amnesic patients show explicit memory deficits, but the decline in implicit memory is not apparent. Based upon the parallels between amnesics and older adults and the research completed with amnesics, it would not be unreasonable to expect spared implicit memory in older adults. The declines in explicit memory have been evidenced in both populations. Is the decline uniform across all types of memory or is implicit memory spared in older adults?

Overall, the results of implicit memory studies with older adults have yielded equivocal findings. Some studies have found differences on priming tasks favoring the younger subjects, although the differences were not statistically significant (Light & Singh, 1987). Some researchers have suggested that age-associated differences do exist, but differences between young and older adults is small and large samples and adequate power are needed to detect the age-related changes (Hultsch, Masson, & Small, 1991). A recent review and meta-analysis (LaVoie & Light, 1994) observed that both studies with small samples (Howard, 1988) and large samples (Hultsch et al., 1991; Davis, Cohen, Gandy,

Colombo, VanDusseldorp, Simolke, & Romano, 1990) have found significant age-related declines in older adults. At the same time, studies with larger samples have not always detected reliable differences.

Chiarello and Hoyer (1988) compared young and older adults on a word-stem completion task or a cued-recall task. After the stimuli were presented, one-half of the subjects were asked to complete the word stem with the first word that came to mind (implicit), and the other half of the older and younger subjects were told that the word stems should be used to help them remember the words (cued recall). The only difference between the two groups was the instructions to intentionally recall the information or the lack of that instruction. The results showed that younger subjects performed better on all memory tasks, including implicit, recognition and recall memory, indicating an age-associated decline.

On a word stem completion task, Davis et al. (1990) found impaired priming in 70 and 80 year-old subjects. The performance of the 60 year-olds was reduced, but was not significantly different from the performance of younger subjects. These researchers also found that in adults who were older than age 70, deficits in implicit memory correlated with Performance IQ (purported non-verbal intelligence), perseverative errors on the Wisconsin Card Sorting Test (WCST; a test that measures the ability to develop, maintain and switch conceptual sets when necessary, a purported measure of frontal lobe functioning), and the number of category shifts on WCST. The results of a meta-analysis showed that Alzheimer patients performed significantly worse on implicit memory tasks, including nonverbal tasks, word stem completion tasks, classical conceptual tasks and

perceptual identification tasks with long delays. The Alzheimer's patients were not impaired on perceptual word tasks that had short delays (Meiran, & Jelicic, 1995). Furthermore, individuals with Alzheimer's over the age of 75 were not significantly impaired on word stem completion tasks when compared to controls. The authors suggest that the Alzheimer patients did not differ from age-matched controls, because the controls were equally impaired, not because the Alzheimer's patients were unimpaired. Hulstsch, Masson, and Small (1991) assessed implicit memory in older adults using a large sample and found that ample power is needed to discern age-related differences and they propose that "small, reliable" age differences do exist.

On word stem and fragment completion tasks combined, Graf (1990) noted that older subjects demonstrate 74% as much priming as younger adults (based upon Light & Singh, 1987; Light, Singh, & Capps, 1986), 69% as much priming as younger subjects on a homophone spelling test (based upon Howard, Heisey & Shaw, 1986; Howard, 1988; Rose, Yesavage, Hill, & Bower 1986) and 84% as much priming on a new association priming tasks (based upon Howard, 1988; Graf & Schacter, 1985). Graf concluded that the variance associated to age-related decline on implicit memory tasks is about 4%, while the variance associated with age-related decrements in explicit memory is about 50%. Although many of the studies analyzed by Graf employed dependent measures that vary methodologically (correct answers versus response times), a meta-analysis (La Voie & Light, 1994) showed that the effect size for item priming and associative priming were equivalent. Therefore, the results of item priming studies (based upon response accuracy) and the results of associative priming studies (based upon response latencies) were

equivalent.

The results of the meta-analysis (LaVoie & Light, 1994) showed that when 39 studies were aggregated across methodologies, the weighted mean effect size for priming was .304, which according to Cohen (1992) is considered a small effect. The confidence interval ranged from .217 to .392 and therefore the null hypothesis was rejected. It was found that age-associated decline is not nearly as great for priming tasks as it is for recognition (effect size .497) or recall (effect size .968). The authors stated:

Although we cannot conclude that there are no age-related differences in repetition priming, such differences appear to be smaller than those for direct measures. Moreover, effect sizes for recall and recognition also differ, with that for recognition lying closer to that for repetition priming (LaVoie & Light, 1994, p. 547).

Light (1988) concluded that implicit memory does not decline with age though small changes may exist; however, these deficits are not nearly as great as those that occur for explicit memory. Howard (1988) concluded that age differences are less evident, but when differences occur, they are in "favor" of the younger subjects and are a result of better explicit memory. When problems in implicit memory are found, Howard believes that these are related to a reduction in information processing abilities. Deficits occur in older adults because they are unable to use "deliberate" search strategies, an example of this is word retrieval deficits which is often found in older adults.

Graf (1990) described 3 explanations for the dissociation of implicit and explicit memory abilities in older adults. Two of these explanations were described above. The first is called a "process view" which postulates that two distinct memory systems exist,

implicit and explicit. The second explanation is based upon Mandler's (1980) assumption that two cognitive processes occur, called "integrative" and "elaborative" processes.

Integrative processes are believed to be more automatic, in which memory is a unit which is activated from a more collective whole or schemata (e.g., a network of associated words). This process is especially relevant when familiar information is used as stimuli, such as words. Elaborative processes involve initiation and activation by the subject.

Therefore, it is hypothesized that age-related decrements are not found in implicit memory because implicit memory is based upon automatic processes, whereas explicit memory declines are more elaborately based, and are reduced in the aged because of the diminished attention capacity. Graf (1990) described a third explanation for the discrepancy between implicit and explicit memory in older adults which is called a "task analysis view" and is postulated by Craik (1983). This idea is that experimental tasks fall on a continuum of environmental support; one end of the continuum having a good deal of support, the other having less. Craik believes that aged subjects demonstrate greater impairment on tasks that have less environmental support. For example, older adults would have difficulty on tasks where more independent activation, or the orchestration of cognitive processes is required. Therefore, it is suggested that deficits on recall tasks which have less environmental support are a result of the reduction in attentional resources. Implicit memory would fall on the other end of the continuum, because such measures have greater environmental support (e.g., word stems).

More recently, investigators are examining the relationship between frontal lobe functioning and implicit memory. Moscovitch and Winocur (1992) described memory

deficits which may occur in older adults as a result of a decline in frontal lobe functioning.

The authors propose that the frontal lobe mediates a "working with memory" function.

Their model suggests that one function of the frontal lobes is the organization of encoding and retrieval of the remembered information (input and output of the hippocampus).

Moscovitch and Winocur surmise the following:

What is impaired after frontal damage or dysfunction is not memory itself but the uses to which memory is put, the inferences based on memory, the temporal ordering of remembered episodes, their placement in proper contexts, and the implementation of encoding and retrieval strategies with respect to particular events (p. 358).

Mayes and Gooding (1989) found that amnesics' difficulties remembering unrelated word pairs and completing word stems were more closely related to frontal lobe dysfunction, and not amnesia severity. From their review of the animal and human frontal lobe literature, Moscovitch and Winocur (1992) hypothesize that the frontal lobes may be involved on implicit memory tasks that require organization, or "have a strategic, lexical, or semantic search component" (p. 337), for example, word stem completion tasks. Therefore, on those tasks which require strategic or semantic processes, elderly subjects may be impaired, and this may be related to frontal lobe decline (as measured by performance of a mental flexibility task, problem solving such as the Wisconsin Card Sorting Test, or measures on verbal fluency).

Davis et al. (1990) found a decline in performance on frontal lobe measures in 70 and 80 year-olds. Furthermore, 70 and 80 year-olds demonstrated significantly lower priming scores and significantly lower explicit memory scores than younger subjects.

Priming scores significantly correlated with performance IQ ($r = .27$), and purported frontal measures such as perseveration errors on the Wisconsin Card Sorting Test (WCST) ($r = -.30$) and the number of category shifts on WCST ($r = .31$).

CHAPTER 3

THE FRONTAL LOBES

Lezak (1983) described the frontal lobes as being involved in initiating and inhibiting behavior, the ability to make behavioral or mental shifts, self-awareness and basic conceptualization of intentionality (deficits in the "how" of solving a problem rather than the "what" of solving problems). There is an array of symptoms associated with frontal lobe damage, and no firmly established hallmark of frontal lobe lesions exist. In this section, neuropsychological and neuroanatomical research indicating age-associated decline in frontal functioning will be presented. Next, a brief review of frontal lobe involvement in attention and memory will be presented.

There has been growing support suggesting that frontal lobe decline may occur in older adults, and in some cases, may decline in people as young as 60 to 65 years-old (Daigneault, Braun, & Whitaker, 1992; Davis, et al., 1990; Craik, Morris, Morris, & Loewen, 1990; Mittenberg, Seidenberg, O'Leary, & DiGiulio, 1989; Uchiyama, Mitrushina, D'Elia, Satz, & Mathews, 1984, Parkin & Walter, 1992). Neuropsychological research suggests that related decrements are more closely related to bilateral frontal lobe measures than other general or specific (parietal or temporal lobe) measures of cognitive ability (Whelihan & Leshner, 1985; Mittenberg, et al., 1989). Further, frontal lobe deficits in older adults are present while deficits on other neuropsychological measures are absent. Moscovitch and Winocur (1992) concluded, "There is remarkable consistency between the memory deficits seen in human patients and experimental animals with frontal lesions and those seen in normal aging. Indeed, there is not one instance where a significant

discrepancy is found" (p. 353). Still other researchers (Boone, Miller, Lesser, Hill & D'Elia, 1990) have not found declines in performance on the Wisconsin Card Sorting Test (which involves mental flexibility, and the ability to develop, shift and maintain a cognitive shift) in older adults; however older adults completed significantly fewer categories, and had more errors, but they did not make significantly more perseverative responses, or other responses (indicating a failure to maintain set). Post hoc analyses indicated that the 70 to 79 year-olds showed poorer performance when compared to 60 to 69 year-olds. In the same study, overall performance on the Stroop revealed age-related decline (Boone, Miller, Lesser, Hill & D'Elia, 1990). On this task, subjects are given a card with color names printed in different ink colors (e.g., the word "blue" printed in red ink). The task requires that the subjects read the colors the words are printed in, while ignoring the color names (if the word "blue" was printed in red ink, the subject would say "red"). The Stroop has been associated with inhibitory functioning often associated with frontal lobe. Further, in this study, there was a trend toward group differences on the verbal fluency task (a purported frontal lobe measure), but this was not significant. The authors concluded that reduced performance on the WCST was due to inefficient strategy selection in the elderly. Reduced performance on the Stroop was a result of decrease information processing speed and not a result of reduced frontal lobe functioning.

Neurophysiological research has indicated that there are neuroanatomical age-related correlates of frontal lobe decline, including neuronal loss (Colon, 1972; Haug, Barmwater, Eggers, Fischer, Kuhl, & Sass, 1983; Terry, DeTeresa & Hansen, 1987), and reduced cerebral blood flow (Gur, Gur, Obrist, Skolnick, & Reivich, 1987; Shaw, Mortel,

Meyer, Rogers, Hardenberg, & Cutaia, 1984) in older adults.

The Frontal Lobes and Attention Abilities

The frontal lobes have important anatomical connections to many other parts of the brain. Connections to the thalamic areas have been implicated in the involvement of the frontal lobes in attentional abilities (Stuss & Benson, 1984). Stuss and Benson (1986) suggest that frontal lobe systems are involved in attention in three ways: "maintaining attention over time (arousal), organizing information into workable chunks, and preventing distraction" (p. 98). Clinically, this may be manifested in a variety of ways, one example being perseverations which are usually associated with frontal lobe lesions (Stuss & Benson, 1984). Perseverative errors may reflect deficits in sequencing behavior or an inability to establish or change cognitive sets, and attention abilities may be especially important under circumstances of interference (Stuss & Benson, 1984). Deficits in "selection and monitoring performance" can be seen clinically by "inflexibility, perseveration... impulsivity, distractibility, and rapid alternation of attention" (Stuss & Benson, 1986, p. 99) or the inability to inhibit incorrect responses.

Stuss and Benson (1984) examined attention measures and found that although patients with frontal lobe dysfunction had difficulty attending to pertinent information, they did not necessarily perform poorly on traditional attention measures. Although the frontal lobes may regulate attention, other parts of the brain contribute to this same process. They noted that it is possible that perseverative behavior may be a better indicator of lesion size rather than location (Goodglass & Kaplan, 1979). Generally, frontal lobe deficit signs are not present in all patients with frontal lobe damage, and

damage to other parts of the brain may show the same cluster of behavioral deficits (Stuss & Benson, 1984)

The Frontal Lobes and Memory

Regarding memory, Luria (1976) stated:

It is a grave mistake to regard it [memory] as a simple recording, storage, and retrieval of information. Memorizing is a highly complex process of analysis of incoming information, followed by its selection and coding. Recall is an equally complex process of choosing the necessary systems of connections from all the possible alternatives, performed by goal-directed mnemonic activity (p. 345).

Stuss and Benson (1986) propose that frontal lobe functions overlap with memory functions in retrieval processes. Patients with frontal lobe lesions are not able to access the information. These researchers concluded that "Frontal lobe damage does not interfere with putting material into storage (memorizing) but does impair essential associated mnemonic activities including attention, motivation, programming, regulation, and verification" (Stuss & Benson, 1986, p. 191). Additionally, memory recency deficits may reflect damage to the frontal lobe system (Stuss & Benson, 1984). For example, Schacter (1987b) noted that people with severe amnesia have difficulty making temporal or familiarity judgments. Still others suggest that some tasks thought to assess frontal functioning also involve the ability to organize strategies and monitor responses which would be dependent upon working memory. Petrides and Milner (1982) compared patients with right or left frontal damage to patients with temporal lobe damage on a self-ordered task which placed demands on their ability to organize a strategy and actively monitor their performance. The patients with frontal lobe damage performed more poorly than the patients with temporal lobe damage, and patients with left frontal damage

performed poorer on more measures than patients with right frontal lobe damage. This suggested that the left frontal lobe may contribute to the ability to monitor and regulate strategic behavior.

Luria (1976) noted that frontal dysfunction related to the inability to weed out distracting information (irrelevant information). He suggested that in patients with frontal lobe lesions, memory problems are more closely linked to the inability to inhibit memory traces rather than a primary dysfunctions of memory per se. For example, patients with frontal lesions will not be able to retain discrete pieces of information, and will lose the semantic properties of the story. These patients have lost the ability to screen out associations to the story (perhaps internal distractions as the story is being read to them) and these "random details" are "substituted" for remembered information. When recanting parts of the story, the patients insert associated thoughts, and these associations actually replace the to-be-remembered information. Luria states, "These disturbances of recall can arise despite the primary integrity of the memory, because they result not from pathologically increased inhibition, but from a gross disturbance of conscious activity" (p. 345). Normal subjects are able to ignore the extraneous information during memorization. Furthermore, according to Luria, these disturbances in memory will occur in patients whose higher cortical functions are intact; memory deficit are not modality specific, and are apparent in "recall of verbal, visual, and motor material" (p. 341).

Moscovitch (1989) discussed the importance of the frontal systems and confabulation. He explained that confabulation is more directly linked to frontal lobe dysfunction than to the degree of memory impairment. Confabulation in frontal patients

occurs because the patient has lost the temporal "frame of reference." Notably, Moscovitch proposed that confabulations are responses to time sequencing (e.g., autobiographical or historical dates) rather than places or procedures. Further, he postulated that confabulation occurs in people with amnesia due to their inability to begin and complete a strategic memory search. This helps explain why amnesics perform better on implicit versus explicit memory measures, and it also explains why amnesics perform better on memory recognition measures than recall measures. Moscovitch believes that retrieval processes are comprised of both strategic and associative activities. Moscovitch presented the following example: If asked what you did two weekends ago, a couple of responses would come to mind. However, through a strategic search, you would be able to determine precisely what occurred that weekend ago; you would be able to fit the pieces together. Amnesic patients who confabulate lack the strategic search mechanism, and their responses instead are associations to the question, with no strategic involvement.

Winocur, Moscovitch and Stuss (1996) compared older adults (26 who lived in an institution and 24 lived in the community) to younger adults on measures of implicit, explicit memory and frontal lobe functioning. They examined performance on a word stem completion task (all words could be completed with 5 letters, the stem was followed by 2 dashes not a continuous line) and a word fragment completion task (all of the words contained 6 letters). The participants were shown the words twice. First they were asked to count the number of vowels in each word and were then asked to read the words aloud. The subjects completed both implicit and explicit memory stems and fragment completions and these values were obtained by subtracting baseline scores from the obtained target

scores. These researchers found a significant age related decline for both explicit memory stem and explicit memory fragment completions but not for implicit memory stem and fragment completions. On the explicit memory word stem completion task, the younger subjects recalled significantly more words than the community dwelling participants who in turn recalled more words than the institutionalized participants. On the explicit memory fragment completion task, both the younger and older community dwelling participants completed significantly more correct fragments than the institutionalized participants, indicating an effect only for institutionalization. In addition, the younger and community dwelling elders did not score significantly different on measures of frontal lobe functioning, but both groups performed better than institutionalized elders. In the institutionalized elders implicit memory stem completion positively correlated with a letter fluency task ($r = .55$) and negatively correlated with errors on the WCST task ($r = -.47$), but did not correlate with a memory task (CVLT $r = -.09$). Implicit memory fragment did not significantly correlate with any neuropsychological measures. Explicit memory stem and explicit memory fragment positively correlated with performance on a memory measure (CVLT $r = .54$, $r = .48$ respectively). In the community dwelling elders, implicit memory stem significantly correlated with letter fluency ($r = .54$) and WCST errors ($r = -.45$), implicit memory fragment correlated with a complex drawing task. Explicit memory stem correlated significantly with verbal memory (CVLT $r = .44$) and explicit memory fragment correlated significantly with the complex drawing task ($r = .40$) and a delayed drawing of the complex figure ($r = .43$). These researchers concluded that age-related declines were evident only on the implicit memory word stem completion task and not

word fragment completion and word stem implicit memory was related to frontal lobe functioning, but not verbal memory. Age related declines were evident for explicit memory which were not related to frontal lobe measures, but did significantly correlate with verbal memory.

In another recent study, Nyberg, Winocur and Moscovitch (1997) manipulated the search space (the number of possible response alternatives e.g., 3 or fewer or 10 or more) and cues (2 or 3 letters in the stem) for measures of implicit and explicit memory in order to better understand the relationship between frontal lobe functioning and memory. All of the target words were five letters long. Generally, a weak relationship was found between implicit memory word stem completion (letter fluency correlated in the 3-10 condition). Stronger relationships were observed in the explicit memory condition, where explicit memory stem significantly correlated with letter fluency (for 3-10, 2-10 and 2-3) and delayed recall. The explicit memory 3-10 condition only significantly correlated with verbal memory. The researchers concluded that frontal lobe involvement is not 'strategic' search process, instead "there is an overriding supervisory role of the frontal lobes in eliciting cue-appropriate responses and in monitoring detection" (p. 73). They suggest that the frontal lobes contribute in a response selection and an inhibitory mechanism, and "these processes are most effective when the combination of letter-cue constraints and search space is conducive to frontal lobe involvement, as in the 3-10 and possibly 2-3 conditions" (p. 73). Thus, when the cues are very constrained and there is a small search space (3-3) then frontal involvement is less likely and performance on the word stem completion task becomes similar to the fragment completion task.

Some researchers have shown that frontal lobe dysfunction has been associated with memory deficits involving discrimination among prior episodes of exposure (Milner, 1971; Petrides & Milner, 1982). A decline in source amnesia (the inability to recall where or when the information was collected) has been shown in older adults. In one study, the degree of source amnesia correlated with age, verbal fluency, number of categories achieved, total errors, and perseverative errors on the WCST. Conversely, it was not significantly correlated to PIQ or measures of fact recall (Craik, Morris, Morris, & Loewen, 1990). In another study, recognition of information that had been contextually based decreased and was inversely related to frontal lobe impairment (Parkin & Walter, 1992).

From this literature review, several conclusions may be drawn. First, generally it has been shown that explicit memory declines in older adults. Second, age-associated declines in frontal lobe functioning also occur. Some researchers suggest that age-related deficits in explicit memory are related to frontal lobe decline. Age-related declines associated with implicit memory are less clear. A meta-analysis indicated that small age-related deficits in implicit memory do occur in older adults, but these deficits are not as large as those found for explicit memory. In the Davis et al. (1990) study, it was shown that age-related deficits in implicit memory were found in adults over the age of 70, but not in younger individuals when analyzed by age group. These older adults also showed impaired performance on frontal lobe measures and implicit memory performance correlated with measures of frontal lobe functioning (e.g., WCST). Some authors have suggested that general memory abilities may be related to frontal lobe abilities, including

implicit memory. Moscovitch and Winocur (1992) propose that tasks such as the word stem completion task are more closely linked to frontal lobe functioning because of the production and organizational demands of the task. Further, the word stem completion task has been described by some as being a task (conceptually driven; Blaxton, 1989) that is not dependent upon the less stable, more perceptually based priming abilities and may be analogous to fluency tasks which are thought to be associated to frontal lobe functioning (Benton & Hamsher, 1983).

Clear, unequivocal age-associated decline in implicit memory has not been demonstrated in the literature. However, evidence for a decline beginning around the age of 70 is growing. It is hypothesized that the frontal lobes facilitate retrieval mechanisms and attention regulation abilities that "work with memory" (Moscovitch & Winocur, 1992; Luria, 1976; Stuss & Benson, 1986) in explicit memory.

CHAPTER 4

FORMULATION AND HYPOTHESES

The purpose of this study is to examine the relationship between implicit memory, explicit memory and neuropsychological measures of frontal lobe functioning in older adults. Specifically, this study addresses the relationship between the "working with memory" formulation described by Moscovitch and Winocur (1992) in hopes of further understanding the role of executive skills (i.e. frontal lobe functioning) in implicit and explicit memory. The literature review indicated that executive abilities play an important role in explicit memory. Further, as Lezak (1983) described, frontal lobe functioning may involve more of the "how" of problem solving than the "what". The relationship between explicit memory (which is encoded and retrieved consciously) and executive skills are fairly straightforward. Executive skills (i.e., frontal lobe functioning) appear to be related to the regulation of attention, the regulation of inhibitory responses, the regulation of encoding and retrieval mechanisms, all of which may facilitate memory. However, the relationship between implicit memory and executive skills is less clear. Implicit memory is believed to be an automatic, non-strategic process. In contrast to explicit memory which involves strategic search mechanisms, implicit memory should not be dependent upon strategic search mechanisms. It is thought to be an activation process that is more automatic and less strategic, and thus would be less dependent upon executive skills.

The present study is based upon the review of the literature of implicit memory, and the role of executive functioning and explicit memory. Some researchers have concluded that executive skills may play a role in implicit memory. However, the implicit

memory research indicates that it is an automatic and more fluid process which should not involve strategic, executive skills.

As the literature is reviewed, two methodological concerns become apparent. First, the concept of executive skills includes diverse, sometimes seemingly unrelated cognitive processes. Executive skills are multifaced, and there is no hallmark measure of frontal lobe functioning or executive skills. For example, research and clinical evidence suggests that fluency (both verbal and non-verbal) tasks are regulated by the frontal lobes. Fluency is assessed by requiring participants to generate words that begin with the letter "F" (as used in this study) or generate unique designs on a stimulus page (e.g., Ruff Figural Fluency Test). Although these tests purport to measure frontal lobe functioning, they encompass many other cognitive processes, each contributing uniquely (the most obvious distinction being the perceptual demands in one and not the other). Frontal lobe involvement is purportedly demonstrated in not only the fluency (the number of words generated), but also the application of a strategic that facilitates the performance. For example, on a fluency task a subject who randomly generates words may have more difficulty generating and tracking what the responses than a participant who imposes a strategy on the task (e.g., names all objects, food, nouns or semantically related words). Again, this relates to Lezak's suggestion that the frontal lobes are associated with the "how" of problem solving rather than the "what." The frontal lobes are more engaged the supervisory role rather than merely participating in word generator and selector.

A second obvious methodological concern is the tenuousness of implicit memory and its relationship to frontal lobe functioning. As indicated by the recent study of

Nyberg, Winocur and Moscovitch (1997) who found that the role of executive functioning in implicit memory is dependent upon the search space (the number of possible responses to a stem) and the retrieval cues (the number of letters presented in the stem). They found that implicit memory stem completion task and executive skills were more strongly associated when 3 letter word stems could be completed with more than 10 words and when there were only 3 possible responses to 2 letter stems. Clearly the results and relationships among frontal lobe variables are tenuously related to the implicit memory measures used. In the present study two measures of implicit and explicit memory were used. The participants were presented with a stem completion task in which they were shown a word, asked to rate its pleasantness and then were presented with word stem completions (e.g., "blo___" after being shown the word "block"). In this case, the subjects were "primed" for the word "block". Implicit memory accounts for the increased likelihood that "primed" subjects will complete the word stem with the word "block". A second measure, word fragment completion, that is commonly used in this field of research was also employed. In the fragment completion the subject is presented with words and asked to rate how pleasant the word is. The same subject is then presented with word fragments (e.g., "_um_r" after having seen the word "humor"). There are many more possible responses to the stem completion than the fragment completion task. Thus the stem completion task appears to be more fluid, seemingly more automatic and the fragment completion appears to be more strategic.

As noted in the literature review, many researchers suggest that the frontal lobes play a role in implicit memory. The role of executive skills in explicit memory is less

disputed. Nyberg, Winocur and Moscovitch (1997) found that explicit memory was more closely associated to executive skills and implicit memory was less strongly associated.

They conclude that

"[frontal] involvement is not 'strategic' in the sense traditionally associated with frontal lobe functioning, in that the search process is not guided by conscious strategies. Nevertheless, there is an overriding supervisory role of the frontal lobes in eliciting cue-appropriate responses and in monitoring and detection." (p. 73).

Based upon the literature review of both implicit memory and frontal lobe functioning it is hypothesized that implicit memory is automatic process and should not be dependent upon strategic search mechanisms. But is this true for all measures of implicit memory? As demonstrated in the Nyberg et al. study, frontal involvement may be associated to the stimuli used in the assessment of implicit memory. If the tie between memory and executive skills is the managerial or supervisory role, then a strong relationship between explicit memory and frontal lobe functioning would be expected. Additionally, because frontal involvement is associated to the search space and the number of cues in implicit memory, it is purported that implicit memory fragment may be associated to executive skills, but to a lesser extent relative to explicit memory. Thus it is hypothesized in the present study that explicit memory is associated with executive or frontal lobe functioning (strategic and "working with memory"). Given the more strategic nature of the fragment task, it is also hypothesized that the fragment tasks will be related to executive skills, with explicit fragment being more strongly associated than implicit memory.

Implicit memory stem completion is not expected to be related to executive skills.

Implicit memory is purported to be an automatic process and should not be related to the

strategic mechanisms found in explicit memory or in fragment completions. Thus the relationship between frontal lobe functioning and implicit and explicit stem and fragment completions may be conceptualized on a continuum. With explicit memory (in this study both stem and fragment completion as will be made more clear in the next chapter) being more closely associated with executive skills, implicit word stem completion lying at the other end of the continuum and implicit fragment completion lying in between.

As mentioned earlier, the problem with assessing executive skills is that it incorporates varying concepts. There is no hallmark measure of frontal lobe functioning. Executive skills are multifaceted and all measures of executive skills involve more than one cognitive process. Thus, several neuropsychological measures were selected to assess executive skills, many of which are considered standard measures of executive functioning. As presented in the literature review, frontal lobe functioning is examined by measures that assess the generation, development and maintenance of a cognitive set. The Wisconsin Card Sorting Test was chosen for this study and it involves the ability to generate concepts, develop, maintain, and switch conceptual sets. Verbal fluency has also been shown to be related to frontal lobe functioning and this involves the generation of words. For example, in this study, the subject was asked to generate words beginning with the letter "F", "A" and "S". This test involves such cognitive skills as generating words, employing strategy to generate words, and monitoring performance (to inhibit intrusive and perseverative responses). Included also in this study is a measure of non-verbal fluency which will be discussed in more detail below (the Ruff Figural Fluency Test). This test requires that the participants generate unique designs. The generation of

unique designs with reduced perseverative errors is enhanced by the development and maintenance of a strategy that guides performance. The Stroop test is also thought to be a measure of executive skills. On this test, the subject is presented with words (e.g., "red", "green" and "blue") which are printed in the three colors (however the name of the color is not printed in the same color ink) and is asked to name the color the words are printed in while ignoring the text that is printed. Thus the subject is required to suppress or inhibit the response of reading the printed words. The Trail Making Test is also thought to measure executive skills. The first part is thought to measure more attention skills than executive (Trail Making Part A). The subject is instructed to sequentially connect numbers that are randomly presented on a page. This task involves psychomotor speed, visual scanning and attention. However, Part B of the Trail Making test is more challenging and believed to place more demands on executive skills. The subject is required to connect sequential numbers alternating with sequential letters (e.g., 1-A-2-B-3-C). Part B involves sequence tracking of both letters and numbers, the ability to adequately shift between the numbers and letters, and mental flexibility.

Measures of attention were also employed in this study. The reasons for using attention measures was two-fold. First, memory is dependent upon attention processes. Attention is necessary in the registration of information and thus is implicated in the storage of information. Second, implicit memory is thought to be an automatic process, and dependent is hypothesized to be reliant upon attention processes. Digit Span forward, a widely used measure of attention was selected for this study and assesses the ability to repeat a string of numbers. Digit Span backward requires that the subject repeat a string

of numbers backward. This task is more difficult and places more demands upon processing resources. The Digit Symbol Modality Test is another measure of attention and processing speed. It requires that the subject match numbers to symbols. Unlike other digit symbol measures, this test also has the subject orally give the responses, which controls for psychomotor slowing, an important consideration in cognitive assessment of older adults.

In order to better establish the construct validity of the experimental explicit and implicit memory measure, the California Verbal Learning Test, a standard measure of verbal learning and memory was used. In this test, the subjects are orally presented with 16 words that are presented 5 times. Following each presentation, the subject is asked to recall the words. At the end of five trials, the subject is presented with a new list of words (List B). Cued and free recall for both short and long-term memory is assessed (long-term memory is assessed after a 20 minute delay).

The Geriatric Depression Scale was administered in order to provide control and estimates on the effects of depression on cognitive processes.

In sum, this project examined the various and multifaceted features of executive skills. There is no one single measure that assess frontal lobe functioning. The measures selected are commonly used to estimate frontal lobe functioning in both clinical practice and research and have acceptable reliability and validity. Each salient feature of executive skills was assessed with these various measures, including problem solving, mental flexibility, perseverations, intrusions and fluency. The same is true of attention and memory. Attention is a complicated cognitive process which involves auditory or visual

sensory pathways, processing speed, psychomotor speed as well as the ability to attend. For this study, two measures were selected in order to assess the construct of attention and to lend more validity to the conclusions that may be drawn relative to this construct.

From the literature and the discussion above the following hypotheses are derived. First, in conjunction with other research, it is hypothesized that explicit memory will decline with increasing age and declines in implicit memory will be weaker. Based upon the research that indicates a "working with memory" model of frontal lobe involvement in memory, it is hypothesized that the strategic search mechanisms involved in frontal lobe functioning or executive skills will be associated to explicit memory, and to a lesser extent with implicit memory fragment completion, and even lesser to implicit memory word stem completion. Because implicit memory is thought to be an automatic cognitive process, it is a significant relationship between implicit memory and attention is hypothesized. Additionally, research indicates that explicit memory is closely associated to measures of attention, and this is hypothesized in this study as well. The hypotheses involving executive skills and memory can be conceptualized along a continuum. It is hypothesized that explicit memory (both fragment and stem completion) will be most strongly associated to all executive skills, while implicit fragment will be associated to a lesser extent, and implicit memory word stem completion will be associated even less so. Research has shown that the frontal lobes play an executive role in explicit memory and this is the basis for many of these hypotheses. However, more recent literature suggests that frontal lobe functioning may also be associated to implicit tasks, as a function of the search space and available cues. It is thus further hypothesized that implicit memory

fragment completions will be moderately associated with executive skills. Implicit memory word stem is thought to be an automatic, and less regulated process that should not be dependent upon executive skills, but is hypothesized to be closely associated to attention abilities.

Hypotheses

1. It is hypothesized that explicit memory will have a strong, negative correlation with age and the correlation between implicit memory and age will be weaker.
2. It is hypothesized that verbal fluency will be most strongly associated to explicit memory (stem and fragment completion), less strongly with implicit memory fragment completion and not associated with implicit memory stem completion.
3. It is hypothesized that the Stroop Test (inhibiting a response) will significantly correlate with both stem and fragment explicit memory and implicit memory fragment completion, but not implicit memory word stem.
4. Because of the strategic search component associated with frontal lobe functioning, it is hypothesized that explicit memory and to a lesser extent, implicit memory word fragment completion and will significantly correlate with problem solving skills (i.e., WCST).
5. It is hypothesized that both explicit and implicit memory word stem completion will significantly correlate with measures of attention (i.e., digit symbol and digit span).

CHAPTER 5

METHOD

Subjects

One hundred and four community dwelling women over the age of 50 were recruited for this study. Four cases were excluded primarily because of incomplete medical/health history prior to assessment or examiner error. Volunteers were solicited from senior citizens groups and community organizations (including churches and community support services) from Lansing, Kalamazoo, and Wyandotte, Michigan. See Table 1 for age distribution. The volunteers ranged in age from 50 to 94 ($M = 72.09$, $SD = 11.94$). Their education ranged from 8 to 20 years, with an average education of 14 years ($M = 13.77$, $SD = 2.94$).

Table 1 - Age Distribution of Sample

Age Category	Number of Participants	Cumulative Percent
50-59	12	12%
60-69	33	45%
70-79	23	68%
80-89	23	91%
90-94	9	100%
Total	100	

Tests and procedure

The data for the present study was collected in one visit which usually took place at the individual's home. After informed consent was obtained (Appendix A), the examiner asked the participants about their health history. This was done in order to eliminate any subjects who had a history of head injury, stroke or other debilitating neurological condition. Following these guidelines, four such participants were eliminated. The study participants were told that the project involved memory testing and that they would receive concise feedback about their memory performance after the testing was complete.

Eight lists of 15 words were prepared following the procedures of Graf et al. (1982), Chiarello and Hoyer (1988), and Davis, et al. (1991). All words contained between five to nine letters. Each word began with a different three-letter stem for which Webster's pocket dictionary gave at least ten alternatives words beginning with that stem. The 8 lists of 15 target words were balanced for length and frequency of words. An additional eight words for each list with the same properties were chosen as fillers (four at the beginning and four at the end of each list) to control for primacy and recency effects. A total of 120 words were typed on 5 x 8 in. individual cards and bound in a 3-ring binder (See Appendix B for a complete list of words). Two separate booklets were prepared. The lists were separated into 2 booklets, each containing 4 lists of 15 words. Initially, it was believed that baselines could be derived in this manner, half the subjects being exposed to half the words (Book 1) and generating baselines for the other half of the subjects (Book 2) and vice versa. However, it was later determined that within subject

baselines would be more useful, and more reflective of research to date. Additionally, half of the subjects completed Lists A and B for implicit memory, and C and D for explicit memory while the other half of the subjects completed lists C and D for the implicit memory task, and A and B for explicit memory. This precaution was taken because participants expressed that the explicit words (C and D) were more difficult than the implicit words. In hindsight, this was probably more directly related to perceived rather than actual difficulty. The complete list of stimuli words is presented in Appendix B.

Implicit Memory Word Stem Completion Task

The subjects were asked to look at each word carefully as it was presented, to think about its meaning and decide how much they liked or disliked each word. The words were presented at the rate of one word every three seconds. Each word was presented twice, in a different order but without interruption and the participants' responses were recorded by the examiner (for both presentations). They were asked to rate the pleasantness of each word on a 7-point scale (1=dislike extremely to 7=like extremely). Immediately after the word list was presented the subject received a word completion test. This task contained 30 three-letter word stems and the participants were asked to complete each stem with the first word that came to mind (See Appendix C). Additionally, speed was emphasized to in an attempt to minimize involvement of conscious recollection. Three minutes were allowed for the stem completion task. Fifteen of the stems could be completed with the words that had been presented, and the other 15 stems served as baseline.

Implicit Memory Word Fragment Completion Task

This task involved the same procedure as the word stem completion task. The participants were asked to rate 15 new words (plus 8 filler words, 4 at the beginning and 4 at the end) twice without interruption. They were then presented with a word fragment completion task, words in which 20 to 50% of the letters were replaced with a dash (See Appendix D). They were instructed to place letters in the dashes in order to complete the words as quickly as possible. Ten minutes were allowed for this task. Of the 30 fragments they were asked to complete, they had seen 15 and the 15 non-presented items served as baseline.

Explicit Memory Word Stem Completion Task

This procedure was conducted similarly to the implicit word stem completion task. The participants were asked to rate 15 new words (plus 8 filler words, 4 at the beginning and 4 at the end) which they were shown twice without interruption. The participants were then given 30 word-stems to complete, 15 word stems they had seen and 15 they had not seen (See Appendix E) and were read the following instructions:

Some of the items on this form are the beginning letters of words you saw in the booklet. Please fill in the blanks for any words you remember seeing. Use the stems as cues to help you remember the words you saw. Please complete all the word stems, but remember only some of the letters are the beginnings of words you actually saw.

The participants were allowed three minutes to complete this task.

Explicit Memory Word Fragment Completion Task

This task involved the same procedure as the implicit word fragment completion task. The participants were asked to rate 15 new words (plus 8 filler words, 4 at the

beginning and 4 at the end) twice without interruption. They were then presented with a word fragment completion task, in which 20 to 50% of the letters were replaced with a dash. As in the explicit word stem completion task, the participants were read the following instructions:

Some of the items on this form are the parts of words you saw in the booklet. Please fill the blanks to form a word. Remember only some of the word parts are from the words you actually saw. Try to complete as many words as you can.

They were instructed to place letters in the dashes in order to complete the words as quickly as possible (See Appendix F). Ten minutes were allowed for this task. Of the 30 fragments they were asked to complete, they had seen 15 and the 15 non-presented items served as baseline.

Scoring for all memory tasks was completed the same way. A word was considered a correct completion only if it was spelled exactly as the target word shown on the card.

Wisconsin Card Sorting Test

The Wisconsin Card Sorting Test (WCST; Berg, 1948; Grant & Berg, 1948) assesses the ability to generate abstract concepts, to apply rules (Stuss & Benson, 1984) and to develop, maintain and switch conceptual sets when necessary. In this test, the subjects are asked to match cards on color, shape or number. The participants are given little instructions as to how to complete the task, but are told each time whether the response is correct or incorrect. The subject is first required to match the cards by color. After the subject has completed ten consecutive correct responses (matching on color), then the examiner will without warning, switch the conceptual set or matching rule (e.g.,

matching on shape). This procedure is continued throughout the test; overall, the examiner rotates the correct set until the participant has matched on color, shape and number twice or until all of the cards have been used. The test is scored on a number of different dimensions including, the number of achieved categories (maximum number of categories is six), perseverative errors, non-perseverative errors, and unique errors. No information about the WCST reliability is available (Spreen & Strauss, 1991) because of the large problem solving demands of this test, it is very likely that a large practice effect would occur.

Many researchers have demonstrated deficient performance on the WCST in individuals with frontal lobe lesions (Milner, 1963; Taylor, 1979; Bornstein, 1986; Hermann, Wyler, & Richey, 1988). However, the WCST does not discriminate well between individuals with diffuse brain damage, and individuals with only frontal lobe impairment (Robinson, Heaton, Lehman, & Stilson, 1980); therefore, the WCST should be used in conjunction with other frontal measures (Heaton, 1981; Heaton, Chelune, Talley, Kay, & Curtiss, 1993).

Controlled Oral Word Association

Controlled Oral Word Association (also called Letter or Word fluency; Benton & Hamsher, 1983) involves a subject's production of words that begin with a designated letter for a designated period of time. The subject is directed to list as many words possible that begin with the letter "F" in a 60 second time frame and the examiner records the responses. After the subject has completed the first letter, the procedure is repeated in the same manner with the letters "A" and "S". Retest reliability range from .70 for older

adults at one year (Snow, Tierney, Zorzitto, Fisher, & Reid, 1988) to .88 for about 3 to 6 weeks (desRosiers & Kavanaugh, 1987). Several studies have shown that the word fluency task is sensitive to frontal lobe damage, generally (Miceli, Caltagirone, Gainotti, Masullo, & Silveri, 1981) and bilateral frontal lesions (Benton, 1968). Others have found that the word fluency test was sensitive to left frontal damage (Parks, Loewenstein, Dodrill, Barker, Yoshii, Chang, Emran, Apicella, Sheramata, & Duara, 1988; Perret, 1974). A positronemission tomography study demonstrated both right and left temporal and frontal involvement in normals while performing this task (Parks, et. al, 1988).

The Ruff Figural Fluency Test

The Ruff Figural Fluency Test (Ruff, Light, & Evans, 1987) is a measure of non-verbal fluency and is believed to be associated with right frontal lobe abilities. The test is comprised of 5 subtests, resulting in a sum of total unique designs and total perseverations. The subject is presented with a form that has 35 identical squares (5 x 7 grid) that contain 5 dots (the first sheet has dots forming a pentagon, the second sheet has the same arrangement of dots with the addition of small diamonds, the third form has the same arrangement, but lines connect some of the dots, the fourth and fifth sheets each have different arrangements of the five dots). On each of the five forms the arrangement of the dots is the same for all 35 squares on each sheet. The subject is instructed to make as many unique designs as possible by connecting at least two dots in 60 seconds.

A normative study of 358 normal subjects found a significant affect for age and education on the number of unique designs, however age and education was not significantly related to the number of perseverations (Ruff, Light, & Evans, 1987).

Further, the number of unique designs did not significantly correlated with motor speed or verbal fluency, and moderately correlated with measures of non-verbal intelligence. Six month follow-up on a portion of the subjects indicated that performance on the number of unique designs improved on the second testing and resulted in a test-retest correlation coefficient of .76. More variability was found in the number of perseverations overall and was generally less reliable, resulting in a test-retest correlation coefficient of .36.

The Stroop Test

The Stroop test (Stroop, 1935) "measures the ease with which a person can shift his or her perceptual set to conform to changing demands and suppress a habitual response in favor of an usual one" (Spren & Strauss, 1991). The Stroop is made up of three parts; the first sheet contains color names printed in black ink, the second, contains a series of "XXX" which are printed in a different colors (red, green and blue). The third sheet is comprised of the same words from the first card, but the color names are now printed in colors (different than the named colors, e.g., the word "green" is printed in blue ink). On the first trial, the participant is asked to read the words, on the second trial, the subject is asked to read the colors, and on the third trial, the subject is asked to read the color the words are printed in, while ignoring the color name. All trials are timed for 45 seconds, and the number of correct words are calculated for each trial. Golden (1976) reported that the Stroop discriminated between brain injured individuals and controls with an overall accuracy of 87%; 89% of the controls were correctly classified and 85% of the brain injured were correctly classified.

The Trail Making Test

The Trail Making Test (Reitan & Wolfson, 1985) is a visual search and visuospatial sequencing task (desRosiers & Kavanagh, 1987). It also assesses the ability to manage more than one stimuli at a time (Eson, Yen & Bourke, 1978). This test is administered in two parts. Because of the sequential, motor and inhibitory components of the task, it has often been considered a measure of frontal lobe functioning (Lezak, 1983). In Part A, the subject is presented with a sheet of paper which has the circled numbers 1 to 25 printed randomly. The subject is instructed to connect the numbers in numerical order by drawing pencil lines (without lifting the pencil). The second part of the test, Trail Making Part B is similar except that the stimulus sheet contains circled numbers and letters. The subject is instructed to alternate consecutive connections between the numbers and letters (e.g., 1-A-2-B-3-C). Part A and Part B have a standard set of instructions for administration, and one practice trial each. The score for each test obtained is the total numbers of seconds to complete the task and the number of errors.

Lezak (1983) found a significant practice effect over 3 administrations and a coefficient of concordance of .98 for Part A and .67 for Part B. In older subjects, one-year test-retest reliability was .64 for Part A and .72 for Part B (Snow, Tierney, Zorzitto, Fisher, & Reid, 1988). Construct validity was indicated by correlations from .36 to .93 with a visual search task and a hidden pattern test in a sample of aphasic and nonaphasic patients and they did not correlate with measures of verbal ability (Ehrenstein et al., 1982). It is reportedly highly sensitive to brain impairment (Dodrill, 1978; O'Donnell, 1983). It has been shown to distinguish closed head injured patients (desRosiers & Kavanaugh,

1987). Alekoumbides et al. (1987) compared normal controls to 3 clinical groups and correctly classified rate of 80% and 74% (Part A and Part B respectively) the normal controls, 26% and 20% for patients with diffuse brain damage, and 95% and 94% for patients with isolated lesions.

California Verbal Learning Test

The California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan, & Ober, 1987) is a test of memory and learning. A list of 16 words, 4 words from 4 groups of semantically related words (i.e., fruits, spices, tools, clothing) is read 5 times and each time the participant is instructed to recall the words (referred to as List A Trials 1-5). After the fifth trial, 16 new words, 4 words each from 4 semantically related words (i.e. kitchen items, fish, fruit, spices) is read and the participant is instructed to recall the words. This list (List B) serves as an interference trial). Next, free recall of List A is assessed and immediately following cued recall is assessed (i.e., the examiner says, "Tell me all of the shopping items...that are spices and herbs" and this is done for each of the 4 semantic categories. After a 20 minute delay, free, cued and recognition memory are assessed.

A factor analysis of the CVLT conducted on 286 control subjects produced the following factors: A general learning factor (comprised of short and long free and cued recall among other measures), response discrimination (comprised of intrusions and false positives on the recognition measure), learning strategy (semantic and serial clustering), proactive effect (List B, List B versus List A Trial 1), Serial position effect (percent primacy recall and percent recency recall), acquisition rate (learning slope) (Delis,

Freeland, Kramer & Kaplan, 1988). These factors were replicated in 700 job applicants (Wiens, Tindall, & Crossen, 1994) and moderate correlations were found between intelligence and CVLT ($r = .20$ in males, and $r = .29$ in females). Another study found modest correlations between the CVLT and other memory measures Wechsler Memory Scale and low correlations between the CVLT and measures of intelligence (Schear & Craft, 1989). A high degree of convergent validity was demonstrated between the Wechsler Memory Scale-Revised (WMS-R) and the CVLT (Delis, Cullum, Butters, & Cairns, 1988), resulting in a correlation of .91 between CVLT Total trials 1 through 5 and the verbal memory index on the WMS-R. Recently, it has been reported that the subjects in the CVLT normative sample were high functioning and their range of memory functioning was smaller and not representative (Randolph, Gold, Kozora, Cullum, Hermann, & Wyler, 1994) which overestimates memory impairment. Therefore in the present study, comparisons will be made within the present sample, and the normative data will not be used.

Patients with Alzheimer's Disease (AD) generated significantly more intrusions on the CVLT cued recall tasks, which were especially prominent at delay when compared to patients with Huntington's Disease (a subcortical dementia), further an intrusion rate of greater than 25% correctly classified 95% of the AD and non-AD patients (Kramer, et al. 1988). In another study (Delis, et al., 1991) AD, HD and Korsakoff patients performed similarly on CVLT free and cued recall, however, HD patients remembered more words on the recognition measure, but AD and Korsakoff patients remained impaired. This suggests that memory impairment in Korsakoff and AD patients is not due to faulty

retrieval mechanisms, but rather consolidation or storage deficits. AD patients did not show learning over repeated trials, and had elevated recency effect.

Digit Span

Digit Span is a subtest of the WAIS-R and the task is twofold; a string of digits is repeated by the subject in a forward sequence and digits are repeated in a backward sequences by the subject. Practice trials are obtained for each of these tasks. Lezak (1983) suggested that the digits backward subtest places greater demands on working memory and involves "double-tracking" where high demands are placed upon memory and reversal operations. Cohen (1993) noted that the digits backward task is more sensitive to attention "dysfunction", places more demands on working memory and requires cognitive effort (not an effortless task).

In a factor analytic study, Paolo and Ryan (1994) examined elderly subjects' WAIS-R subtests scores (75-96 years of age) in relation to educational level. They found that for individuals with 11 or less years of education, two factor solution emerged, a factor of verbal ability and a factor of perceptual organization. In individuals with 12 or more years of education, a three factor solution emerged; the factors were verbal ability, perceptual organization and freedom from distractibility. Digit Span loaded on the distractibility factor. When two factors were examined for both groups based on educational level, Digit Span loaded on the verbal ability factor for those with less education but it loaded equally on both factors for the group with more education.

Digit Symbol Modality Test

The Digit Symbol Modality Test (Smith, 1973) is a measure of processing speed

(motor and non-motor). On this test, the patient is presented with a sheet that has a key at the top of the page where unique symbols are each paired with the numbers one through nine. Below the key is several rows of boxes with symbols in the top portion and a blank box below each symbol. The subject is instructed to fill in the appropriately paired number as fast as possible. They subjects are stopped after 90 seconds. The sheet is removed and the subject is presented with another blank sheet and they are instructed to complete the task in the same manner except this time they read their responses aloud to the examiner who records their responses. They are stopped after 90 seconds. The rendered score is the total number of correct responses.

Validity studies indicate that it is useful in identifying brain injured adults and children. Smith (1973) points out that this test is useful in assessing older adults, because the oral assessment eliminates the confound of slowed motor speed associated with older adults and more cleanly assesses the mental operations.

The Geriatric Depression Scale

The Geriatric Depression Scale (GDS; Brink, Yesavage, Lum, Heeresema, Adey, & Rose, 1982; Yesavage, Brink, Rose, Lum, Huang, Adey, & Leirer, 1983) is a 30 item self-report screening inventory which was designed specifically to assess depression in older adults. The questionnaire is easy to complete, and requires the subject to simply read a brief statement and circle "yes" or "no". By design, somatic symptoms which are generally common to older adults were omitted, because they not helpful in distinguishing depressed from non-depressed elders (i.e., sleep disturbances). A validity study (Yesavage et al., 1983) classified depressed individuals as being normal, mildly depressed or severely

depressed which was based upon a clinical interview using stringent research criteria for depression. The means for each of these categories were reliably different, adequately distinguishing the levels of depression. Alpha coefficient indicating overall internal consistency was 0.94, and split-half reliability was 0.94, test-retest reliability, one week intervening was 0.85. Using a cut-off of 11 or greater endorsed items, Brink et al., (1982) derived a sensitivity rate of 84% and a specificity rate of 95%.

CHAPTER 6

RESULTS

The curious reader might wonder at this point whether or not amount of education has any bearing on this study. Education is an important variable to consider whenever cognitive functions are assessed, especially in measures that depend upon verbal abilities. The number of years of education did not significantly correlate with implicit memory word stem completion ($r = .02$), implicit memory word fragment completion ($r = -.12$), explicit memory word stem completion ($r = -.03$), or explicit memory word fragment completion ($r = -.01$).

The number of correct baseline and target words were tallied for each participant in each condition (implicit memory word stem and word fragment completion, explicit memory word stem and fragment completion). Next, in accordance with other research (Winocur, Moscovitch & Stuss, 1994) the correct number of target words and baseline was divided by the total number possible, yielding a proportion score. The baseline proportion scores were subtracted from the proportion of correct target words and were then transformed to z scores in order to equate the different stimuli. The test stimuli did differ between forms of the test and this is why the scores were standardized. However, for ease of interpretation and understanding, the mean number of correct words is presented in Tables 2 and 3. Table 3 shows the mean number of correct target and baseline words for the two versions. In each booklet, the stimuli for the implicit stem and fragment completions were administered in the explicit stem and fragment completions and vice versa. This table highlights the shared stimuli (e.g., what some people saw for

the implicit tasks, others saw on the explicit task).

The word stem completion (WSC) and word fragment completion (WFC) scores were higher than the baseline performance in all conditions. The priming effect was evaluated with two-tailed paired t tests (mean comparisons between the number of correct primed words and the number of correct baseline words) and was found to be statistically significantly different in all conditions, implicit memory word stem completion ($t(99) = 13.10, p < .01$), implicit memory word fragment completion ($t(99) = 7.22, p < .01$), explicit memory word stem completion ($t(99) = 17.86, p < .01$), and explicit memory word fragment completion ($t(99) = 7.73, p < .01$).

Mean alpha reliability coefficients for each scale were as follows: implicit memory word stem completion $r = .51$ (correlation between target and baseline stem, $r = -.05$), implicit memory word fragment completion $r = .74$ (correlation between target and baseline fragment, $r = .50$), explicit memory word stem completion $r = .55$ (correlation between target and baseline stem, $r = .20$), explicit memory word fragment completion $r = .77$ (correlation between target and baseline fragment, $r = .60$).

Mean comparisons of the correct number of primed words and the correct number of baseline words were made for implicit and explicit word stem completion tasks (Table 2). The participants completed significantly more words (minus baseline) in the explicit memory word stem completion task ($M = 4.99$) than in the implicit memory word stem completion task ($M = 3.86$) ($t(99) = 7.81, p < .01$). Mean comparisons were also made between implicit and explicit word fragment completion tasks and these means did not significantly differ.

**Table 2 - Mean Completions on Implicit and Explicit Memory Baseline,
Word Stem Completion, Word Fragment Completion**

Word Stem Completion			Word Fragment Completion	
Implicit Memory				
	Baseline	Target	Baseline	Target
<u>M</u>	2.60	6.46	7.5	9.72
<u>SD</u>	1.30	2.58	2.99	3.14
Explicit Memory				
	Baseline	Target	Baseline	Target
<u>M</u>	3.15	8.14	7.71	9.87
<u>SD</u>	1.70	2.57	2.89	3.28

Table 3 - Mean Performance on Implicit Word Stem & Word Fragment, Explicit Word Stem & Fragment Completions of the Two Stimuli

		Version 1A (N=28; Age $\bar{M}$ = 71.07)		
		Target	Baseline	Difference
A	IM WSC	6.07	2.43	3.64
B	IM WFC	11.18	7.89	3.29
C	EM WSC	9.75	3.18	6.57
D	EM WFC	12.29	7.57	4.71

		Version 1B (N=21; Age $\bar{M}$ = 75.76)		
		Target	Baseline	Difference
C	IM WSC	8.10	2.71	5.38
D	IM WFC	10.62	5.48	5.14
A	EM WSC	6.81	2.38	4.43
B	EM WFC	9.86	7.00	2.86

		Version 2A (N=26; Age $\bar{M}$ = 67.35)		
		Target	Baseline	Difference
A	IM WSC	6.96	1.73	5.23
B	IM WFC	9.46	7.85	1.62
C	EM WSC	8.00	4.62	3.39
D	EM WFC	8.96	8.89	.08

		Version 2B (N=25; Age $\bar{M}$ = 75.08)		
		Target	Baseline	Difference
C	IM WSC	5.00	3.60	1.40
D	IM WFC	7.60	8.40	-.80
A	EM WSC	7.60	2.24	5.36
B	EM WFC	8.12	7.24	.88

Table 4 - Pearson Correlations Between Implicit Memory (IM) and Explicit Memory (EM) Word Stem (WSC) and Word Fragment Completions (WFC)

	IM WFC	EM WSC	EM WFC	CVLT Trial 1
IM WSC	.04	.25**	-.01	.09
IM WFC		.17	.20*	.06
EM WSC			.30**	.37**
EM WFC				.18

* = $p < .05$, ** = $p < .01$

The correlation coefficients between implicit memory, explicit memory word stem completion and word fragment completion conditions are found in Table 4. If the tests are actually measuring distinct constructs i.e., implicit and explicit memory, then one would expect implicit memory word stem completion and implicit memory word fragment completion to correlate more strongly than implicit and explicit memory word stem completions or implicit and explicit word fragment completions. However, the results showed that implicit memory word stem completion only significantly correlated with explicit word stem completion. Additionally, implicit memory word fragment significantly correlated with explicit memory word fragment completion. This is may be a reflection of shared method variance. Notably, neither implicit memory task significantly correlated with a standard measure of memory. Explicit memory word stem and word fragment did significantly correlate with each other. But only explicit memory word stem correlated with a standard memory measure. The significant correlation between explicit memory word stem and word fragment completions suggest that the explicit tests (stem and

fragment) may be measuring a similar construct. However, the correlation between explicit memory word stem completion and CVLT trial 1 suggest that the explicit word stem task may be a better estimate of memory. The non-significant correlation between both implicit and explicit memory word fragment completion and the CVLT suggest that the fragment conditions may be measuring something other than explicit memory. Again, notably only explicit memory word stem completion correlated significantly with a standard measure of memory.

These findings suggest that both fragment tasks (fragment tasks that were designed to measure implicit and explicit memory) are not measures of explicit memory per se and that the explicit memory word stem completion appears to be measuring general memory abilities. Perhaps the fragment tasks are more closely associated to verbal abilities than memory generally. This pattern of correlations directly impacts the hypotheses in this study. Perhaps the relationship between the fragment tasks and neuropsychological measures will shed some light on this situation.

Although no specific hypotheses about depression were developed, a brief discussion of the correlations between the Geriatric Depression Scale (GDS) and measures of implicit, explicit and neuropsychological variables is warranted. The GDS correlated significantly with the CVLT free recall delay ($r = -.23$), CVLT intrusions ($r = .25$), Category fluency ($r = -.22$), non-verbal fluency ($r = -.19$), Stroop ($r = -.21$), Trail Making Part A ($r = .24$) and Part B ($r = .28$) and Digit Symbol Modality Test-Oral ($r = -.25$) and Written ($r = -.25$). It is not surprising that an index of depression significantly correlated with measures involving processing speed and fluency, but the finding that reduced

memory and increased intrusions on the CVLT is interesting and warrants future exploration. Depression was not significantly correlated to experimental measures of implicit and explicit memory.

The first hypothesis examined the relationship between implicit and explicit memory and age. It was hypothesized that explicit memory would have a significant negative correlation with age. In line with other studies, no strong relationship was expected between implicit memory and age. This hypothesis was supported. The correlation coefficients between age and implicit memory word stem completion ($r = -.14$), age and implicit memory word fragment completion ($r = .03$), and age and explicit memory word fragment completion ($r = -.12$) was not significant; however age and explicit memory word stem completion significantly correlated ($r = -.31$, $p = .01$).

The second hypothesis examined the relationship between implicit memory, explicit memory and measures of verbal fluency. Fluency is thought to be a cognitive process associated with frontal lobe functioning. Individuals may develop and apply strategies to improve their performance on fluency tasks. For example, individuals using semantic associations (e.g., types of animals or food) to guide their associations on a letter fluency task may perform better than individuals who randomly generate words. The development and application of a strategy is thought to be associated with frontal lobe functioning. Given the strategic mechanisms involved in this task, it was hypothesized that verbal fluency would be strongly associated to explicit memory (both stem and fragment) generally, and implicit word fragment completion. This hypothesis was partially supported (See Table 5). Both explicit and implicit word stem completions significantly correlated

with category fluency. Implicit and explicit memory word fragment completions did not. Explicit word fragment completion significantly correlated with perseverative errors on category fluency, but not with the fluency task itself.

The Ruff Figural Fluency Test is purported to measure right frontal lobe functioning. Although this is not a verbal task, individuals using a strategy will complete more unique designs and have fewer perseverative errors. Thus, it was hypothesized that figural fluency would significantly correlate with explicit memory stem performance and with both implicit and explicit fragment tasks. This hypothesis was partially supported (See Table 5); both explicit memory word stem completion and word fragment completion significantly correlated with figural fluency. Neither of the implicit, explicit completion tasks significantly correlated with perseverative errors on the RFFT.

Table 5 - Pearson Product Moment Correlation Between Implicit Memory (IM), Explicit Memory (EM) Word Stem Completion (WSC) and Word Fragment Completion (WFC) and Measures of Verbal Fluency and Perseverations

	Category Fluency	Category Perseverations	RFFT Total	RFFT Perseverations
IM WSC	.20*	-.10	.16	-.07
IM WFC	-.07	.16	.02	.08
EM WSC	.21*	.08	.35**	-.01
EM WFC	.12	.30*	.32**	.16
Age	-.61**	.21*	-.64**	-.09

* = $p < .05$, ** = $p < .01$

The third hypothesis dealt with the ability to inhibit responses (e.g., ignore distracting information), thought to be associated with frontal lobe functioning, as measured by the Stroop Color/Word Test. Again, because of the strategic mechanisms involved (deliberate), it was hypothesized that this frontal measure would significantly correlate with implicit word fragment and both measures of explicit memory. This hypothesis was partially supported (See Table 6). Both explicit memory stem and fragment completions significantly correlated with the Stroop Test. However, implicit word stem completion significantly correlated as well, but the fragment test did not.

Table 6 Pearson Product Moment Correlation Between Implicit Memory (IM), Explicit Memory (EM) Word Stem Completion (WSC) and Word Fragment Completion (WFC) and Measures of Inhibition

	Stroop Color/Word
IM WSC	.20*
IM WFC	.02
EM WSC	.37**
EM WFC	.25**
Age	-.56*

* = $p < .05$, ** = $p < .01$

The WCST has been conceptualized as a measure of executive functioning and includes purported measures of frontal lobe functioning including the ability to develop and maintain a conceptual set or problem solving, and perseverative responses. Similarly, Trail Making Part B is thought to involve mental flexibility and dual tracking, both being executive skills. The fourth hypothesis stated that the strategic problem solving mechanisms underlying these executive skills would also be related to executive or strategic search mechanisms underlying explicit memory. This hypothesis was partially supported (See Table 7). None of the implicit, explicit memory completion measures significantly correlated with errors on the WCST. Explicit memory word stem completion significantly correlated with Trail Making Part B, but explicit memory word fragment and implicit memory word fragment completion did not correlate with Trail Making B.

Table 7 - Pearson Product Moment Correlation Between Implicit Memory (IM), Explicit Memory (EM) Word Stem Completion (WSC) and Word Fragment Completion (WFC) and Measures of Problem Solving and Mental Flexibility

	WCST Errors	Trail Making Part B
IM WSC	.02	-.22*
IM WFC	.15	-.05
EM WSC	-.03	-.32**
EM WFC	.06	-.14
Age	.38**	.55**

* = $p < .05$, ** = $p < .01$

The fifth hypothesis examined the relationship between implicit memory, explicit memory and measures of attention. It was hypothesized that both implicit and explicit memory would be strongly, positively correlated with measures of attention. This hypothesis was partially supported (See Table 8). Explicit memory word stem completion consistently significantly correlated with Digit Span, Digit Symbol Modality Test and Trail Making Part A. Neither implicit or explicit memory word fragment were significantly associated to any measures of attention. Implicit memory word stem completion was significantly correlated to DSMT and Trail Making Part A, but not to Digit Span.

Table 8 - Pearson Product Moment Correlation Between Implicit Memory (IM), Explicit Memory (EM) Word Stem Completion (WSC) and Word Fragment Completion (WFC) and Measures of Attention and Memory Tests

	Digit Span Total	DSMT Oral	Trail Making Part A
IM WSC	.11	.22*	-.24*
IM WFC	.01	.02	.07
EM WSC	.31**	.45**	.28**
EM WFC	-.02	.16	.12
Age	-.33**	-.72**	-.62**

* = $p < .05$, ** = $p < .01$

CHAPTER 7

DISCUSSION

One of the main findings of this study was that explicit memory negatively correlated with age. Consistent with other similar studies, no clear age-related decline in implicit memory was found. Unexpectedly, implicit memory word fragment completion was not related to any measures of strategic executive skill. Some measures of frontal lobe functioning were associated with implicit word stem completion, especially those tasks involving verbal fluency and attention. Explicit word stem completion appears to be more closely associated to executive measures than any of the other completion tasks. This is surprising given the seemingly strategic demands of the fragment tasks.

The implicit memory stem completion was significantly associated to its explicit counterpart, but not to the CVLT. It is possible that this is a reflection of the shared method variance. It may also be reflective of an underlying incidental memory. Incidental memory is information that is remembered after exposure, but is not necessarily unconsciously encoded and is not unconsciously retrieved.

Implicit memory word fragment completion did not significantly correlate with any other neuropsychological variable. Implicit memory word stem completion significantly correlated with verbal fluency, the Stroop Test, DSMT and Trail Making Parts A and B. Three of these measures are associated with attention and appear to be more fluent than elaborate in nature. It did not significantly correlate with the CVLT, figural fluency, verbal and figural perseverative errors, or WCST errors. It is notable that implicit memory word stem completion was related to verbal fluency and measures of attention.

These findings are congruent with Graf and Mandler's (1984) conclusion that implicit memory is a result of automatic activation of pre-existing mental representations whereas explicit memory is a production of an elaboratively based system which makes the words more accessible. Further, in 1990 Graf suggested that implicit memory does not decline with age because implicit memory is an automatic process. However, age-associated explicit memory declines are found because a more deliberate activation takes place which is detrimentally affected by declines in attention, or as suggested in the present study, elaborative search mechanisms.

In contrast to its word stem counterpart, the explicit memory word fragment completion significantly correlated with fewer variables. It was significantly correlated with figural, but not verbal fluency, the Stroop Test and category perseverations. The RFFT and the Stroop Test are both perceptually oriented tasks. It is not clear why this fragment task would be associated positively to perseverative errors on category fluency. The explicit word fragment completion task did not significantly correlate with digit span, Trail Making A and B, or category fluency.

In sharp contrast, explicit memory word stem completion task correlated significantly with the CVLT, verbal and figural fluency, the Stroop Test, digit span, DSMT, Trail Making Part A and B. It did not significantly correlate with WCST errors, or verbal and non-verbal perseverative errors. It is surprising that the WSCT performance was not associated with explicit memory performance as demonstrated in other studies. This may be a reflection of the fluent (and elaborative) aspect of the task. As will be discussed in more detail later, other studies using the stem completion task had dashes

following the words not a continuous line, possibly placing more demands on the executive or elaborative processes. It is notable that the CVLT did not strongly correlate with the WCST either ($r = -.19$).

The results of this study partially resemble the results of a similar study (Winocur, et al., 1994) which found that implicit memory stem completion significantly correlated with verbal fluency, WCST errors, but not CVLT performance. In the present study, implicit memory stem completion was related to semantic fluency, but not WCST errors. Interestingly, in the Winocur, et al. study implicit memory fragment completion only significantly correlated with a visuo-spatial task (which had great organizational demands). This is similar to the findings of the present study where the fragment task (albeit explicit memory) was related to figural fluency, purportedly a measure of right frontal lobe functioning and the Stroop test which is also more perceptually based. Notably however, there were methodological differences between the present study and the Winocur, et al. (1994) study. First, in this study the word stem and word fragment completion tasks were equated for word length and word frequency. In the Winocur et al. study all the words used in the stem completion tasks contained only five letters while the words in the fragment tasks contained six letters. Thus the participant need only come up with two additional letters to complete the correct word stem. The tasks in the present study were more difficult; the word length ranged from five to nine letters and were equivalent for both stem and fragment completion and the participant was required to generate as many as six letters to complete the correct word stem. Additionally, in the Winocur et al. study, the word stems (the first three letters of the word) were followed by two non-continuous

dashes which might have made the implicit task more strategically oriented. In the present study, the stems were followed by a continuous line in order to make the task more fluid and less defined. Additionally, in the Winocur et al. study, the subjects were asked to count the number of vowels during the first presentation and read the words in the second exposure. This may have made their task more perceptually based than the semantic rating used in the present study. As was demonstrated in the Blaxton (1989) study, the modality of the stimuli may greatly influence performance. These are all important variables that could be clarified empirically and would alleviate possible confounding and equivocal findings.

It is possible that unconscious processes may be more closely related to non-verbal, possibly right hemisphere functioning. In the clinical literature, some believe that affect related information may be processed in the right hemisphere (Score, 1994) and the right hemisphere may certainly play a larger role in language than once believed. Given that this study attempted to engage the participants in semantic processing of the words, they were equally likely to engage in an emotional reaction to the word, (they were indeed instructed to rate how pleasant or unpleasant the words were) which may have generated an affective state for those participants who actively engaged in these directions. Future research should examine the relationship between emotional reaction or pleasantness association (which could possibly be assessed by participant rating) to implicit or unconscious memory functioning.

Additionally, still other research suggests that the "left hemisphere has a greater facility for the utilization of previously learned information, while the right hemisphere

tends to approach every task as a novel experience, as though previous learning was irrelevant" (Goldberg & Costa, 1981). These researchers give the example of research conducted by Drewe (1974) which showed that individuals with right hemisphere lesions made more perseveration errors on the WSCT than did patients with left hemisphere lesions who made more non-perseverative errors. Thus, because the implicit memory task may be considered a novel task (it was administered first) and perhaps it engaged more right hemisphere involvement than would have been initially hypothesized. The second exposure to the words and the subsequent task (i.e., explicit memory word stem completion) may have involved more left hemisphere processing because it is a less novel task.

As suggested earlier, some researchers believe that the fragment tasks may be more perceptually driven. For example, the processing account has been used to explain the dissociation between implicit and explicit memory performance, and places importance on the type of processing used. The processing variables are either "data driven" or "conceptually driven" processes. Data driven processes refers to the processing of the physical features of the word which are tapped by perceptual identification. Conceptually driven processes refer to more semantically related processes. Blaxton found that performance on conceptually driven tasks was not affected by modality changes, however, data driven tasks were. She concluded that the dissociation was better explained by the type of processing (data driven versus conceptually driven) distinction than by the episodic, semantic, implicit, explicit distinction. The explicit measures were influenced by modality specific and typographic manipulations (the actual appearance of the text)

whereas implicit measures were influenced by semantic manipulations. The processing mode is more pertinent than the specific memory system.

Thus the results of this study suggest that implicit memory does not appear to decline with age. However, age-related decrements in explicit memory were found and may be associated to some, but not all strategically oriented executive skills. Future research should more directly assess such cognitive processes as incidental memory, language skills, right hemisphere functioning (non-verbal), or perceptual skills.

Much about methodology was learned from this study. The first discussion will involve methodological concerns that were properly addressed in this study. The word stems and completions were embedded in completion tasks in an attempt to make the implicit tasks less obvious. This was done in order to divert the subject's attention from the memory component of the task. In other studies, the target word stems are first presented and baseline stems are presented separately. When the stimuli are presented separately, the memory component of the implicit task may be more noticeable to the participant.

In this study, the length of the target word stems and fragments were equivalent, thus making the stimuli as comparable as possible. In the Winocur, et al. (1994) study, the word stems were all five letters long and the fragments were six letters long, making the tasks less equivalent and thus reducing the amount of generalizability of the two forms of implicit memory. Additionally, in this study continuous lines were used after the word stems in order to make the task more fluent and less strategic. Also, in the present study, the stem and fragment tasks were more challenging. In the Winocur et al. study, the

participants only had to come up with two letters to complete the word stems.

Regarding methodology, much was learned that may benefit future research. First, shorter time limits should be imposed on the fragment tasks to help alleviate some of the verbal problems solving component that may have taken place (e.g., completing the fragments like a cross word puzzle). Second, the length of some words may have been too long and other criteria for word selection may be beneficial. For example, in the present study the stimuli words were of varying lengths and thus varying levels of difficulty. Specifically, in the fragment tasks this may have been a problem. Many of the words had only one possible answer and may have created a more verbal problem solving task than was desired. The use of baselines was helpful, and the next step in the research will be to examine the baseline responses between subjects (in this study, the subjects provided their own baseline estimates). While the data was being scored, it became evident that some word fragment had more possible solutions than others and were completed with non-stimuli words and these words. Ideal words such as these would increase the memory component and decrease the verbal problem solving demands. For example, the fragment "_RE_D" was completed with a number of different words other than the target words "trend" (e.g., subjects completed the fragment with "dread, bread, creed, greed, etc."). More words with more possible answers would have reduced the high baseline rate found in the fragment completion tasks. It is suggested that these and similar words be used in the future.

Much implicit and explicit memory research lies ahead. For example, this study did not examine the different types of learning that may be associated with implicit and

explicit memory. A more thorough investigation into the varying types of learning impairments may shed more light on frontal lobe involvement in memory generally. For instance, what type of memory or frontal lobe dysfunction is involved in intrusion and perseveration errors on a learning task? Do people make intrusive errors because they have reduced self-monitoring (frontal lobe dysfunction), poor memory, or is it related to implicit memory? Another research question involves the role of incidental memory. It would be beneficial to have a memory of incidental memory to better examine these closely related processes. Further, what does the right hemisphere contribute to implicit and explicit memory? Clearly, much of what has been discussed is perceptually dependent and the examination of non-verbal abilities might be quite interesting. Additional research examining the affective rating or pleasantness rating may contribute interesting insight into the realm of unconscious memory.

In conclusion, it is hoped that the results of this study will be beneficial to clinical psychology on a number of different levels. First, it may help clinical psychologists better understand the mechanisms of subconscious processes. Indeed, Freud (1966) was the first to make a convincing case for the existence of memory without awareness, and its application to therapy. Implicit memory may be associated with the positive benefits of psychotherapy. It is possible that much of the rapport building that occurs between therapist and client may be quite subtle and subconscious. Also, positive modeling demonstrated by the therapist in subtle interactions, communications or ways of thinking may be processed and retained at a subconscious level by the patient. Therapeutic interpretive work and suggestions may be retained even outside one's awareness. It is

also possible that affectively laden material which may not be processed consciously may be retained outside of awareness, perhaps being consciously processed later. This study specifically shows that explicit memory may be more closely associated to deliberate or executive skills. Perhaps future work will shed some light on learning that is obtained therapeutically via implicit memory. Individual with disorganized characterological structure (i.e., Borderline personality) and disorganized cognitions may benefit more from psychotherapy in an implicit manner than can be explicitly described. These same concepts could be applied to individuals with brain impairment and may be beneficial to psychologists treating individuals with head injuries in both therapy and rehabilitation.

An understanding of implicit and explicit memory in older adults may be helpful to clinical gerontologists conducting psychotherapy. Older psychotherapy clients (especially very old) may be retaining more than can be explicitly stated. Therapy techniques such as "reminiscent" work may assist individuals in revitalizing subconscious memories by using techniques that may not be executive or deliberate in nature. For example, using free association or non-verbal stimuli to spark memories that are not readily attainable through deliberate pathways. Reminiscent memory therapy may sharpen cognitive processes or improve mood.

Further, this information may be useful to clinical neuropsychologist who work with older adults in memory rehabilitation, or who perform gerontological assessment and make recommendations (compensatory or otherwise). For example, this study speaks to the utility of non-deliberate strategies for word retrieval in older adults. Word finding problems are a common complaint in older people. Many people acknowledge that the

more they try to recall a word, the more difficult it is to remember it. Perhaps there are more associative methods that may facilitate implicit and explicit processes. Further research in this area can help not only in understanding human weaknesses, but also understanding persistent human strengths.

CHAPTER 8

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APPENDIX A

APPENDIX A
INFORMED CONSENT

The purpose of this study is to better understand cognitive abilities in older adults, including memory functioning. You will be given a variety of cognitive tests. The testing will take about 2 hours to complete. Some of the tests may be challenging, but your participation is voluntary and you may refuse to answer a question, complete a test, or you may discontinue at any time without any penalty whatsoever. All of the test results will be kept confidential and anonymous. Upon request, you will be given brief feedback about your general memory abilities after all the testing has been completed. Only those individuals that request feedback will receive it. For example, you will be told whether your memory is better, not as good or about the same as other people your same age. If you have any questions or concerns regarding this study, please call Michelle Merwin, M.A. at 355-9564. Your signature below indicates that you have had this explained to you and that you are indicating your voluntary consent to participate.

_____	_____	_____
Print Name	Signature	Date

If you are interested in receiving a summary of the research findings of this study when they are available, please write your address below.

APPENDIX B

APPENDIX B

STIMULI WORDS

maturity	telephone	follow	sensitive
warning	allow	popular	artist
territory	evening	crowd	income
member	drink	reduce	detective
newspaper	winter	truck	medium
attack	submarine	search	positive
plant	tendency	variety	secret
decision	clothes	handle	empty
railroad	learn	operation	welfare
shelter	begin	advice	brother
harbor	manner	temple	enter
rapid	relative	apply	dramatic
immediate	serious	minister	worry
store	pencil	excess	solution
block	throw	quiet	model
plenty	electric	illusion	radiation
finish	review	weakness	random
location	dress	price	chief
circle	wheel	flower	capital
extreme	freedom	natural	master
clean	beneath	patient	officer
musical	chemical	metal	union
thick	involve	credit	heart
teacher	camera	regular	glance
beside	influence	depend	passage
engine	humor	balance	theater
accept	active	watch	baseball
desire	bridge	salary	honest
reach	notice	effective	flight
market	valley	thousand	trend

APPENDIX C

APPENDIX C

STEM COMPLETION WORDS

mat _____
war _____
ter _____
mem _____
new _____
att _____
pla _____
dec _____
rai _____
she _____
har _____
rap _____
imm _____
sto _____
blo _____
ple _____
fin _____
loc _____
cir _____
ext _____
cle _____
mus _____
thi _____
tea _____
bes _____
eng _____
acc _____
des _____
rea _____
mar _____

APPENDIX D

APPENDIX D

FRAGMENT COMPLETION WORDS

_ele__one
_l__ow
_ven_ng
dr__n__
_i__ter
s__bm__ri__e
te__den__
_lo__hes
_ear__
_eg__n
m__nn__r
_elat__v__
_er__us
_enc__l
th__ow
_le__tr__c
r__vi__w
_re__s
_he__l
_re__dom
b__ne__t__
c__em__ca__
i__vol__e
_am__ra
_nfl__en__e
_um__r
_ct__e
_ri__ge
_ot__e
_all__y

APPENDIX E

APPENDIX E

STEM COMPLETION WORDS

fol _____
pop _____
cro _____
red _____
tru _____
sea _____
var _____
han _____
ope _____
ad _____
tem _____
app _____
min _____
exc _____
qui _____
ill _____
wea _____
pri _____
flo _____
nat _____
pat _____
met _____
cre _____
reg _____
dep _____
bal _____
wat _____
sal _____
eff _____
tho _____

APPENDIX F

APPENDIX F

STEM COMPLETION WORDS

s_ns__ive
_rt_st
_nco_e
d_tec__ve
m_diu_
_os_t_ve
s_cr_t
_mp_y
_elf_e
_ro_her
nte
_ram_ti_
_or_y
_olut_on
m_d_l
_adi_tion
r_nd_m
_h_ef
c_pi_al
m_ste_
_ff_c_r
un_o_
_ea_t
_lan_e
_as_age
t_eat_r
_as_bal_
_one_t
_lig_t
_re_d

APPENDIX G

APPENDIX G - Pearson Product Moment Correlations of Implicit, Explicit Memory, Neuropsychological Measures, the Geriatric Depression Scale, Age and Education (* = $p < .05$, ** = $p < .01$)

	Implicit Stem	Implicit Fragment	Explicit Stem	Explicit Fragment	CVLT Trial 1	CVLT Total	CVLT Trial B	CVLT Delay
Implicit Stem	1.00							
Implicit Fragment	.04	1.00						
Explicit Stem	.25**	.17	1.00					
Explicit Fragment	-.01	.20*	.30**	1.00				
CVLT Trial 1	.09	.06	.37**	.18	1.00			
CVLT Total	.13	.08	.39**	.18	.77**	1.00		
CVLT Trial B	-.04	.01	.17	.06	.53**	.62**	1.00	
CVLT Delay	.17	.05	.34**	.15	.58**	.84**	.45**	1.00
CVLT Intrusions	-.03	-.11	-.13	-.24	-.14	-.27**	-.11	-.38**
CVLT Perseveration	-.05	.13	.13	.19	.14	.20*	.30**	.02
Category Fluency	.20	-.07	.21	.12	.45**	.59**	.43**	.55**
Category Perseveration	-.10	.16	.08	.30**	-.10**	-.14	.01	-.26
Verbal Fluency	.12	.04	.26**	.15	-.10	.28**	.21*	.22*
Verbal Perseveration	-.07	-.03	-.02	.04	.20*	-.20*	-.16	-.30**
Ruff Figural Fluency	.16	.02	.35**	.32**	.38**	.50**	.28**	.42**
Ruff Figural Perseveration	-.07	.08	-.01	.16	.08	-.06	.11	-.12
WCST Total Errors	.02	.15	-.03	.06	-.19	-.33**	-.06	-.28**
WCST Perseverative Errors	.06	.07	-.02	.07	-.25*	-.37**	-.10	-.31**
WCST # of Categories	-.03	-.07	.06	.02	.16	.27**	.04	.22*
WCST Failure to maintain set	.02	-.08	-.09	-.10	-.07	-.08	.03	-.12
Stroop	.20*	.02	.37**	.25**	.30**	.50**	.30**	.47**
Trail Making A	-.24*	.07	-.28**	-.12	-.37**	-.46**	-.34**	-.36**
Trail Making B	-.22*	-.05	-.32**	-.14	-.40**	-.58**	-.41**	-.47**
Digit Span Forward	.13	.02	.25**	-.08	.02	.08	.08	.10
Digit Span Backward	.06	.00	.25**	.04	.19	.21*	.06	.24*
Digit Symbol Modality Test-Oral	.22*	.02	.45**	.16	.43**	.62**	.44**	.56**
Digit Symbol Modality Test-Written	.15	-.02	.42**	.20*	.45**	.60**	.49**	.50**
Geriatric Depression Scale	.01	.11	-.05	-.08	-.08	-.17	-.18	-.23*
Education	.02	-.11	-.03	-.01	.04	.17	.14	.19*
Age	-.14	.03	-.31**	-.12	-.37**	-.55**	-.38**	-.50**

APPENDIX G - Pearson Product Moment Correlations of Implicit, Explicit Memory, Neuropsychological Measures, the Geriatric Depression Scale, Age and Education (* = $p < .05$, ** = $p < .01$)

	CVLT Intrusions	CVLT Per.	Category Fluency	Category Per.	Verbal Fluency Per.	Verbal Fluency Per.	Ruff Fluency Per.	Ruff Per.	WCST Error
Implicit Stem									
Implicit Fragment									
Explicit Stem									
Explicit Fragment									
CVLT Trial I									
CVLT Total									
CVLT Trial B									
CVLT Delay									
CVLT Intrusions	1.00								
CVLT Perseveration	.06	1.00							
Category Fluency	-.05	-.06	1.00						
Category Perseveration	.17	.42**	-.09						
Verbal Fluency	-.03	-.06	.52**	1.00					
Verbal Perseveration	.35**	.15	-.24*	.08					
Ruff Figural Fluency	-.16	.02	.58**	.39**					
Ruff Figural Perseveration	.02	.16	-.02	-.04					
WCST Total Errors	-.13	.03	-.37**	.10					
WCST Perseverative Errors	-.12	.02	-.42**	.12					
WCST # of Categories	.12	.02	.33**	.18					
WCST Failure to maintain set	.08	-.07	-.23*	-.01					
Stroop	-.18	.19	.46**	-.03					
Trail Making A	.05	-.14	-.53**	.00					
Trail Making B	.12	-.18	-.51**	-.03					
Digit Span Forward	-.15	.00	.19	.01					
Digit Span Backward	-.13	-.23*	.30**	-.08					
Digit Symbol Modality Test-Oral	-.10	.16	.70**	-.05					
Digit Symbol Modality Test-Written	-.10	.21*	.65**	-.02					
Geriatric Depression Scale	.25**	-.13	-.22*	.03					
Education	-.02	-.12	.29**	-.04					
Age	.08	-.08	-.61**	.21*					

APPENDIX G - Continued Pearson Product Moment Correlations of Implicit, Explicit Memory, Neuropsychological Measures, the Geriatric Depression Scale, Age and Education (* = $p < .05$, ** = $p < .01$)

	WCST Per. Errors	WCST# of Categories	WCST FTMS	Stroop	Trails Part A	Trails Part B	Digit Forward	Digit Backward
Implicit Stem								
Implicit Fragment								
Explicit Stem								
Explicit Fragment								
CVLT Trial 1								
CVLT Total								
CVLT Trial B								
CVLT Delay								
CVLT Intrusions								
CVLT Perseveration								
Category Fluency								
Category Perseveration								
Verbal Fluency								
Verbal Perseveration								
Ruff Figural Fluency								
Ruff Figural Perseveration								
WCST Total Errors	1.00							
WCST Perseverative Errors	-.75**							
WCST # of Categories	.16	1.00						
WCST Failure to maintain set	-.32**	-.42**	1.00					
Stroop	.38**	.25**	-.22*	1.00				
Trail Making A	.42**	-.40**	.15	-.47**	1.00			
Trail Making B	.01	-.35**	.05	-.55**	.77**	1.00		
Digit Span Forward	-.25**	.01	-.08	.22*	-.06	-.16	1.00	
Digit Span Backward	-.38**	.09	-.16	.32**	-.16	-.17	.29**	1.00
Digit Symbol Modality Test-Oral	-.37**	.32**	-.21*	.69**	-.67**	-.72**	.32**	.38**
Digit Symbol Modality Test-Written	-.01	.35**	-.19	.67**	-.72**	-.74**	.23*	.26**
Geriatric Depression Scale	-.19	.01	.05	-.21*	.24*	.28**	-.07	.03
Education	.39**	.24*	-.22*	.20*	-.22*	-.33**	.11	.10
Age		-.35**	.24*	-.56**	.62**	.55**	-.25**	-.29**

APPENDIX G - Continued Pearson Product Moment Correlations of Implicit, Explicit Memory, Neuropsychological Measures, the Geriatric Depression Scale, Age and Education (* = $p < .05$, ** = $p < .01$)

	Digit Symbol Oral	Digit Symbol Written	Geriatric Depression	Education	Age
Implicit Stem					
Implicit Fragment					
Explicit Stem					
Explicit Fragment					
CVLT Trial 1					
CVLT Total					
CVLT Trial B					
CVLT Delay					
CVLT Intrusions					
CVLT Perseveration					
Category Fluency					
Category Perseveration					
Verbal Fluency					
Verbal Perseveration					
Ruff Figural Fluency					
Ruff Figural Perseveration					
WCST Total Errors					
WCST Perseverative Errors					
WCST # of Categories					
WCST Failure to maintain set					
Stroop					
Trail Making A					
Trail Making B					
Digit Span Forward					
Digit Span Backward					
Digit Symbol Modality Test-Oral	1.00	1.00			
Digit Symbol Modality Test-Written	.92**	-.25*	1.00		
Geriatric Depression Scale	-.25**	.32**	-.26**	1.00	
Education	.30**	-.73**	.23*	-.23*	1.00
Age	-.72**				

APPENDIX H

APPENDIX H

APPENDIX FOR THE TECHNICALLY ORIENTED READER

Implicit and Explicit Memory, Dependent Processes?

One question that has been addressed in the implicit memory research concerns whether there is a dependent relationship between implicit and explicit tasks. Is implicit memory independent or dependent of explicit memory? Jacoby and Witherspoon (1982) demonstrated a dependent relationship between priming and recognition for pronounceable pseudowords, but independence for real words in a perceptual identification task. Graf and Schacter (1985) found that words recalled under cued conditions was higher for words that were also used on the completion task. Perruchet and Baveaux (1989) performed a correlation analysis in which subjects were compared on four implicit memory measures and two explicit measures. The subjects were exposed to the words which were shown on a screen for 3 seconds. Implicit memory was assessed by the following methods: perceptual clarification task in which the subjects were shown partially masked words and were asked to name the word as soon as they recognized it; fragment completion task in which the subjects were shown fragments and were asked to complete them; tachistoscopic identification in which the area of the screen where the word was going to appear was highlighted, the word was shown, and the letters were replaced by percent symbols and the subjects are asked to say the word they saw; anagram solution in which the subjects were presented with scrambled words and were asked to rearrange the letters to make a word (performance on the perceptual clarification task was measured by response latency and the others were measured by correct responses). The

results showed that the highest correlation occurred between the recall and recognition (.50) tasks. The perceptual clarification task correlated with the fragment completion task (.31) and perceptual clarification task also correlated recognition (.30) and recall (.28), while the completion task correlated with recognition (.38). The anagram task significantly correlated with tachistoscopic identification (.27) and recall (.25). The authors concluded that the perceptual identification task and the fragment completion task were associated with explicit memory, while the tachistoscopic and anagram measures were not. Further, implicit memory measures are more closely associated with measures of recognition than measures of recall. A factor analysis resulted in two factors; one factor which accounted for 23% of the variance and included recognition, recall, clarification and fragment completion. The second factor accounted for 12.5% of the variance and included tachistoscopic identification and anagram solution. The authors offer the following explanations for their findings: Implicit and explicit memory are dependent upon the same general ability, possibly verbal. It is possible that implicit memory mediates explicit memory performance. Conversely, it is possible that explicit memory influences implicit memory. Schacter (1987) has coined the term "involuntary explicit memory" to describe such a phenomenon.

Implicit and Explicit Memory, Independent Processes?

The dissociation between implicit memory and cued recall or recognition tasks (explicit memory) has led some researchers to conclude that implicit memory and recognition memory are independent processes (Jacoby & Witherspoon, 1982). Some researchers conclude that priming is not dependent upon explicit memory, because

amnesics demonstrate priming when compared to controls, and amnesics by definition have reduced explicit memory (Graf, Shimamura & Squire, 1985; Shimamura & Squire, 1984). Tulving, Schacter and Stark (1982) concluded that implicit and explicit memory were independent processes because they were able to demonstrate a decline in recognition, but intact priming. Also, they found that there was no relationship between correct priming responses and words that the subjects thought were part of the experiment. Independent processes were demonstrated when the presentation variable was manipulated (the study condition involved presented words, words presented in picture form, and the words were presented visually or auditorily). Subjects better explicitly recalled words that were initially shown in picture form, while implicit memory was poorest for this form of presentation (Rajaram & Roediger, 1993).

Cross Modal Considerations

Some studies have shown that implicit memory cannot be demonstrated robustly, and is readily influenced by perceptual changes in the stimuli. In one study, subjects were either presented with words visually or orally and then were assessed by visual presentation; priming occurred only for subjects who were exposed to the words visually, and not for those who were presented with the words orally (Jacoby and Dallas, 1981). In another study subjects were compared on a perceptual identification task in which either 10% or 90% of the word list from the study were presented at test (Jacoby & Witherspoon, 1982). They found that the probability of word identification was higher for words when 90% of the word list was presented (.66); however, even when only 10% of the list was retained, priming still occurred (.55). The authors concluded that changes

between study and test format slightly affected changes, yet other more gross experimental changes did not (e.g., different examiners, presence of music).

Rajaram and Roediger (1993) made direct comparisons of four verbal implicit memory measures (word identification, word stem completion, word fragment completion, anagram solution) and found that for all 4 tasks, the largest degree of priming occurred in the within-modal condition (i.e., visual study, visual test). Further, cross-modal priming did occur, but to a lesser extent. However, priming did not occur across forms, i.e., when pictures were shown at study but words were shown at test. They also showed that changes in the type between presentation and test did not impact performance. The greatest amount of priming occurred for words that were presented visually, less for words that were presented auditorily and very little priming was demonstrated at all for words represented by pictures. Conversely, recall was best for words depicted by pictures during study. In yet another study, priming was demonstrated even under conditions in which the subjects were not shown the words. Graf, Shimamura and Squire (1985) demonstrated priming under both within (e.g., visual study, visual test) and between modes of presentation and test, in amnesics and controls; however, more priming was found in the within conditions. Shimamura and Squire (1984) presented amnesic and controls with words and the subjects were asked to free associate to them. Both amnesic and controls demonstrated priming even when stimuli words were not shown to the subjects during study. In another study, Graf, Shimamura and Squire (1985) presented subjects with related (e.g, dog, cat, horse) and unrelated words. The subjects were then given category names (animals) and were asked to say the first exemplar that came to

mind. The amnesics were impaired on explicit recall, but showed equivalent priming when compared to controls. Thus, implicit memory was not a result of sensory or perceptual stimulation.

Test order effects

Graf and Mandler (1984) examined the test order effects and found that cued recall was not affected by recall or a completion task, however, completion was significantly greater when it followed cued recall, but only in the semantic condition. Tulving, Schacter and Stark (1982) examined the test order effects and the independence of fragment completion and recognition tasks at 1 hour and 7 day test intervals. They found that recognition and priming were independent processes. Because, recognition declined after 7 days, but priming effects did not. And when comparison of recognized words were made, priming was demonstrated for both words identified as "new" and words identified as "old."

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