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MEMORY DETERIORATION IN SENILE DEMENTIA OF THE ALZHEIMER-TYPE

BY

COLLEEN S. HAMMERMASTER ©

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Memory Deterioration in Senile Dementia of the Alzheimer Type" submitted by Colleen S. Hammermaster in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Counselling Psychology.

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This thesis is dedicated to my gramma, Emily Majeski,

who is a constant reminder that wisdom, rather than dementia,

is an inevitable part of aging

ABSTRACT

Memory problems are among the first as well as the most disabling of the cognitive deficits that occur in Senile Dementia of the Alzheimer-Type (SDAT). Much remains unknown regarding the complexity of memory deterioration in SDAT, and therefore the purpose of this study was to investigate how memory in SDAT is impaired in terms of particular memory structures and functions. Specifically, this study sought to determine whether the memory deterioration in early-stage SDAT is characterized by a failure in adequate encoding, storage, or retrieval processing in both short-term memory (STM) and long-term memory (LTM).

22 subjects who were diagnosed with mild-moderate SDAT were administered the California Verbal Learning Test (CVLT) to measure the multiple underlying processes of memory functioning.

The results of this study reveal that the degenerative process in SDAT, as presented by this sample, appears to disrupt the subject's ability to successfully encode new information into long-term memory (LTM). Encoding processes are impaired in two ways. Firstly, SDAT subjects generally did not transfer information into LTM for permanent storage. Instead they attempted to maintain information in STM through rehearsal of the information. Secondly, when information was encoded into LTM, it was done so in an ineffective manner based on sequence or some other irregular nonsemantic strategy, rendering the information inaccessible at the time of recall.

Based on the results of this study, investigations of encoding processes in SDAT and how these processes deviate from conventional encoding of information would be valuable to further elucidate the specific nature of the encoding deficits evident in SDAT. The results also suggest the need for

investigations into ways to facilitate or accommodate encoding deficits in this population. Some suggestions are provided for family members and other caregivers regarding how to assist persons with SDAT in memory tasks.

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CHAPTER I

INTRODUCTION

Overview of Senile Dementia of the Alzheimer-Type

Senile dementia of the Alzheimer-type (SDAT) is a degenerative, irreversible disease of the brain. It begins with mild memory problems, such as increased difficulty in remembering names, phone numbers, or appointments. Such mistakes are often overlooked at first. Jokes and other coping strategies cover up for memory losses and lapses. Gradually however, the condition grows worse until sufferers have trouble finding their way home and remembering the names of their spouse and children. Eventually they become totally confused, are unable to perform even simple tasks like dressing or grooming themselves, and experience an almost total loss of memory. SDAT is the ultimate insult to the human personality as it insidiously strips away a lifetime of learning and skills. To date, there is no fully effective method of prevention, treatment, or cure (Lefton & Valvatne, 1992).

SDAT could well be the most widespread neurological disorder of all time. As the population grows older, as a result of advanced medical technology aiding more people to survive illness and injury, the number of cases of SDAT increases. A recent estimate suggested that the numbers may be even greater than once thought: 1 in 10 people over age 65 may have the disease, and almost one half of those over age 85 may have the disease (Evans et al., 1989).

Purpose of the Study

The purpose of this study was to investigate the memory functioning of people with SDAT and to identify a pattern of memory deterioration including both spared and impaired aspects of memory. Research has already clearly revealed that memory is impaired in SDAT. This study has attempted to elucidate "what" exactly it is in memory that is impaired and "how" exactly the process or structure is defective in order to gain a more complete understanding of the disease. Specifically, this study sought to determine whether the memory deterioration in early-stage SDAT is characterized by a failure in adequate encoding, storage, or retrieval processing in both short-term memory (STM) and long-term memory (LTM). It was hoped that the results would reveal a clearer picture of the particular memory mechanisms pivotal to the changes observed in the early stages of SDAT. Clinicians and practitioners can use this information as the basis for diagnosis, intervention, and treatment.

Significance of the Study

Psychologists have largely delegated responsibility for researching SDAT to medical professionals, and as a result factors relating to the cognitive processes of Alzheimer patients have been ignored. Investigation into the memory processes of Alzheimer patients may not lead directly to a cure for the disease, but its contribution is nonetheless valuable. Because much remains unknown about the complexity of the memory deterioration in SDAT, research efforts by psychologists have been directed toward elucidating the nature of the memory impairments, which provides a better understanding of the disease. In this quest, psychological investigations have attempted to determine whether the deterioration of memory in SDAT represents a progressive worsening of memory changes observed in nonclinical aging, or whether the memory dysfunction in SDAT is characterized by the memory impairment of some memory process other than that identified in nonclinical aging. Identifying the specific nature of the memory deterioration in SDAT will contribute to early detection of the disease which is necessary not only for treating the disease once recognized, but for tracing its etiology so that someday it may prevent its tragic onset.

Implicit in the results of psychological investigations into memory deficits in SDAT are suggestions as to how family members and other caregivers may accommodate to these deficits at early stages of the disease's progression. For example, if recall problems are primarily due to retrieval difficulties, caregivers can facilitate recall by demanding recognition rather than free recall. By restructuring memory dependent tasks to use recognition instead of requiring total recall of names, times, dates, events, etc., a prosthetic environment would be created with various "clues" that would induce persons with SDAT to produce otherwise irretrievable material from storage. In training family members and other caregivers to adapt to identified memory impairments, functional declines in SDAT patients are minimized.

Finally, in investigating cognitive changes associated with SDAT, researchers inherently develop a better understanding of normal age-related memory changes and memory functioning in general. The maintenance of meaning is central to our survival and this is the essence of memory research.

Problems in Investigating SDAT

Two problems face any attempt to carry out research in SDAT. The first of these concerns the question of severity of impairment. As mentioned earlier, the disease is typically progressive, moving from a pattern of deficit that may be relatively specific to one of total intellectual deterioration. Severe cases are likely to be impaired on any test given to them, and indeed are likely to have difficulty even in understanding the instructions for the simplest task. Thus any attempt to explore the nature of the psychological deficit in SDAT is much more likely to be productive if it concentrates on mild to moderate cases where there is not global impairment. In addition to this, if as was suggest by the results of past research that early and late stages of SDAT may be differentiated in terms of type of memory deficit, all patients with this disease should not be considered a homogeneous group, but must be distinguished in terms of the severity of the disease (Ober, Koss, Friedland, & Delis, 1985; Pepin & Eslinger, 1989; Vitaliano, Breen, Albert, Russo, & Prinz, 1986).

The second problem in carrying out research in SDAT concerns the specifity of diagnosis. Although SDAT accounts for the majority of senile dementia, it is by no means the only source of such impairment. Any sample of patients referred for diagnosis is likely to contain patients with a mixture of etiologies including somewhat rarer dementias such as Huntington's disease as well as patients suffering from multi-infarct dementia, resulting from multiple minor brain lesions caused by a series of minimal strokes. Since each type of dementia, by having a different cause, may well produce a different dysfunction, it is clearly undesirable to lump these conditions together in order to look for a specific pattern of memory deficit. Diagnosis is far from easy, and requires information from a variety of sources, together with the clinical skills of an experienced geriatrician, if major misdiagnoses are to be avoided. Even with care, diagnosis tends not to be confirmed until the patient has die and his/her brain has been examined for the presence and number of the characteristic plaques and neurofibrilary tangles. For this reason, such patients tend to be referred to using somewhat tentative terms as "senile dementia of the Alzheimer-type" (SDAT).

This study attempted to overcome these problems in researching SDAT by applying rigorous diagnostic criteria and by accounting for disease severity. A detailed discussion of sample selection is found in chapter III.

Limitations and Delimitations of the Study

The small sample size of SDAT subjects limited this study in two respects. First, the generalizability of the results are limited, and second, the statistical analyses that could be performed were restricted. While many of the results of the investigation of memory performance of these SDAT subjects are consistent with findings of other researchers, further investigations which utilize larger sample sizes and more diverse subject samples are recommended. Unfortunately for this study the availability of subjects who met the rigorous diagnostic criteria for SDAT, who were over age 65, and who had no potentially-interfering health or neurological problems was restricted.

Another limitation resulted from the fact that the random assignment of subjects to "experimental" and control groups was not possible. As with many other types of quasi-experimental research, one cannot unequivocally generalize the results of this study to all other persons with SDAT. There may be variables inherent in "nature's" assignment of SDAT that have not yet been discovered by research that contribute to the differences in memory performance that have been attributed to the disease process. The fact that the SDAT subjects selected for this study were drawn from two different locations, and that no significant differences were found in the memory performance of subjects from each area, lends some credence to the fact that location of residence is not a variable that interfered with generalizability in this study. Also, no significant differences in memory performance were found between genders, age subgroups, or subgroups with different levels of education. However, generalizing research findings from this limited sample of SDAT subjects to all persons with SDAT is risky.

Regarding the limitations of the CVLT as a measure of the multiple aspects of memory, it should be recognized that the CVLT only measures verbal memory but not spatial memory, and as such the results of this study are limited in their assessment of overall memory functioning.

This study does not contribute to investigations of disease etiology by implying alterations in neuroanatomical structure or neurotransmitter dysfunction. Although some studies of dementia have directly related specific measures of memory function to brain structures or neurotransmitter systems, this study does not draw such connections.

Finally, for the purposes of stability and reliability, it would be useful to check research results over a longer period of time to trace the nature of the progressive change in cognitive function in SDAT patients. However, due to limitations of time and finance, an extensive longitudinal study was impossible.

CHAPTER II

SELECTIVE REVIEW OF THE LITERATURE

Introduction

Memory problems are among the first as well as the most disabling of the cognitive deficits that occur in senile dementia of the Alzheimer-type (SDAT). Much remains unknown regarding the complexity of the memory deterioration in SDAT, and therefore, recent research efforts in this area have been directed toward elucidating the nature of the memory impairments, hoping to provide a better understanding of the disease by delineating the status of particular memory functions and structures in SDAT. In this quest, researchers have attempted to determine whether the memory deterioration in early-stage SDAT is characterized by a failure in adequate encoding, retrieval, or both, and how it is that these memory operations are impaired.

This study contributes to the discussion of these unresolved issues by comparing the memory performance of nonclinical elders and elders with mild-moderate SDAT, and by focusing on encoding, storage and retrieval processes in both short-term and long-term memory.

Comment on Theoretical Memory Models

Laboratory studies of aging and memory have been dominated by an information processing model that is based on three major assumptions (Murdock, 1974). The model assumes that an individual is an active participant in the acquisition and retrieval processes, that both qualitative and quantitative patterns of response can be analyzed, and that information flow can be traced through several hypothetical stages or memory stores. One of the most widely accepted models of memory in contemporary research is the information processing model proposed by Atkinson and Shiffrin (1968). To illustrate how this model works, Atkinson and Shiffrin devised a flow chart that characterized how information might move through the memory system. The model begins with the assumption that when an individual first notices a stimulus in the environment only the raw physical features of that stimulus become represented in memory. These physical features are stored in a memory structure called the "sensory register" or "sensory memory store" and remain there only briefly (0.5-1.0 seconds). Atkinson and Shiffrin proposed that the sensory memory store has an extremely large capacity but that attentional mechanisms select only certain stimuli for further processing in the short-term memory store.

According to this model, the first time we become consciously aware of a stimulus input is when that input enters the short-term memory store. It is assumed that because we can be conscious of only a limited number of items at one time, the short-term store must have a very limited capacity. The short-term store is also viewed as being a temporary facility. That is, unless information is actively processed upon entering this store, it can remain there only for a matter of seconds. The importance of the short-term store is that this is where information is purposely rehearsed and encoded for permanent storage, which is why several researchers have called short-term memory the working memory store.

According to Atkinson and Shiffrin the long-term memory store is characterized as having an unlimited capacity. This model also assumes that once represented in long-term store, memories can be maintained there almost indefinitely without any need for active processing. The model does presume, however, that memories can be lost from the long-term store through processes such as decay or interference of new memories.

Atkinson and Shiffrin based their model on evidence that suggests that different memory stores exist and that information has to pass through these stores to become permanently registered in memory. However, other theorists have used the same evidence to draw different conclusions. For example, Craik and Lockhart (1972) disagree with the notion that multiple memory stores exist, but rather contend that a single memory store with different levels of processing is implicated. Although this and other conceptualizations of memory are viable models for understanding the complexities of memory, information processing constructs and procedures are best suited to investigate the nature of memory deficits in aging and in SDAT. Craik (1977), in his review of the literature since 1959 on human memory and aging, notes that the majority of the research in this area grew from information processing ideas. The functional compartmentalization of memory into different components provides the most useful framework for the study of memory impairments by allowing for the assessment of specific components of memory. Clinically speaking, it is much more useful to investigate specific memory mechanisms and processes than to consider memory as a unitary process that can be measured in terms of a global score, the latter of which fails to identify a pattern of memory deterioration including both spared and impaired aspects of memory. Research has already clearly revealed that memory is impaired in SDAT--we now seek to discover how memory is impaired in SDAT, and this requires an investigation of particular memory structures and functions. The information processing model best facilitates this exploration, and therefore this study, like an increasing number of recent studies will apply an information processing approach to the clinical assessment of the memory deficits characteristic of SDAT.

Memory and Normal Aging

Before proceeding with a discussion of memory deficits in SDAT, it is necessary to consider the status of memory functioning in normal aged elders. That declines in mental functioning are attributable to normal aging must be recognized so as to alter performance expectations on memory tasks for persons with SDAT. Using normal young adults as the comparison group for older adults with SDAT, confounds dementia-related memory changes with memory changes associated with normal aging. A well-controlled research design will account for both memory-change processes by comparing nonclinical elders with demented elders. A comparison of these two groups allows for observations of pathology-related changes, while controlling for the effects of normal aging.

As has been previously discussed, information processing provides the most influential theoretical model for the study of memory processes. Information processing investigations of age-related memory differences have found that aging is a process usually accompanied by a decline in the ability to acquire and remember information.

Short-term Memory

The memory-span task has been used frequently to estimate the capacity of short-term memory (STM). Early studies of span estimates reported by Botwinick and Storandt (1974), and Talland (1965, 1968) are representative of more recent results of this line of research; namely these studies showed that age differences are not usually found and that when they are, they are small in magnitude. After reviewing this literature, Craik and Simon (1980) have concluded that age differences in STM capacity are minimal. Any ambiguities in the literature on STM in older people have been attributed by Craik and Simon to the degree to which the tasks used have required manipulation of information in STM or have required division of attention during information input. To the extent that attention cannot be focused exclusively on performance of the memory span task, or that organization of the material is required or encouraged by the task, older people perform at a lower level than younger people. Thus, the conclusion that STM is not impaired in older adults may require some qualification. Under minimally demanding conditions STM capacity does not seem to be reduced in older adults. But STM capacity under conditions that require cognitive manipulation for restructuring or reorganizing the input may, in fact be effectively reduced and may result in substantial age differences in the amount of information available for storage in subsequent long-term memory stages.

Long-term Memory

One of the clearest findings in the field of aging and memory research is that once the amount of material to be remembered exceeds the span of STM, older people are unable to recall as much of the material as younger people (Hartley, Harker, & Walsh, 1980). Consequently, the majority of recent research on aging and memory has concentrated on understanding the nature and causes of age-related deficits in long-term memory (LTM). In formulating hypotheses about age differences in LTM, researchers have differentiated between acquisition, storage and retrieval operations. Because little evidence has been found that retention is impaired in older people, few researchers now consider the storage stage of memory as a possible locus of age-related deficits (Poon, 1985).

Instead, interest has focused on acquisition and retrieval stages, where researchers have attempted to specify whether memory decrements in older people reflect mainly an acquisition or encoding deficiency (in which the information is not available in memory) or a retrieval deficiency (in which the information is available but is not accessible at the time of recall). The strategy in this research has been to compare the performance of older and younger groups on tasks that are assumed either to minimize retrieval requirements (recognition or cued-recall tasks) or to maximize them (free-recall tasks). Effective retrieval of information by recognition but not free recall would imply difficulty in finding and extracting material that had been adequately encoded. Conversely, orienting or priming procedures, where subjects are given particular strategies to enable them to enter information in memory, have been incorporated to facilitate potentially impaired encoding processes.

Some early studies implicated the retrieval stage of memory as the primary locus of age-related memory deficits. Schonfield and Robertson (1966) found that age differences were absent when recognition of words was tested, even though age differences were found in free recall of the same material. However, other investigators have since shown that age differences occur even with recognition procedures (Byrd, 1984; Rabinowitz, 1984). Byrd's study suggested that the difficulty of the recognition task was an important factor in the recognition performance of older subjects and that earlier studies had employed a task too simple to allow for the observation of possible age differences. Similarly, further studies on the effects of retrieval cues have shown that age deficits are not always eliminated when cues are provided (Hartley, 1986; Smith, 1977). The rather extensive literature on this problem has been reviewed by Smith (1980), who concluded that retrieval difficulty, though one of the causes of age differences in recall of information, is probably not the sole cause. There is also evidence (Craik & Simon, 1980; Smith 1980) that older and younger people do not encode information the same way, which makes it even more difficult to examine retrieval independently.

Research into encoding processes of elders has frequently hypothesized that, during the acquisition of new information, elders fail to process the information as "deeply" as their younger counterparts. Therefore "orienting" or "priming" tasks are used to experimentally induce deeper or semantic encoding. The requirements of a semantic-orienting task should guarantee that semantic processing occurs during encoding and should therefore reduce age differences in recall. Experimental tests of this hypothesis have been reviewed by Craik and Simon (1980) and by Smith (1980). The results of this research have been surprising: Age differences in free recall are generally found to be larger with semantic orienting tasks than with nonsemantic tasks. These results suggest that the processing deficit in older persons may not be just a failure to engage in semantic processing, but rather an inability to maximize the mnemonic benefits of semantic processing. As Craik and Simon (1980) concluded, the key seems to be that while semantic encoding leads to more effective acquisition, it does not necessarily guarantee retrieval of the information. When retrieval requirements are minimized, as in a recognition test, the superiority of semantic encoding can be observed. On the other hand, a study by Mason (1979) found both recall and recognition to be more impaired in older adults than in younger, when semantic processing was required by the orienting task. Contrary to this evidence, West and Cohen (1985) found that although younger adults performed better than elderly adults on a recall task, the age differences in performance were more reduced when a semantic orienting condition was used than when an acoustic orienting condition was used. These results suggest that elderly adults do rely on semantic information for encoding and that they respond well to semantic recall cues, but the results fail to comment on the functional status of encoding and retrieval as distinct operations. Clearly, there are broad inconsistencies in the literature, and locating the source of these inconsistencies in either encoding or retrieval processes will require further investigation. The efficiency of retrieval is dependent on efficiency of encoding and it is difficult to untangle the two processes. Therefore, more research is necessary to enable us to understand how encoding and retrieval processes interact in the memory functioning of the elderly.

Additional to encoding and retrieval deficit hypotheses, a second approach to understanding age differences in LTM has focused on organizational processes in older and younger learners. The impetus for this line of research is based on early evidence of a high correlation between amount recalled in a free-recall task and the degree of organization detected in the recall protocols (Mandler, 1967; Tulving, 1962). Early attempts to substantiate organizational deficiency as an explanation of age differences in free recall have used three strategies: (1) direct measurement of organization in the recall protocols of older and younger learners, (2) manipulation of the amount of organization inherent in the list, and (3) instructions to organize.

The measurement of organization has not produced consistent results. Laurence (1966) assessed subjective organization (SO) by having children, young adults, and older adults provide verbal recall of pictorial material. Laurence found no differences in SO between the two adult groups, even though there was a substantial recall difference. But Hultsch (1974), who used a different measure of SO, one that presumably did not penalize younger subjects for increases in number of words recalled from trial to trial, found that older subjects did not organize as much as younger subjects.

Laurence (1967) used the second strategy in a study with lists of either unrelated words or words that were related conceptually. While older adults scored lower than younger adults on free recall, the age differences were less with the related words. The interaction between age and material suggested that the older subjects made use of organization to enhance recall, once the basis of organization was obvious, but they apparently did not organize spontaneously.

The third strategy was used by Hultsch in several experiments (Hultsch, 1969, 1971). Each of these studies found a significant beneficial effect for older and younger subjects when organization was encouraged by the experimental manipulations. However, in only one study (Hultsch, 1971) was the magnitude of the age difference in recall reduced by the manipulation of organizational factors.

In a more recent investigation of the hypothesis that impaired organizational processes are responsible for reduced recall in later years, Byrd (1985) had old and young adults recall and summarize prose passages. Effective summarization of text is based on organizational processes whereby the subject deletes elements of the surface structure of the material while retaining the essential deeper meaning of the text. Whereas older persons' results showed a moderate age-related decline in the amount of information recalled, they had considerably more difficulty in summarizing the same material, implicating organizational deficits.

Simon, Dixon, Nowak, and Hultsch (1982) attempted to assist subjects with organizational processes by preceding the reading of the passage with one of three orienting tasks" to be employed in processing the passage. A syntactic condition had subjects focus on spelling and grammar, a stylistic condition directed subjects' attention to the interest and organization of the passage, and the advice condition asked subjects to solve the problem implicit within the passage. The latter two conditions were intended to orient the subjects to process the passage at a deeper semantic level. Results showed that older adults failed to demonstrate any recall benefit from either syntactic or semantic reading conditions, whereas young adults were able to utilize the semantic conditions to gain and retain more meaning. It should be noted that incidental recall, where subjects were never informed of the impending memory test, rather than "intentional" recall was measured in this study.

Not all research has demonstrated a clear age-linked deficit in recall due to dysfunctional organization of main ideas. Petros, Tabor, Cooney, and Chabot (1983) concluded that, although age-related deficits in prose recall were confirmed, the organization of meaning in prose and its relationship to the automatic activation of meaning in the memory network, is not a major component of adult age differences in recall. This study found that subjects from all ages and educational levels were equally able to identify the important information in the stories.

Thus, attempts to support a hypothesis of organizational deficiency in older adults have not been uniformly successful. Certainly, more evidence is required in order to assess this hypothesis, especially since organizational differences are offered frequently as an explanation for age differences in LTM.

Most of the research surveyed has assumed that age differences in memory result from differences in the way older and younger people process information in terms of encoding, retrieval or organization. Waugh and Barr (1980) and Salthouse (1980) have disagreed with the notion that processing strategies under the learner's control are the key to age differences in memory; instead, they suggest an explanation based on a general slowing in the speed of behavior as a result of changes in the nervous system. In this formulation, the elderly are viewed as employing the same types of processing strategies as younger people, and the limiting factor in memory performance is seen as the rate at which these operations can be accomplished by the central nervous system. Hartley, Harker, and Walsh (1980) present three reasons that the speed-of-processing explanation is an unproductive research hypothesis for memory investigations. First, within the framework of existing models of memory (e.g., Atkinson & Shiffrin, 1968), the speed-of-processing explanation predicts large age differences in STM, predictions that are not supported by much memory research. Second, the proponents of speed-of-processing explanations have not articulated the LTM mechanisms that would be affected adversely by slower processing. Third, the stages that show the greatest slowing also show the least memory impairment, and the stages that show the greatest memory impairment show the least slowing.

Summary

While much progress has been made toward delineating the nature and extent of age-related deficits in memory, many important questions remain to be examined. Questions remain unanswered about age-related memory changes and the impairment of specific components or processes of broader memory functions. Hypotheses surrounding organizational deficiency and speed-of-processing differences have failed to account for age-related differences in memory performance. Some evidence exists, suggesting that the age-related deficit for recall is in the initial encoding or input phase of processing information. Aging possibly involves a breakdown of the process whereby information is encoded based on semantic features. From the research reviewed it is also possible that the age-related deficit in memory primarily involves retrieval operations. The fact that the age-related differences are greater under free recall conditions than under recognition conditions (Till & Walsh, 1980) suggests that the information is, in fact, stored in memory, but that it cannot be retrieved. Finally, it is possible that deficits exist in both processing information for encoding and processing information for retrieval. Although the exact nature of the memory changes demonstrated in many investigations of elders' memory have not been determined, the evidence seems to support the notion of a processing deficit, be it in encoding, retrieval, or both. Clearly, definitive research is needed in these areas.

Memory Deficits in SDAT

Memory impairment is the most prominent aspect of the cognitive decline associated with SDAT. Early studies described this memory deficit simply as the inability to remember recent events (eg. Blessed, Tomlinson & Roth, 1968). More recent investigations of memory in SDAT, however, have begun to consider some of the multiple processes that are known to be involved in normal memory functioning. Given the findings of memory changes noted in normal aging, particularly in LTM, research efforts into the nature of memory deficits in SDAT are testing hypotheses for selective impairment in the processes of encoding and/or retrieval.

Short-term Memory

The available research into STM functioning in SDAT, collectively suggests that STM is impaired in patients with SDAT, which is contrary to normal aging memory processes in which STM is generally well-preserved. The forward digit span test has most often been used to study STM in SDAT, and most studies have found SDAT patients to be impaired on this test (Corkin, 1982; Crook, Ferris, McCarthy, & Rae, 1980).

Another procedure that has been employed to examine STM in patients with SDAT is the free-recall procedure, in which the subjects is presented with a supra-span list of words and instructed to recall as many words as possible, in any order, immediately following the last presented word. Traditionally, probability of recall is plotted against the serial position. For normal individuals, the plot is a U-shaped curve; the first few words and the last few words of the list are recalled more often than words in the middle of the list. A well-accepted hypothesis is that words from the end of the list are recalled from STM, whereas words from the beginning of the list are recalled from LTM (Glanzer & Cunitz, 1966).

Using the free recall procedure, Miller (1971) tested patients with SDAT and found that compared with normal subjects, the dementia patients had poorer recall across all word positions. Words from the end of the list (STM component) were recalled more poorly by the SDAT patients, although the group difference was even more marked for words from the beginning of the list (LTM component). A more recent study using the same verbal free recall procedure obtained similar evidence of reduced STM and LTM components in patients with SDAT, compared with age-matched control subjects (Kaszniak, Wilson, & Fox, 1981).

Long-term Memory

Recall of material presented in verbal learning tasks has been interpreted as reflecting a LTM as well as a STM component, because the word lists used have been longer than presumed STM capacity. As a result of evidence of possible retrieval difficulties in normal aging, many of the studies investigating memory in SDAT, incorporate a combination of free recall, cued recall, and recognition conditions to account for the potential impairment in retrieval.

In one of the most frequently cited studies, Miller (1975) tested the impaired retrieval hypothesis by presenting patients considered to have presenile dementia and age-matched normal but similarly-hospitalized controls (with either extracranial pathology or pulmonary tuberculosis) with lists of monosyllabic words. After a 30-second distracted delay, retention of the list was assessed in one of four ways: (1) immediate recall, (2) recognition of the 10 words that were mixed with 10 incorrect words, (3) recognition of the correct word in a pair of one correct-one incorrect word, or (4) recognition of the word given the first letter. Results indicate that retention by the control group was significantly superior in all conditions but the partial information condition where the subject was provided with the initial letter of the word to be recalled. For the demented group, recognition cued by initial letters of the word most significantly reduced pathology-related differences in recall. These results suggest that difficulty in the retrieval demanded by the free recall condition was assisted by cues afforded by the recognition task. However, the most beneficial cue was the first letter of the word rather than the whole word paired with a distractor, which is converse to the control group, suggesting that the information was initially encoded based on syntactic rather than semantic features. It may be that information was not processed at semantic levels where word meaning predominates syntax. Such findings may suggest that dementing processes produce a qualitative change in memory which is manifested in irregular encoding of information. However, these results should be interpreted with caution as the validity of the control group in this study is questionable in generalizability to "normal" elderly persons. Given that they are hospitalized one may presume the administration of some type of medication, the impact of which upon cognitive processes is left to speculation. This study fails to address the potentially confounding impact of hospital-administered medications on cognitive performance.

Other observations have focused on impaired encoding processes as responsible for memory deficits, and have supported the interpretation that poor initial encoding of information into LTM may account for the deficit in recognition memory in patients with SDAT. Wilson and his colleagues (1983) have suggested that patients with dementia often fail to encode important features of verbal material to be remembered, and that this defect in initial processing contributes to their subsequent poor performance on recognition memory tasks.

The encoding deficiency explanation for memory impairments in SDAT received additional support by the finding that performance on verbal, but not facial, recognition memory tasks has been shown to be negatively correlated with the severity of language impairments (Wilson, Kaszniak, Bacon, Fox, & Kelly, 1982). These results suggest that linguistic deficits limit verbal encoding and make a specific contribution to impairments in verbal recognition memory. Furthermore, manipulating the depth of processing of verbal stimuli by asking orienting questions prior to presenting each stimulus word, which is intended to focus the subject on either phonemic or semantic aspects of the words, has less effect on the verbal recognition performance of patients with SDAT than on that of matched control subjects (Corkin, 1982).

In a recent study researchers (Dick, Dean & Sands, 1989) examined the nature of the encoding problem in patients with SDAT by using subject-performed tasks (SPT's). Such tasks provide optimal conditions for effective encoding to occur because, in contrast with most verbal memory tasks requiring the subject to engage in effortful or strategic kinds of mnemonic processes in order to transfer the to-be-remembered information to LTM, memory for SPT's is essentially nonstrategic and results simply from their performance and registration. SPT's also offer subjects a contextually rich encoding environment with several different sensory store systems being activated during their performance. Furthermore, given the active role of the self in SPT situations, this provides an additional opportunity for more efficient memory encoding to occur. The results indicated that not only were the SDAT patients deficient at verbal encoding, but that this encoding deficiency extended to a number of other processing domains. The study also attempted to employ various manipulations to enhance encoding operations in the demented subjects, and the results found all such efforts to be unsuccessful.

It must be recognized, however, than not all research supports the encoding deficiency explanation for memory impairments in SDAT. Buschke (1984) utilized a method for memory assessment which combines manipulation of initial encoding with the provision of specific cues to prompt retrieval. Subjects are required to engage in visual scanning of a random display of pictures of common objects using semantic categories as prompts. This procedure ensures verbal encoding of the cues to be used later. Following a distraction task used to minimize rehearsal, the subject's performance over trials on both free and cued recall is examined. In this study all of the subjects were able to encode the semantic cues to successfully complete the visual search procedure. The normal subjects showed a rapid increase in free recall over trials. Any items not recovered by free recall were retrieved using cued recall. This indicated that all of the information had been acquired. The demented patients showed severely limited free recall over the trials and were able to recover essentially all items with the aid of cues. These findings indicate that processing deficits are evident in both the initial encoding and retrieval of information and suggest that the manipulation of encoding and retrieval through specific cueing can serve to accommodate memory impairments in SDAT.

A study by Vitaliano, Breen, Albert, Russo, and Prinz (1986) added a crucial bit of information to the hypothesized relationship between encoding/retrieval processes and dementing processes. In this study, all subjects were administered the attention and memory items from the Mini-Mental State Exam (Folstein, Folstein & McHugh, 1975) and the Dementia Rating Scale (Mattis, 1988), resulting in performance measures in five areas: attention, calculations, recognition memory, recall, and orientation. The results indicate that the patterns of attention and memory that distinguish controls from mildly impaired SDAT patients differ from those that distinguish mildly from moderately impaired SDAT patients. From the five cognitive variables examined, free recall items are most important for differentiating those with mild dementia from controls, whereas recognition items, in conjunction with attention are most useful for grading the severity of impairment between mildly and moderately impaired SDAT patients. These results seem to reveal that early stages of SDAT are characterized by memory deficits attributable to impaired retrieval processes made evident by the fact that the noted memory deficits are diminished by the retrieval cues offered in recognition tasks. However, the progression of the disease seems to involve the manifestation of changes in memory that endure despite cues intended to assist in recall, which may reflect qualitative changes in memory processes. These results suggest that the nature of the memory deficit in SDAT differs according to the stage of the disease, which is a concept that previous research failed to consider. The hypothesis that memory performance is related to disease severity may also explain the lack of consistency in research investigating specific memory operations in SDAT.

Recently, Pepin and Eslinger (1989) also questioned the fact that the nature of the memory deficit in SDAT has been assumed to represent a unitary disorder. In so doing, they designed an investigation to test the hypothesis that the nature of the memory impairment in SDAT differs according to the disease stage, using the serial-position function as the dependent measure. Their findings indicated that the lowering of the serial-position function in SDAT patients at different stages of disease progression was not uniform but differentially affected the various portions of the curve depending on the severity of the dementia. With a mild degree of dementia, the serial-position function was U-shaped, as it is observed in normals. With an increasing severity of dementia, a consistent modification of the serial-position function appeared, with a progressive fading of the primacy effect. In the more advanced stage of the disease, no primacy effect remained. Pepin and Eslinger applied these results to specific memory operations, with recency purportedly occurring at the time of retrieval, and primacy as a consequence of processing occurring at the time of acquisition, to formulate the following hypothesis for the progressive memory deterioration in SDAT: Although the ability to maintain information over time appears to be impaired in early stages of the disease, "controlled processes" appear to be unaffected given the preservation of the primacy effect. As the degenerative process evolves, it gradually disrupts the subject's ability to successfully apply an active learning strategy at the time of acquisition. Retrieval strategies related to the recency effect seem relatively spared in the early and moderate stages of the disease, only to be affected in the more advanced degree of dementia. This hypothesis is far from definitive and requires research to delineate a proper model for the serial-position effect. The evidence does, nonetheless, suggest that the memory decline in SDAT not only represents a quantitative deterioration, but differs in its qualitative profile as well according to disease severity.

A very informative study by Ober and her colleagues (1985) used the selective reminding paradigm (Buschke & Fuld, 1984) to compare multiple aspects of verbal learning and memory performance in mild as compared to moderate patients with SDAT. The selective reminding paradigm is a method of multiple-trial verbal learning that allows for the quantification of the following memory processes: retrieval from STM, storage in LTM, and retrieval from LTM. In this study, the control group was able to master the list of to-be-remembered verbal items rapidly, requiring fewer item presentations and recalling more items over trials. The mild SDAT subjects, on the other hand, focused most of their efforts on the recently presented items and, after recalling them, had great difficulty in recalling any of the other list items. In contrast, the moderate SDAT subjects often recalled one or more of the previously presented items in addition to one or more of the just presented items. Analysis of the results revealed that the SDAT subjects showed much greater deficits in LTM than in STM, and the degree to which LTM functions were impaired depended on the severity of the dementia. The mild SDAT subjects were actually less likely to encode information into LTM than the moderate SDAT subjects; however, the mild SDAT subjects were more likely to retrieve items which had presumably been encoded into LTM than were the moderate SDAT subjects. As in the studies by Vitaliano and his colleagues (1986) and Pepin and Eslinger (1989), this study supports the notion that memory operations are differentially impaired in relation to disease severity in SDAT.

Thusfar, the research reviewed has focused on the type and amount of information that has been correctly recalled. Several studies have added to our understanding of the nature of memory deterioration in SDAT by focusing on the types of incorrect responses or errors that are typically made. Two types of errors that have been investigated are "perseverative" errors, which are defined as the immediate inappropriate repetition of a prior response, and "intrusion" errors, which are defined as the inappropriate repetition of prior responses after intervening stimuli. Fuld and his colleagues (1982) first suggested that intrusions are typical of SDAT and may be helpful in distinguishing it from other causes of dementia. Shindler, Caplan, and Hier (1984) tested this hypothesis and concluded that, while intrusions are a useful sign of dementia, they cannot be considered pathognomonic of SDAT.

A more recent investigation distinguished five different types of intrusive errors: 1) test intrusions, which are errors related to the content of the distractor task after a new set has been established, 2) shift intrusions, also involving material from the distractor task but reflecting difficulty in shifting set, 3) conceptual intrusions, which are responses that are close approximations of the original stimulus items, 4) confabulatory intrusions, involving the creation of a single percept from two unrelated target items, and 5) unrelated intrusions, which include any intrusion errors that are unrelated to either target items or the distractor task (Loewenstein et al., 1989). The most significant finding from this study involved the last category of intrusions, labelled unrelated intrusions. Results indicated that unrelated intrusions occurred much more frequently than any other type of intrusion error among SDAT patients, and that this particular measure could distinguish between SDAT and non-SDAT groups. The mechanisms underlying the occurrence of the intrusion errors have been described by Shinder, Caplan, and Hier (1984) in terms of a four-stage process: the subject initiates an unsuccessful search throughout LTM for the correct word or phrase, he/she then selects from STM a recently heard word or phrase, and then after failing to inhibit the incorrect word or phrase the incorrect word or phrase is emitted. In so doing, the SDAT subject appears unable to recognize the fact that his/her erroneous response has no relation to target items.

Although research consistently supports the fact that SDAT subjects also emit numerous perseveration errors (Salmon et al., 1989; Fuld et al., 1982), research also reveals that perseveration errors are more likely to occur in disorders other than SDAT, such as communicating hydrocephalus and Wernicke aphasia (Shindler, Caplan, & Hier, 1984). As Buckingham, Whitaker, and Whitaker (1979) point out, the issue of perseverative responses as being characteristic of any one disorder is complicated by the fact that under certain conditions, even normal subjects perseverate.

The research into error analysis therefore suggests that perseverative errors, although common in SDAT patients' responses, are not pathognomonic of the disease. Intrusions that are unrelated to target items or distractor tasks, however, may serve to distinguish SDAT from other disorders. Research involving the analysis of error types clearly provides insight into the detailed nature of the underlying memory deficit in SDAT, and therefore, should not be neglected by future research. Not only need we focus upon what can be correctly recalled, but also upon what is not being correctly recalled. Both types of analysis serve to further elucidate impaired memory processes in SDAT.

Summary

Although there is considerable empirical support of dementia-related memory deficits, no clear consensus has emerged to support or refute the existence of a relationship between these noted deficits and any specific memory operation, be it encoding, retrieval, or both. Information processing approaches to assessing verbal memory in patients with SDAT have provided evidence of impairment of STM, which may contribute to the overall severity of memory impairment, by limiting the amount of information available to be processed into LTM.

As suggested by this review of the research, an important variable in studying dementia is that of severity. SDAT is typically progressive, developing from a pattern of initial deficits that may possibly be quite specific to one of massive and general deterioration. A serious problem evident from the preceding review of the dementia research is the necessity to identify the degree of disease severity. If, as was suggested by the results of the research reviewed, early and late stages of SDAT may be differentiated in terms of type of memory deficit (ie. impaired retrieval vs impaired encoding), all patients with this disease cannot be considered a homogeneous group, but rather must be distinguished in terms of the stage, and thus, severity of the disease. Further to this, severe cases are likely to show decrements on virtually any test used and, indeed, are likely to have great difficulty in even understanding instructions. Such cases are unlikely to provide insight into the detailed nature of the underlying psychological deficit, and for that reason studies are likely to be more informative if they focus on subjects at early stages of the disease.

There is clearly a lack of consensus in the research findings thusfar presented, limiting the number of conclusions that can be drawn. A satisfactory explanation of these discrepancies has not been forthcoming although a reasonable working explanation is that the interaction of intervening variables, such as disease severity, may account for the inconsistent results. The fact that the majority of researchers have treated SDAT as a unitary disease in terms of memory changes likely accounts for the discrepancy in results across studies. Future research needs to identify and control factors that artificially amplify or diminish impairments in memory so that a clearer picture of dementia-related memory processes may be obtained.

General Conclusion

In conclusion, a critical review of the research into memory deterioration in SDAT does not point toward the necessary modification of research questions that have been asked in the past. What does require modification, however, is the control--or lack thereof--over confounding variables related to the task, the subject, and the dementing process itself. That studies in this area have failed to account for potentially-intervening variables, contributes to the fact that research results are largely inconsistent across studies, and thus inconclusive.

Inclusion of free recall, cued recall and recognition conditions have proven useful in allowing for the investigation of potentially impaired encoding and retrieval mechanisms. The nature and presentation of information given at recognition is critical in providing an indication as to how information was initially stored. With intervening variables controlled, the continued inclusion of these encoding and recall conditions will hopefully reveal a clearer picture as to the particular memory mechanisms pivotal to the changes observed in the early stages of SDAT.

Future research directions require persistent efforts to answer questions such as: How do memory changes in SDAT differ from those characterizing normal aging? Is the memory deterioration in DAT a quantitative extension of normal aging processes or are qualitative changes involved that are not explained by conventional models of memory? What is the pattern of memory deterioration, and how consistently is this related to the disease progression? Is the memory deterioration in early-stage SDAT characterized by a failure in adequate encoding, retrieval, or both, and how is it that these memory phases are impaired? To answer such questions, clinical tests employed in research must address the complexity of memory processes by quantifying the numerous cognitive components of verbal memory. Measurement instruments need to assess how learning occurs or fails to occur, in addition to measuring the amount of verbal material learned. Error analysis is one aspect of memory measurement that should not be neglected, given the evidence suggesting that unrelated intrusion responses may be pathognomic of SDAT.

CHAPTER III

RESEARCH PLAN AND METHOD

Subjects

This study, like many others, was designed to investigate the specific memory mechanisms of people with SDAT. However, previous studies failed to apply rigorous diagnostic criteria in selecting subjects, so that subjects with a variety of conditions that negatively affect memory were included. The result has been a lack of consensus in the results that attempt to elucidate "how" memory is impaired in SDAT.

Inconsistencies in results have also resulted from a failure to recognize and control for disease severity. Research has revealed that early and late stages of SDAT may be differentiated in terms of type of memory deficit (i.e., impaired retrieval vs. impaired encoding). Therefore persons with SDAT must be distinguished in terms of the stage of the disease.

In recognizing the weaknesses of past research in achieving accurate diagnosis and in accounting for disease severity, this study employed strict criteria in both of these areas.

Diagnosis of SDAT

The criteria for selection of subjects with SDAT followed the standards proposed by Berg et al. (1982) in a study that proposed explicit clinical diagnostic criteria for SDAT in research. These criteria are also consistent with the criteria presented in the Diagnostic and Statistical Manual of Mental Disorders (3rd ed. revised; 1987) for Primary Degenerative Dementia of the Alzheimer Type, but include functional, as well as cognitive, abilities.

The differential diagnosis of SDAT from other conditions is achieved by clearly assessing:

A. Mental/Functional Status and

B. The Nature of Memory Dysfunction

Accurate diagnosis also requires ruling-out conditions that may masquerade as SDAT such as:

C. Other Neurologic Disorders,

D. Psychiatric Disorders,

E. Reversible Dementias and Metabolic Conditions

A. Mental and Functional Status

Although memory impairment is usually the most prominent symptom in SDAT, a diagnosis of SDAT necessitates that impairment in other cognitive and functional abilities be evident. To assess mental and functional status, all subjects were given the Functional Assessment Inventory (Pfeifer, 1982). Based on the results of this assessment, subjects were selected for this study who demonstrated deterioration of memory, plus impairment in at least three of the following five abilities:

(1) Orientation: awareness of where one is in relation to time, place, and person.

(2) Judgment and Problem Solving: effective decision-making and problem resolution.

(3) Functioning in Community Affairs: ability to function independently in job, shopping, business and financial affairs, volunteer and social groups.

(4) Functioning at Home and in Hobbies: ability to maintain involvement in household chores and pursuit of intellectual interests.

(5) Functioning in Personal Care: ability to care for self, including maintenance of hygiene.

B. The Nature of Memory Dysfunction

Memory deterioration comes in many forms, beginning suddenly or insidiously; lasting for weeks or lasting for years; gradually worsening, alternating between periods of deterioration and periods of stabilization, or rapidly deteriorating and then stabilizing; and fluctuating between morning and night or not fluctuating at all. Each of these factors provide evidence as to the probable cause of the memory deterioration. Too often memory dysfunction in the elderly is automatically associated with SDAT without proper differential diagnosis. Many other disorders, some of which are treatable, also result in memory impairments. Many of these are mistaken for SDAT. For example, a primary affective disorder, such as major depression, may lead to a clinical picture that is difficult to differentiate from SDAT, particularly in the elderly. For this reason the onset, progression, and duration of memory difficulties were scrutinized as a means for identifying other conditions that may be misdiagnosed as SDAT, such as multi-infarct dementia, delerium, focal brain damage, and depression. Information regarding memory changes was obtained from a close friend or relative in a clinical interview using standardized questions. The clinical interview questions are presented in Appendix A. Zarit, Orr, and Zarit (1985) have developed a chart that was used in this study to select subjects based on the onset, progression, duration, and fluctuation of memory problems. This chart is presented in Appendix B.

C. Other Neurologic Disorders

Individuals in this study were excluded if other neurologic disorders were present. Subjects were screened by a medical geriatrician for Parkinsonism, Huntington's disease, communicating hydrocephalus, progressive supranuclear palsy, infection, brain tumour, subdural haematoma, multiple sclerosis, stroke, multi-infarct dementia, seizure disorder, and brain trauma.

D. Psychiatric Disorders

Persons with histories or symptoms indicative of psychiatric disorders, including affective disorder or major depression, schizophrenia, alcoholism or other substance abuse were excluded from the study.

E. Reversible Dementias and Metabolic Conditions

Following are medical investigations that were carried out on all subjects to identify reversible dementias and metabolic conditions:

Complete blood count (C.B.C.) and differential
Blood smear morphology
Routine urinalysis
Sequential multiple analyzer (S.M.A) 12
Serum electrolytes (sodium, potassium, chloride, carbon dioxide)
Triiodothyronine (T3) resin uptake
Thyroxine (T4) resin uptake
Serum free thyroxine (T4) index
Serum B12 level
Serum folic acid levels
Chest X-ray (P.A. and lateral)
Venereal Disease Research Laboratory Test (V.D.R.L.
Rapid Plasma Reagin)
Total Iron Binding Capacity (T.I.B.C)

These specific investigations identify reversible dementias and other medical disorders that may reduce cognition, including overmedication, impaired function of the lungs, heart, kidneys or liver, anaemia, hypothyroidism, vitamin B or folate deficiency, and malignancy. Any person having any of these conditions was excluded from the study.

To summarize, a diagnosis of SDAT was achieved by first assessing mental and functional status for impairments in orientation, judgment/problem-solving, functioning in community affairs, functioning at home and in hobbies, and functioning in personal care. This assessment provided a broad clinical picture of cognitive and functional abilities in areas that are generally impaired in SDAT. Then the prodromal symptom of memory impairment was also assessed in terms of onset, duration, progression, and fluctuation. This served to rule-out other conditions that involve memory changes. Medical and laboratory screening for specific neurological disorders, psychiatric disorders, reversible dementias, and metabolic conditions that may be confused with SDAT concluded the diagnostic process for SDAT subjects.

Assessment of Disease Severity

The literature on SDAT has reported qualitative differences in the memory deficits experienced in the early and later stages of the disease's progression, requiring the recognition of disease severity as an independent variable. The literature also supports the usefulness of studying individuals at early stages of SDAT where such cases are likely to provide more information on the detailed nature of the underlying deficit than in severe cases where cognitive deterioration is usually pervasive. For this reason the most recent edition of the Clinical Dementia Rating Scale (CDR) (Berg, 1984) was used to select persons with mild-moderate levels of disease progression.

The CDR, which is presented in Appendix C, was developed for use in the Memory and Aging Project at Washington

University, St. Louis for measuring and staging the natural history of SDAT. The CDR scale is a five-point scale describing subjects without dementia (0) and with questionable (0.5), mild (1), moderate (2), and severe (3) dementia. The overall rating is derived from scores in the six previously discussed categories of function affected by SDAT: Memory, Orientation, Judgment and Problem solving, Involvement in Community Affairs, Involvement at Home and in Hobbies, and Personal Care. Each category is scored as independently as possible according to descriptions of impairment found in the CDR table, using the five-point scale of impairment. These scores are then combined to determine the overall rating.

The CDR is the most widely used method for staging the level of disease progression (Rubin, Morris, Grant, & Vendegna, 1989; Storandt & Hill, 1989). The strength of this measure lies in the fact that it investigates multiple areas of function, and not simply cognitive performance as do many other severity rating scales. The CDR has been in use in the Memory and Aging Project at Washington University, St. Louis, since 1977, where its use in assessing the severity of SDAT has been evaluated. Appendix D presents the results of interrater reliability testing for the overall CDR and for each of the individual boxes that constitute it. The agreement on overall CDR score was 80%; no disagreements were of more than one CDR class. The k value, which accounts for chance agreement, was .74; and the weighted k was .87. Correlation of the overall CDR ratings, as assigned by the two raters, was high (r=.91). Due to the high reliability, widespread use, and assessment of multiple areas of function the CDR was selected to determine disease severity in this study.

Other Subject-Related Variables

In addition to accuracy of diagnosis and severity of impairment, several other potentially confounding variables were also controlled. A medical doctor assessed auditory functioning, and no persons with serious hearing impairments were included in the study. Auditory impairments would interfere with memory testing: it would be difficult to determine whether a subject could not recall the information or whether the subject had not heard the information in the first place. All subjects used English as their only or primary means of communication. Using English as a second language could also have interfered with memory testing. It would be difficult to determine to what degree a failure to recall information could be attributed to factors associated with learning a second language. Neither formal education or intelligence were controlled in this study. Regarding formal education, Surber, Kowalski, and Pena-Paez (1984) recognized the inconsistency of formal education as a means of comparing intergenerational groups, particularly in the elderly. Most of the older adults in the sample failed to graduate from high school (in fact, approximately 80% completed their education with grade eight), not because of an inability to progress, but because of deprived opportunity. Therefore for these and many other older adults, the independent variable of education relates more so to opportunity than intelligence. Additional to this, they have been many years removed from their education, thus minimizing the influence several years of education may have relative to sixty-some years of life experience. Intelligence was not considered to be a potentially-confounding variable based on evidence from studies such as that by Hultsch, Hertzog, and Dixon (1984) which investigated whether there is an interaction between intelligence and age in determining differences in recall. The results of this study clearly demonstrated that general intelligence was not related to recall performance of the elderly. With increasing age, recall performance is decreasingly related to intelligence, and for this reason intelligence was not a controlled variable in this study.

Selected Sample

On the basis of the above assessments for disease diagnosis, rating of severity, and test-related variables such as hearing and language, 22 subjects were selected for memory testing. The subjects in this study were 14 males and 8 females with a mean age of 82.1 years and an age range from 70-88 years. 12 subjects were age 70-79 years, and 10 subjects were 80-88 years. The average level of education attained was 8.4 years, with 5 subjects having 0-7 years of education, 10 subjects having 8 years of education, and 7 subjects having 9-13 years of education. Subjects were recruited from one large (5 subjects) and one small city (17 subjects) in Alberta. All were living in their own homes and were referred by their physicians as a result of memory problems. All subjects met the criteria for diagnosis and severity-rating of Senile Dementia of the Alzheimer Type (SDAT).

Test Instrument - The California Verbal Learning Test (CVLT)

Description of the CVLT

The California Verbal Learning Test (CVLT) (Delis, Kramer, Kaplan, & Ober, 1987) was designed to provide quantitative measures of the multiple underlying processes of memory functioning. In so doing, the CVLT measures the multiple aspects of how verbal memory functions, or fails to function, in addition to measuring the amount of verbal information recalled. This makes the CVLT very well-suited for this study, the purpose of which was to elucidate the nature of the memory impairments in SDAT. It is in measuring particular memory functions that a better understanding of SDAT is achieved.

Another important consideration in selecting the CVLT as an instrument for this study is that it incorporates the information processing approach into the investigation of specific memory processes. As has been discussed in the previous chapter, the functional compartmentalization of memory into different components--as in the information processing approach--provides the most useful framework for the study of memory impairments in SDAT.

The basic format of the CVLT was modeled after the Rey Auditory Verbal Learning Test (RAVLT) (Rey, 1964). To increase the ecological validity of the memory task, rather than presenting a list of randomly selected words as in the RAVLT, the CVLT uses items of a shopping list, making the CVLT similar to a task a person would be likely to encounter in everyday life. The testing is more relevant for the patient and, given that Worden and Sherman-Brown (1983) found the meaningfulness of test stimuli to significantly impact the recall performance of elders, the relevance of test stimuli is central to its validity.

A second difference is that the CVLT entails the learning of categorical lists rather than lists of unrelated words. The lists are made up of 16 words reflecting four categories--four words per category. The words are presented in such a way that a given word is never followed by another word from the same category. This provides the subject with the opportunity to organize the words into categories, which is an effective recall strategy. This strategy facilitates the encoding of new information into memory through organization,. Literature in the area of memory and aging has suggested that elders may fail to effectively organize information in memory. This feature of the CVLT allows for the investigation of organizational processes in memory in SDAT.

All words in the lists are equivalent in terms of mean frequency in the English language (Thorndike & Lorge, 1944); and mean rank order of a word as an exemplar of a category (Battig & Montague, 1969). An attempt was made to minimize a ceiling effect in semantic clustering in normal subjects by varying the word frequency of items within each category and between categories i.e. the higher-frequency category of "clothing" versus the lower-frequency category of "spices and herbs."

Normative Data for the CVLT

The CVLT allows for the comparison of a SDAT individual's scores with those obtained from a sample of "normal" individuals of the same age and gender.

The normative sample consists of 273 neurologically intact individuals (104 males, 169 females). They were recruited to serve as normal or nonclinical control subjects in neuropsychological research projects conducted in San Fransisco, California; Miami, Florida; Providence, Rhode Island; and Oklahoma City, Oklahoma. Subjects were screened for any history of neurological or psychiatric disorder, chronic obstructive pulmonary disease, liver dysfunction, cardiac disease, uncontrolled hypertension, renal failure, insulin-dependent diabetes, substance abuse, or developmental learning disability. Each CVLT was administered by a masters- or doctoral-level psychologist.

Because the reference group is a combination of several independently-collected samples, the distributions of age and sex are uneven. In order to makes the best use of the data while giving due regard to the varying number of cases at each age and sex, smoothed age curves were fitted to the raw data using multiple regression. These curves provide estimates of the mean score at each age for each sex. Once means had been estimated, a similar curve-fitting technique was used to estimate the standard deviation at each age and sex. Using the estimated mean and standard deviation, any raw score can be expressed as a standard score that shows the number of standard deviations by which it deviates from the expected mean for that age and sex.

Norms using standard-score equivalents of raw scores are presented in the CVLT Manual - Research Edition for 7 age groups of neurologically intact individuals, ranging from age 17 to 80 years for each gender. The midpoint of each range is used to compute the expected mean and standard deviation for the group. Knowing the estimated mean and standard deviation in each age group for each sex, it is possible to express any raw score as a standard score that shows how far the observed score is from the mean in standard deviation units. Tables for converting raw scores to standard scores are provided in the test manual. The scoring and administration computer software automatically calculates and reports these scores. For all variables the standard scores have a mean of 0 and a standard deviation of 1. All of the standard scores are non-normalized, meaning that any skew in the raw score distributions is preserved in the standard score distributions.

Reliability of the CVLT

Measures of internal consistency and test-retest reliability for the CVLT are reported in the administration manual. Three methods were used to estimate the internal reliability of recall scores on the CVLT. The sample used in calculating these estimates consisted of 133 subjects from the normal reference group. An analysis of total trial scores was used to estimate internal reliability, as this strategy minimizes problems related to item interdependence which is characteristic of tests of recall ability. There is item interdependence within trials because of the fact that learning and memory capacity is limited, and therefore recalling any one word on a trial decreases the liklihood the other items will be recalled on that same trial. There is also item interdependence between trials in that the process of recalling a word on one trial tends to increase the probability that the same word will be recalled on subsequent trials. The reliability estimate, a split-half correlation, which indicates whether five trials are sufficient to give an accurate estimate of free-recall ability as a global measure of memory performance, was .836 for trials 1 + 3 versus trials 2 + 4, and .819 for trials 2 + 4 versus trials 3 + 5, which when corrected with the Spearman-Brown formula yielded an estimated reliability of .92 for the total score over five trials.

The second reliability index is based on the correlation between the total (five-trial) scores on two independent halves of the test. The split-half correlation is .63, yielding an estimated total-test reliability of .77. Coefficient alpha based on the four category scores is .74.

The third reliability index is based on the total (five-trial) score for each of the 16 stimulus words. The correlation between total scores on odd-numbered and even-numbered words is .54, yielding an estimated total-test reliability of .70; coefficient alpha is .69. This third analysis was also carried out on a mixed clinical and nonclinical sample of 78 examinees, including 26 normal adult subjects (mean age = 36.84, SD = 11.41; 16 males, 10 females), 26 heterogeneous brain-damaged subjects (mean age = 49.60, SD = 12.26; 26 males, 0 females), and 26 detoxified chronic alcoholics (mean age = 33.50, SD = 8.85, 24 males, 2 females), because estimates of internal consistency may be underestimated when a homogeneous sample of normal subjects is studied. The odd-word/even-word reliability is .85 and coefficient alpha is .86.

21 normal adults (mean age = 33.00, SD = 8.82, 12 males, 9 females) were retested on the CVLT one year after being originally tested to provide a measure of test-retest reliability. 13 of the 18 correlations are statistically significant, including those for the total immediate recall of list A across the five trials ($p < .01$), percent primacy region recall ($p < .01$), long-delay free recall ($p < .001$), number of recall errors (perseverations and intrusions) ($p < .001$), and hits and false positives on recognition testing ($p < .05$).

Validity of the CVLT

The validity of the CVLT has been investigated in two ways. First, the intercorrelations among the CVLT variable scores have been factor analyzed. Second, the CVLT variables have been correlated with scores on the Wechsler Memory Scale (Wechsler, 1945).

Existing memory tests have been criticized for reducing the multifactorial nature of memory performance into a single, achievement score. Because the CVLT purports to assess multiple dimensions of memory, it is critical to determine whether the numerous CVLT indices cluster into orthogonal domains of performance or whether they are merely redundant measures of a single verbal learning factor. Several factor analyses of the CVLT were conducted to determine whether the various CVLT indices cluster into independent domains of performance, or whether they are merely multiple measures of a single learning factor. The sample consisted of 399 individuals: 286 neurologically intact normal individuals (mean age = 60.20, range = 19-91; 105 males, 181 females). The patient group consisted of 55 patients with multiple sclerosis, 8 with Huntington's disease, 24 with chronic alcoholism, and 26 with Parkinson's disease. The varimax rotated factor structure matrix for age-uncorrected scores of the normal subjects yielded a six-factor solution with loadings greater than .40 considered significant. The factors reflect General Verbal Learning, Response Discrimination, Learning Strategy, Proactive Effect, Serial Position Effect, and Acquisition Rate. The varimax rotated factor structure matrix for age-uncorrected scores of the neurological patients revealed a five-factor solution. The factors represent General Verbal Learning, Response Discrimination, Serial Position Effect, Learning Strategy, and Retroactive/Short-Delay Effect. Factor analysis of the age-uncorrected scores of the combined sample of 399 normal subjects and neurological patients yielded the same six-factor solution as the analysis for the normal subjects only. The robustness of this six-factor solution was demonstrated in the factor analysis of the age-residualized scores of the 399 subjects. In general, the results of the factor analyses indicate that the multiple indices assessed by the CVLT cluster into theoretically meaningful factors consonant with the experimental constructs they were designed to measure.

As a measure of criterion-related validity the CVLT and the Wechsler Memory Scale (WMS) were administered to 105 patients: 55 heterogeneous brain-damaged patients (mean age = 49.33, SD = 15.03; 52 males, 3 females), 25 substance-abuse patients (mean age = 39.29, SD = 13.96; 25 males, 0 females), and 25 heterogeneous psychiatric patients (mean age = 50.17, SD = 15.90; 20 males, 5 females). The fact that 64% of the correlations between CVLT raw scores and WMS scores are significant at the .05 level or better shows that the correlations cannot be attributed to chance. The total immediate recall of list A across the five trials correlates .66 with the WMS Memory Quotient and in the .60s with several other WMS variables, including Total Paired Associates, Hard Paired Associates (Immediate and Delayed), and Visual Reproduction (Delayed).

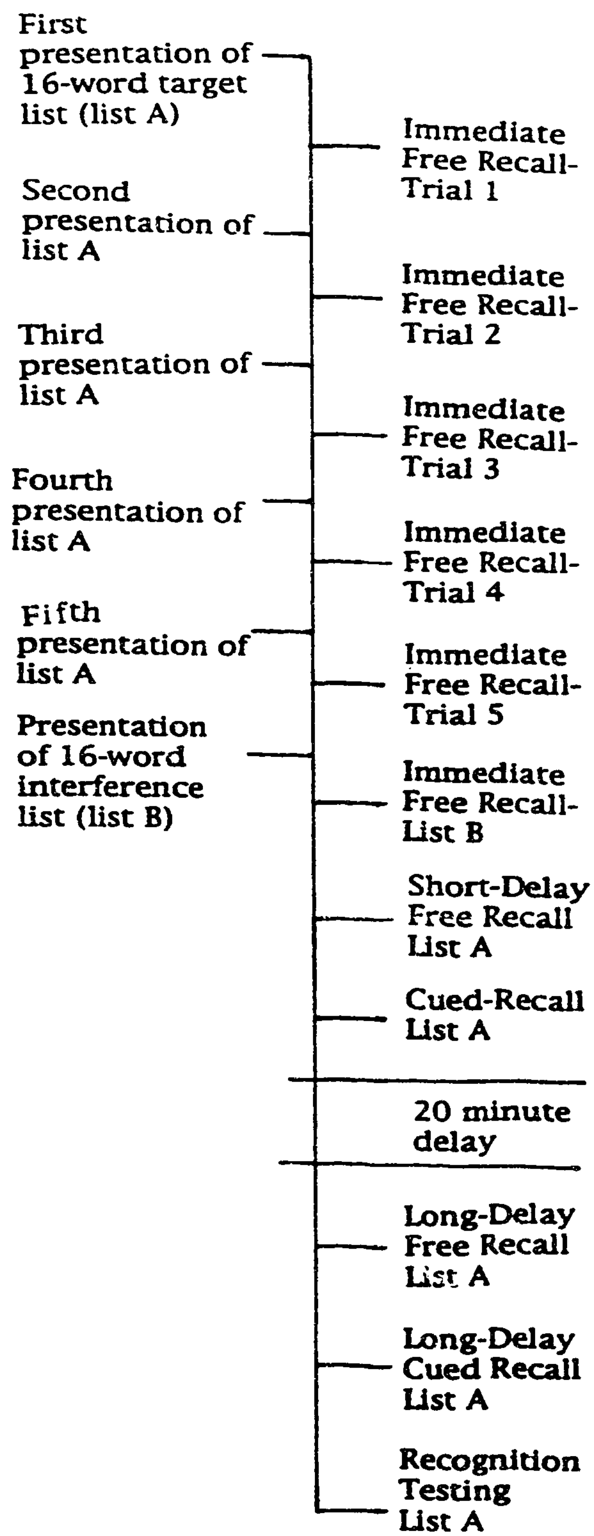
Clinical investigations to date have demonstrated the validity of the CVLT in identifying selective verbal learning and memory deficits in patients with SDAT, Huntington's disease and Parkinson's disease (Delis, Levin, & Kramer, 1987; Kramer, Delis Blusewicz et al., 1988; Kramer, Levin, Brandt, & Delis, 1988), alcoholism (Kramer, Blusewicz, & Preston, 1989), schizophrenia (Authelet & Raymond, 1987), head injury (Crosson, Novak, Trenerry, & Craig, 1989), cerebral vascular accidents (Raymond et al., 1987), multiple sclerosis (Kessler et al., 1985; Raymond et al., 1987), and temporal lobe epilepsy (Hermann et al., 1987).

Procedure

Instructions for test administration are provided in the CVLT Manual. A list of sixteen words was read to the subject at a rate of approximately one per second. The examiner recorded all of the subject's responses in the order in which they were given on the test protocol. A flow chart of the testing procedure is presented in Figure 1. The same list was presented for five immediate free-recall trials. A second list consisting of sixteen different items that represent two of the same categories as the first list (fruits; spices and herbs) and two new categories (fish; and kitchen utensils) was then presented and recalled by the subject. Next, the examiner tested for "short-delay" free recall of the first list. Short-delay cued recall of the first list involving categorical cueing follows. i.e. "Tell me all of the shopping items from the first list that are spices and herbs." A 20-minute interval ("long delay") was provided during which biographical information was gathered. After the long-delay the subject was tested for both free recall and cued recall of the first list in the same manner as in the short-delay. Finally, in testing for recognition of the first list, the examiner read a list of shopping items, and after each item the subject responded "yes" if the item was from the first list and "no" if it was not.

Figure 1

Flow Chart of Testing Procedure with the California Verbal Learning Test



Informed consent was obtained from all subjects or guardians prior to administration of testing. Appendix E outlines the ethical considerations involved in obtaining informed consent from this sample of demented elders.

Memory Measures of the CVLT

The CVLT groups the memory measures into four areas entitled: recall measures, learning characteristics, recall errors, and recognition measures. Following is a list of the specific memory measures that have been normed by the CVLT and used in this study to investigate the nature of the memory deterioration in SDAT:

Recall Measures

1. Immediate Free Recall, List A, Trial 1 and Trial 5
2. Immediate Free Recall, List B
3. Short-Delay Free Recall, List A
4. Cued-Recall, List A
5. Long-Delay Free Recall and Cued Recall, List A

Learning Characteristics

6. Semantic Clustering
7. Serial-Order Clustering

Percentage of Total Recall from:

8. Primacy Region
9. Middle Region
10. Recency Region
11. Learning Across Trials - "Slope"
12. Recall Consistency Across Trials

Recall Errors

13. Perseverations
14. Free Recall Intrusions
15. Cued Recall Intrusions

Recognition Measures

16. Correct Target Recognitions (Hits)
17. False Positives
18. Discriminability
19. Response Bias

All of the standard scores are non-normalized, meaning that any skew in the raw score distributions is preserved in the standard score distributions.

Following is a discussion of the specific CVLT memory measures that were used in this study.

Recall Measures

1. Immediate Free Recall, List A (Trial 1 and Trial 5)
Free recall testing requires the examinee to recall any items that they can from the list without any assistance from the examiner. The scores on immediate free recall trials provide global measures of learning and memory performance. Because the same list is presented over 5 trials, a comparison of Trial 1 with Trial 5 allows for the observation of any improvement in performance due to repetition. The CVLT also provides a measure of total immediate recall on Trials 1-5, which was excluded from this study because the CVLT scoring system converts this measure to a t-score, which makes comparison with all other CVLT measures, that are converted to z-scores, difficult.

2. Immediate Free Recall, List B

Immediate free recall of List B measures the number of words that can be recalled from a "new" list, after five presentations of List A. The presentation of List B requires the refocusing of attention to a new list of words, and is described as an "interference list" because it may interfere with the learning of List A. Conversely, performance on List B may be adversely affected by the five previous List A trials, which is defined as proactive interference. Interference occurs when new information that is stored in LTM is not kept distinct from other information previously stored in LTM.

3. Short-Delay Free Recall

Short-delay free recall measures the ability to recall List A after an interference interval, where a new list was presented. A low score on the Short-Delay Free Recall trial of List A relative to Trial 5 of List A may be related to the combination of unusually high degrees of forgetting during the delay interval and retroactive interference (i.e., the decremental effect of attempting to learn List B on Short-Delay Free Recall of List A). If either proactive or retroactive interference is responsible for memory deficits in SDAT then it would naturally follow that memory functioning could be improved by minimizing interfering events.

4. Short-Delay Cued Recall

It is important in this study to identify the locus of a SDAT subject's deficit along the information-processing chain. One criticism of many extant memory tests is that only immediate free recall is assessed. As a result, when recall is impaired, examiners cannot determine whether the deficit is one of encoding, storage, or retrieval. One way of isolating retrieval deficits is by comparing free recall performance with that on cued recall (and recognition) (Delis, Kramer, Fridlund, & Kaplan, 1990). Free Recall and cued recall differ in their retrieval demands, with free recall placing the greatest demand on retrieval mechanisms. Cued recall aids recall by providing the examinee with the categories to which the items belong, by saying, "Tell me all of the shopping items from the list that are fruits." Comparing an examinee's cued recall performance with free recall performance provides evidence as to whether a memory problem reflects predominantly encoding or retrieval difficulties. Markedly better performance on cued recall than on free recall may indicate more of a retrieval than an encoding problem. If free recall and cued recall are both impaired, then problems in encoding may contribute significantly to the examinee's memory dysfunction.

5. Long-Delay Testing (Free and Cued Recall)

The CVLT provides systematic long-delay testing, unlike many standardized memory tests that assess only immediate recall. Performance on long-delay testing reflects the examinee's ability to retain verbal information over time (20 minutes). The importance of the extended delay periods is to determine whether memory problems are particularly evident after a distraction interval has been imposed between learning and recall. A low score on long-delay testing may indicate impaired retention over an extended delay period.

Learning Characteristics

6. Semantic Clustering

From the information processing perspective, understanding how an individual encodes and organizes the lists adds an important dimension to memory assessment. For example, how subjects organize the material they are learning yields information about whether they are encoding the material semantically, on the basis of its temporal qualities, or idiosyncratically. A researcher can document not only the presence of a memory problem, but also the deficient learning strategies that may contribute to poor performance. In respect to the CVLT, because consecutive words on the CVLT lists are from different categories (i.e. fruit and tools), this allows for the measurement of the degree to which an examinee actively organizes the list according to the semantic properties of the words. The semantic clustering score indicates the degree to which the examinee uses the active learning strategy of reorganizing the target words into categorical groups. It implies that the examinee has identified the categories represented by the list words, has learned to associate the category name with the instances on the list, and can retrieve the category names during recall. Semantic clustering is associated with more efficient encoding into LTM (Delis, Freeland, Kramer, & Kaplan, 1988). It also facilitates recall because retrieval can proceed from larger organization units (i.e. fruits) to their component elements (i.e. grapes, plums). Low semantic clustering scores correlate with poor performance on many of the other CVLT parameters and may suggest that the examinee is using less effective learning strategies (e.g., serial clustering). To control for overall recall levels, the CVLT yields a semantic clustering ratio, which is the observed semantic clustering score (the number of times a correct response follows another correct response from the same category) divided by the expected semantic clustering score (the chance value of semantic clustering given the total number of words recalled from each category).

7. Serial Clustering

The serial clustering score indicates the degree to which the examinee recalls target words in the same order as they are presented. This serial-order clustering strategy is less effective than semantic clustering, and correlates with poor performance on many of the other CVLT parameters. Serial clustering may reflect a "stimulus bound" response style in which the examinee adheres rigidly to the temporal order of the list when recalling the words. As with semantic clustering, the CVLT yields a serial clustering ratio score that considers observed serial clustering relative to serial clustering due to chance.

8, 9, 10. Percentage of Total Recall from Primacy, Middle, and Recency Regions

Information about serial-position effects during recall also clarifies how an examinee approaches a list-learning task. Recalled words can be characterized in terms of their position on the target list. Researchers have found that the probability of a word being recalled when plotted against its serial position on the list, produces a U-shaped curve (Klatzky, 1980); there is maximum recall for words at the beginning and end of the list. Words at the beginning of the list (primacy region) are more likely to be recalled because they are subject to rehearsal, which aids encoding into LTM. Words at the end of the list (recency region) can be reported directly out of STM span without being further encoded. SDAT subjects who are impaired at encoding information into LTM would be expected to rely more extensively on STM. Subjects who rely on STM would be expected to recall a greater proportion of words from the recency region. This prediction is confirmed in studies of demented and amnesic patients (Pepin & Eslinger, 1989; Kramer et al., 1988).

11. Slope

This measure quantifies the rate of learning across the five immediate recall trials. This index is the slope of the least-squares regression line calculated to fit the recall scores on the five immediate recall trials. A slope value near zero may indicate that the examinee quickly reaches a learning plateau; a slope value greater than 1.00 reflects sizable increases in recall from trial to trial. Typically, examinees who are highly anxious or have problems acquiring the set of a task often perform poorly on the first trial but improve considerably on subsequent trials (Lezak, 1983). Conversely, examinees with intact STM span, but limited learning capacity involving LTM functions, may achieve a normal score on the initial trial; however, they quickly reach a plateau on subsequent trials (Luria, 1981).

12. Consistency of Item Recall from Trial to Trial

The CVLT quantifies recall consistency as the percentage of target words recalled on one of the first four trials that are also recalled on the very next trial. Inconsistent recall may occur when an examinee with limited learning capacity shows erratic recall strategies. Low recall consistency reflects haphazard or disorganized styles of learning, and may indicate that the examinee has difficulty formulating or maintaining a learning plan. Inconsistent recall is prominent in patients with frontal lobe pathology; these patients often lack a consistent plan of learning (Luria, 1981).

Recall Errors

13. Perseverations

Examination of the types of recall errors made by patients also yields important information about the underlying nature of their memory difficulties. Two types of recall errors measured on the CVLT are perseverations and intrusions. Perseverations are repetitions of previous responses within the same trial. A high number of perseverations can occur for at least two reasons. If a word is repeated shortly after the original response (proximal perseveration), this may reflect a problem in response inhibition, such as is commonly associated with frontal lobe pathology. Examinees with this type of impairment are unable to inhibit repeating their most recent responses. In contrast, examinees with attention or amnesic deficits may repeat a response a considerable time after it was originally reported (distal perseveration). Such examinees often forget that they have given the response earlier on that trial, and they may believe they are reporting the perseverative response for the first time.

14, 15. Intrusions (Free Recall and Cued Recall)

An intrusion error is a response given on a recall trial that is not on the target list. While searching memory, an examinee may retrieve not only words from the target lists but also incorrect words. A high number of intrusions (i.e. responses not on the target list) may reflect a deficit in discriminating between the correct target words and incorrect items. An intrusion which is in the same category as the preceding response may indicate that semantic processing is intact but that there is impairment in the ability to discriminate previously studied items from other category members. If intrusions are given primarily on cued-recall rather than free-recall trials, this suggests that external prompting by the examiner may be responsible for triggering problems in response discrimination. If the intrusions reported either on the List B trial or the delay trials of List A are primarily items from the other CVLT list (e.g., List A items are recalled on the List B trial), this may indicate that difficulties in response discrimination are related to an unusually high degree of proactive or retroactive interference. Tabulation of intrusion errors may be of value diagnostically in that previous research has noted that SDAT subjects are particularly prone to making large numbers of intrusions (Fuld, Katzman, Davies, & Terry, 1982; Loewenstein, Wilkie, Eisdorfer, Guterman, & Berkowitz, 1989).

Recognition Measures

16. Correct Target Recognitions (Hits)

In testing recognition memory, the CVLT utilizes an auditory presentation of a list containing the target words (all 16 List A items) and 28 distractor words in a yes/no recognition paradigm. Accurate recognition performance occurs when an examinee endorses target items and rejects distractor items. All distractor items are names of objects that could be on a shopping list. There are five distinct types of distractors on the recognition test:

1. List B - Shared, which are items from List B that are from the categories shared with List A ("fruits" and "herbs and spices").
2. List B - Nonshared, which are items from List B that are from the categories not shared with List A ("fish" and "utensils").
3. Neither List - Prototypical, which are items found on neither of the lists but which are prototypical of categories on List A (e.g., "apples" for "fruit").
4. Neither List - Phonemically Similar, which are distractors that are phonemically similar to words on List A (e.g., "drums" for "plums").
5. Neither List - Unrelated, which are distractors that share neither obvious semantic nor phonemic features with items on the two lists (e.g., "aspirin" or "rug").

The distractors are either semantically similar to the target items, with "List B - Shared" the most semantically similar, "List B - Nonshared" moderately semantically similar, and "Neither List - Prototypical" least semantically similar. "Neither List - Phonemically Similar" is syntactically similar to the target list, but semantically different, and "Neither List -

Unrelated" is different in both meaning and syntax. The recognition paradigm with the various types of distractors is designed to provide insight into how the list items were initially encoded based on how the items are "recognized." Previous research has suggested that if encoding, based on semantic properties has occurred, any errors will be of the semantic-distractor type (Craik & Byrd, 1982). Based on research findings, some suggestions have also been made that phonemic/syntactic functions can be maintained independently of semantic abilities in patients with advanced cortical atrophy (Bayles, Tomoeda, & Caffrey, 1982). A preponderance of "Phonemically Similar" responses during recognition testing would support this hypothesis. This would also suggest that the original list of words was not encoded based on the meaning of the words, but rather on the syntactic structure of the words. The "Unrelated" distractor is included in anticipating the possibility that some subjects may have no recognition of the information based on either semantic or syntactic cues, implicating some deviant, qualitatively different, encoding strategy.

In the same way that a comparison of free recall and cued recall performance is a way of isolating retrieval deficits; comparing recognition performance with free recall and cued recall performance also addresses the issue of whether a memory problem reflects predominantly encoding or retrieval difficulties. Recognition testing maximally aids retrieval, whereas cued recall testing provides a lesser degree of assistance. In contrast, free recall testing provides no retrieval assistance. As with cued recall, markedly better performance on recognition than on free recall may indicate more of a retrieval than an encoding problem. Accurate recognition indicates that the target items were encoded even though they may not have been retrieved on the free-and cued-recall trials.

17. False Positives

A high hit rate does not necessarily indicate accurate recognition performance, because the examinee might also have made a large number of false positives. For example, in one study of dementia patients (Kramer, et al., 1988), there were no differences in "correct" hit rates between any of the dementia groups and the normal controls. However, the recognition memory deficits of patients with SDAT and advanced Huntington's disease were manifested in their high rate of false positives. A false positive involves the examinee responding "yes" to a distractor item. A high number of false positives may indicate one or both of the following: (a) a deficit in discriminating target items from distractor items; and (b) a "yes" response bias. Some types of false positives reflect a more serious recognition problem than others. A high number of "Neither List-unrelated" false positives represents the most impaired performance, because these items should be the most conspicuous distractors, that is, they were never presented on the learning trials of the test, and they do not share obvious semantic or phenomic features with the target items. In contrast, a few "List B-Shared" false positives represent the least impaired performance, because these words have the potential to be the most confusing distractors; that is, they were previously presented on the test and are semantically related to the target items. A high number of "Neither List-Phonemically Similar" false positives may reflect either a superficial processing strategy (more phonemic than semantic), or a hearing problem (e.g., reduced auditory acuity may cause an examinee to perceive "chimes" as "chives"). A high number of "Neither List - Unrelated" endorsements would suggest that information had been encoded in some random or unrecognizable fashion, without attention to either the meaning of the phonemic structure of the word.

18. Discriminability

Discriminability refers to the ability to distinguish target items from distractor items (i.e., "signal" from "noise"). The formula used by the CVLT to calculate discriminability is:

Discriminability = [1 - {(False Positives + Misses)/44}] x 100

Because this index takes into account both hits and false positives, it provides the single best measure of overall recognition performance. A low discriminability score may indicate an impairment in differentiating target items from distractor items, suggesting that problems in encoding contribute significantly to the examinee's memory deficits. Investigations with neurological patients have shown deficits in discriminability (Warrington & Weiskrantz, 1970).

19. Response Bias

Response bias refers to the tendency to favor "yes" or "no" responses when the examinee is doubtful about the correct answer. Atypical response biases have been reported in SDAT patients who favor "yes" responses, and depressed patients who favor "no" responses (Post, 1975). The formula used by the CVLT to calculate response bias is:

Response Bias = (False Positives - Misses) / (False Positives + Misses)

A perfect score on the recognition trial (16 hits, 0 false positives) yields a response bias score of 0 and indicates a "neutral" response tendency. Scores approaching +1 or -1 reflect a "yes" or "no" response bias, respectively, regardless of the type of recognition item.

Thus, analysis of test results will provide information as to "how" memory processes operate, or fail to operate, in addition to measuring the "amount" of verbal material memorized. In this way this study will satisfy the general objective of attempting to more clearly elucidate the nature of memory impairments in SDAT, which would not be achieved in using a test that employs a global scoring method.

Research Questions

Using the memory measures outlined, the following research questions were asked:

Recall Measures

I. Do SDAT subjects perform poorer than nonclinical elders on the following recall measures?

1. List A Trial 1
2. List A Trial 5
3. List B
4. Short-Delay Free Recall
5. Short-Delay Cued Recall
6. Long-Delay Free Recall
7. Long-Delay Cued Recall

II. Is there a difference in memory performance for SDAT subjects on the Interference List (List B) and Trial 5, List A, indicating proactive interference?

III. Is there a difference in memory performance for SDAT subjects on the Interference List (List B) and Short-Delay Free Recall, indicating retroactive interference?

IV. Is there a difference in memory performance for SDAT subjects in cued recall conditions and free recall conditions?

V. Is there a difference in memory performance for SDAT subjects after an extended delay period (20 minutes)?

Learning Characteristics

I. Is there a difference between SDAT subjects and nonclinical elders in how information is organized in memory? Specifically, is there a difference in the amount of semantic and serial organization imposed on information in memory?

II. Is there a difference between SDAT subjects and nonclinical elders in the amount of information recalled from different regions of the word list, namely:

1. Primacy Region
2. Middle Region
3. Recency Region

III. Is there a difference between SDAT subjects and nonclinical elders in the rate of learning across trials (slope)?

IV. Is there a difference between SDAT subjects and nonclinical elders in the consistency of recall from one trial to the next?

Recall Errors

I. Is there a difference between SDAT subjects and nonclinical elders in the number of perseverative errors produced?

II. Is there a difference between SDAT subjects and nonclinical elders in the number of intrusion errors produced?

Recognition Measures

I. Is there a difference between SDAT subjects and nonclinical elders in the number of correct target recognitions (hits)?

II. Is there a difference in memory performance for SDAT subjects in recognition performance and free recall performance?

III. Is there a difference between SDAT subjects and nonclinical elders in the number of false positives?

IV. Is there a difference between SDAT subjects and nonclinical elders on the discriminability index?

V. Do SDAT subjects show evidence of a response bias?

CHAPTER IV

RESULTS

The current study involved an examination of specific memory mechanisms in patients with mild-moderate Senile Dementia of the Alzheimer-Type (SDAT). Strict criteria were applied in achieving accurate diagnosis and in identifying disease severity. In keeping with the majority of the research in this area, this study employed the information processing model, which assumes that information flow can be traced through several hypothetical stages or memory stores. The information processing model provides the most useful framework for the study of memory impairments by allowing for the assessment of specific components of memory. Research has already clearly revealed that memory is impaired in SDAT. The focus of this study was to discover how memory is impaired in SDAT, and this required an investigation of particular memory structures and functions.

The California Verbal Learning Test (CVLT) was used to assess the multiple underlying processes of memory. The CVLT yields a total of 21 individual memory measures that are categorized into 4 areas: recall measures, learning characteristics, recall errors, and recognition measures. SDAT subjects' performance on the 21 memory measures was compared to CVLT test norms to determine the nature of memory impairment.

Both descriptive and statistical analyses of the data are presented.

Descriptive Analysis

SDAT subjects' performance on the 21 individual CVLT measures is presented in Figures 2 - 5, using the following groupings: recall measures, learning characteristics, recall errors, and recognition measures. Box plots were used to describe SDAT subjects' performance with the following features: the center line indicates the median, the lines across the ends of the box mark the upper and lower quartiles, and the extending points indicate the outliers or the most extreme scores. The box plots represent the standard scores of the SDAT subjects, and are plotted against zero, which is the mean of the nonclinical elders norm group.

Examination of Figure 2 reveals that most of the SDAT subjects perform well below the mean performance of nonclinical elders on all seven recall measures. The fact that the median and upper and lower quartiles (represented by the middle line and ends of the boxes) are close together, particularly on "Trial 5" and "List B", reveals little spread in scores, which suggests that SDAT subjects' performance on these measures is highly similar and predictable.

Figure 3 presents SDAT subjects' performance on seven learning characteristics. The results reveal that most of the SDAT subjects recall of words in the "Primacy" and "Middle" regions of the list was well below the average of nonclinical elders, as was the "Consistency" of their recall from trial to trial. The measure of their ability to group words according to meaning ("Semantic"), and their learning across trials ("Slope") was also below the ability of nonclinical elders. However, Figure 3 also reveals learning characteristics in which SDAT subjects' performance was not deficient relative to nonclinical elders. The ability of SDAT subjects to recall words in the order they were presented ("Serial") was similar to the nonclinical norm group, and the recall of words from the last part of the list ("Recency") was superior to nonclinical elders. The great spread in the learning characteristics box plots reveals a wide divergence in performance on these measures.

Figure 4, which presents data on the type of recall errors made by SDAT subjects relative to their nonclinical counterparts reveals that although SDAT subjects made fewer perseverative errors than nonclinical elders, they made more intrusion errors, particularly under cued recall conditions, in which case excessively more intrusion errors were made.

In Figure 5 we see that under recognition conditions for recall, most SDAT subjects correctly recalled as many words as nonclinical elders as presented by the box plot for "Recognition Hits". However, we also see that they generally responded "yes" to all words on the recognition list, as indicated by the box plot for "Response Bias", thereby achieving an extremely high rate of "False Positive" responses. Consistent with this, their ability to "Discriminate" between correct and incorrect words was extremely low.

A review of the descriptive presentation of data in Figures 2 - 5 reveals recall, learning, and recognition deficiencies, with excessive intrusion errors. The following inferential statistical analysis applies the data to the research questions posed in this study.

Figure 2

<u>Recall Measures</u>

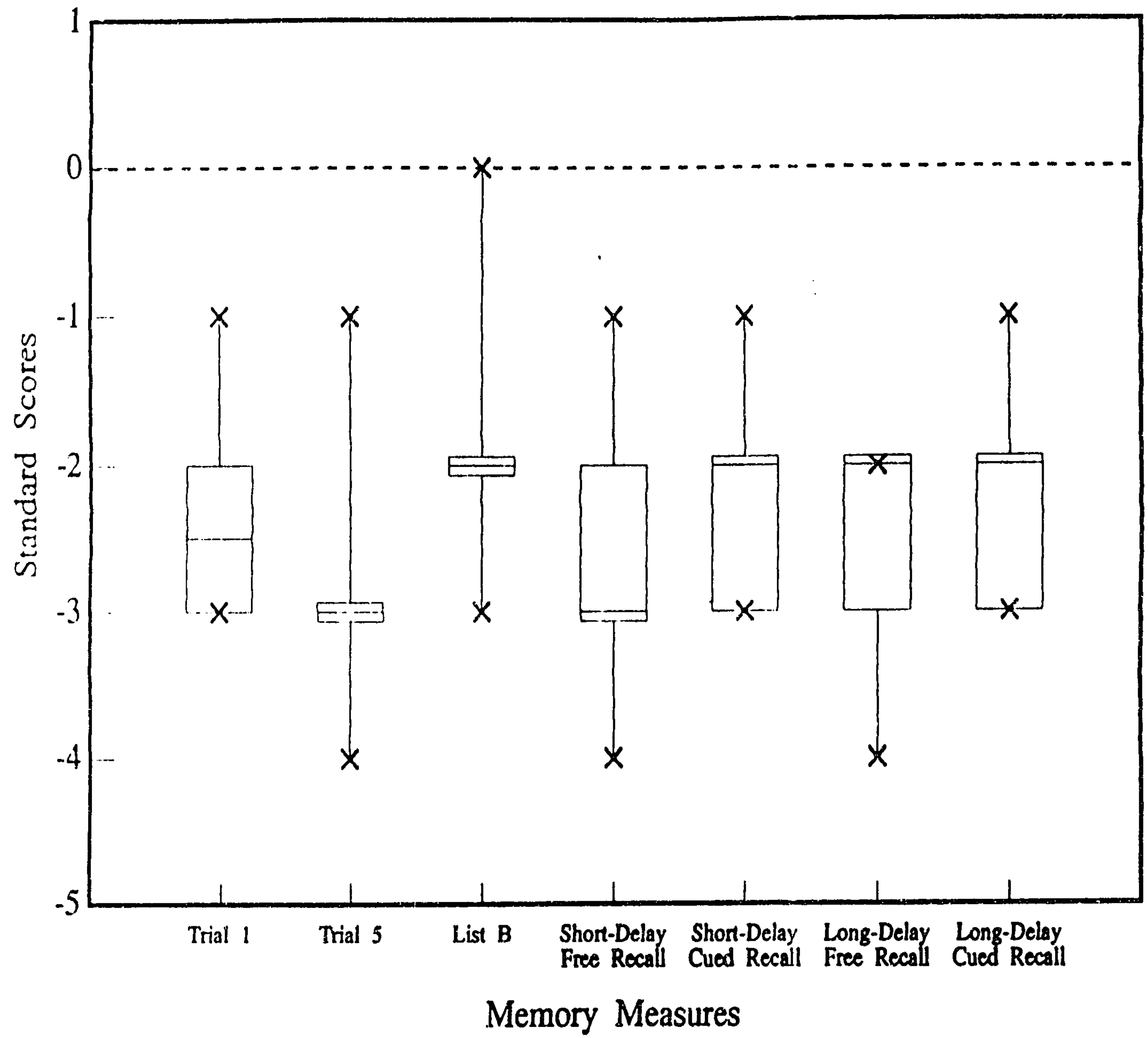


Figure 3

Learning Characteristics

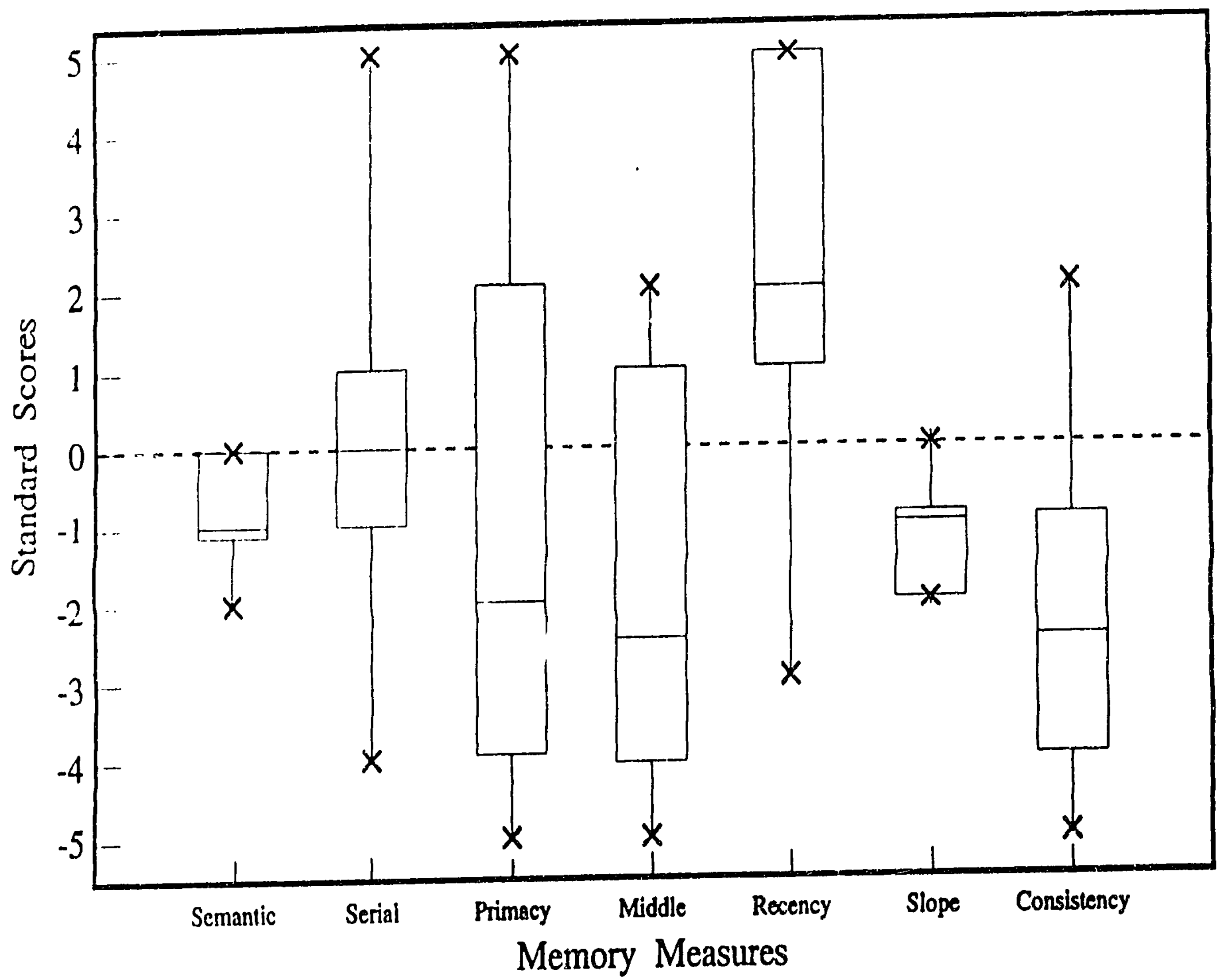


Figure 4

Recall Errors

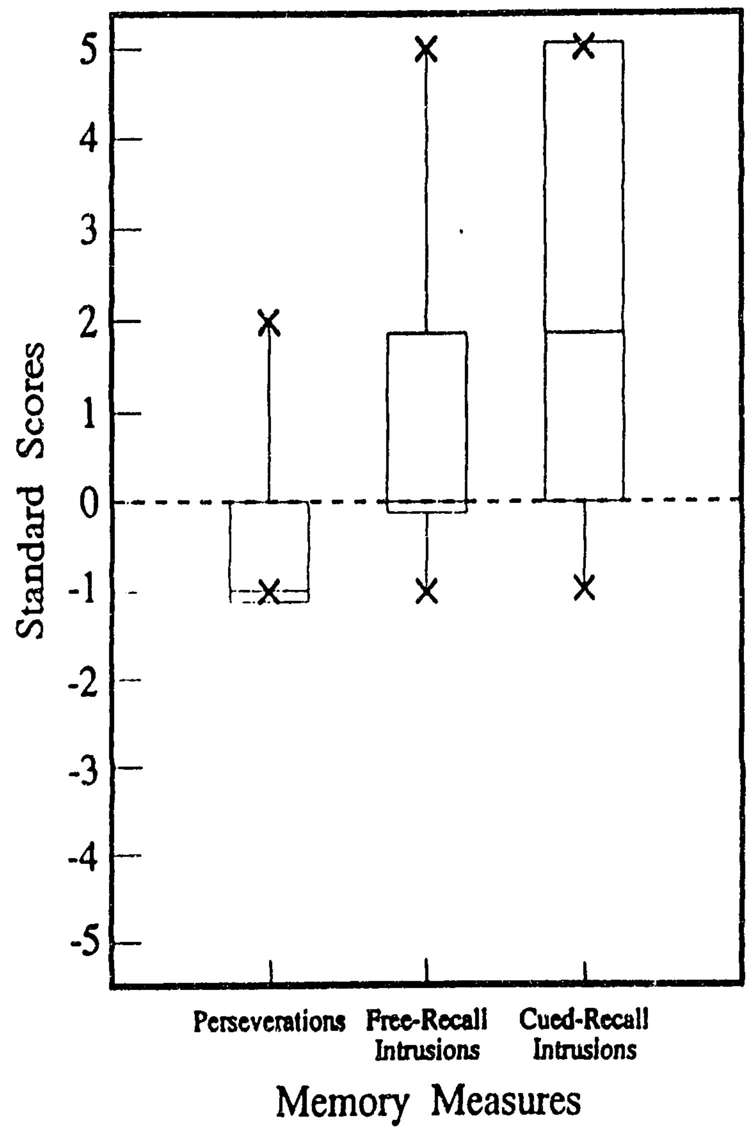
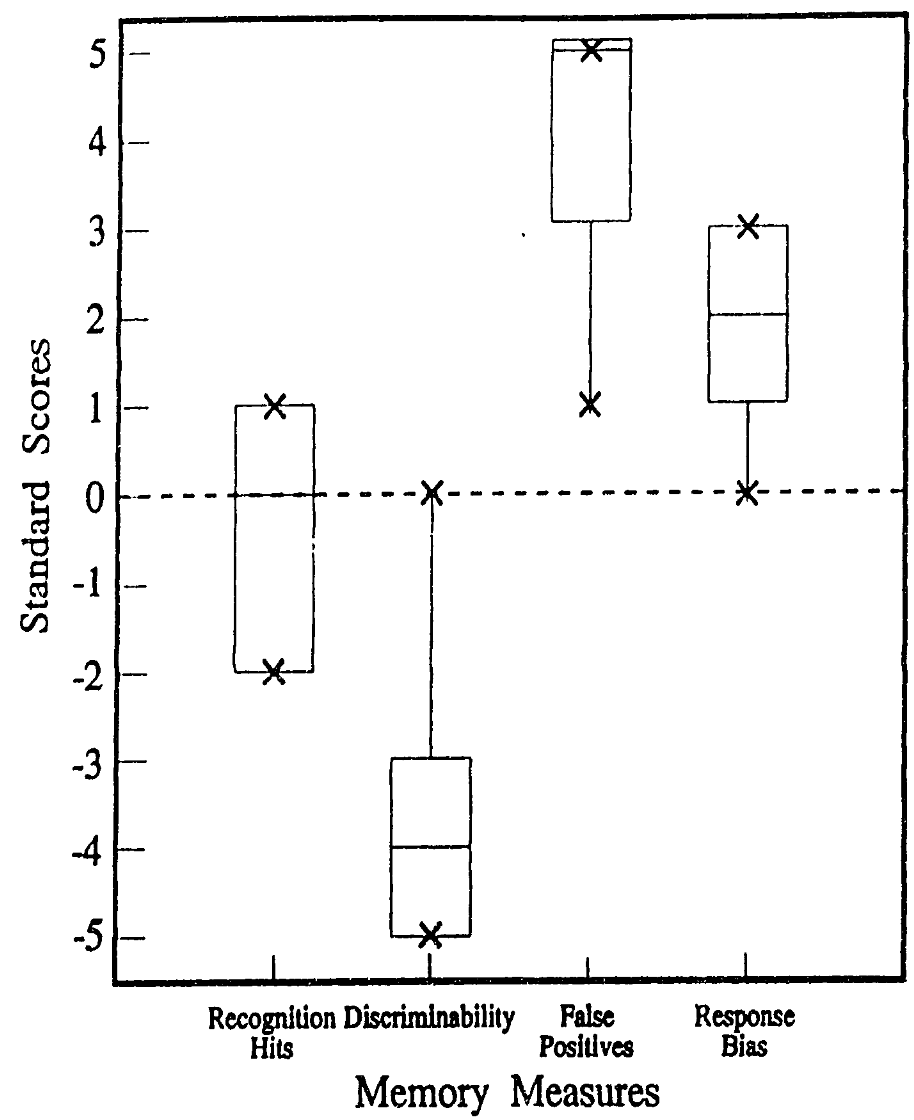


Figure 5

<u>Recognition Measures</u>



Statistical Analysis

Statistical analysis was undertaken to compare the memory performance of SDAT subjects and nonclinical elders. SDAT subjects and nonclinical elders were compared on the 21 individual CVLT measures that were grouped accordingly: 7 recall measures; 7 learning characteristics; 3 types of recall errors; and 4 recognition measures. Because most past research assessing memory functioning in SDAT has failed to breakdown memory into component processes, it was impossible to hypothesize on which individual memory measures SDAT subjects would show significant impairments relative to nonclinical elders and on which measures they would not.

A second kind of statistical analysis involved comparing SDAT subjects' performance on one CVLT measure to their performance on another CVLT measure to isolate specific memory processes and mechanisms to determine how each contributes to overall memory impairments. Lack of consensus in previous research makes predictive speculation of this nature difficult. This analysis is considered investigative rather than confirmatory.

The central research question investigated in this study asked which specific memory processes and functions are primarily impaired in SDAT. To answer this question research must look at memory in its complexity rather than as a uniform measure. The CVLT provides 21 measures of the multiple underlying processes of memory. So the primary question becomes: On which of the 21 individual CVLT measures do SDAT subjects demonstrate significant deficits relative to nonclinical elders?

To answer this question, a Multivariate Hotelling T^2 test for significance was completed for each of the four groupings of individual CVLT measures to determine whether there was a difference between SDAT subjects' and nonclinical elders' memory performance. Given overall findings of significance as determined by the Multivariate Analysis, a series of Univariate tests was done using the 21 individual CVLT measures in the following categories: recall measures, learning characteristics, recall errors, and recognition measures. These analyses were completed to determine which of the individual memory CVLT measures produced differences between SDAT subjects and nonclinical elders. As can be seen in Table 1, the results reveal that SDAT subjects are significantly more impaired than nonclinical elders on all individual CVLT memory measures with the exception of "Serial" and "Correct Recognitions (Hits)". A comprehensive discussion of the 21 specific memory measures, as well as an explanation for these results follows.

<u>Recall Measures</u>

1. Trial 1

Trial 1 measures the amount of information recalled after only one presentation of List A. The results presented in Table 1, reveal that SDAT subjects are significantly impaired relative to nonclinical elders in their ability to recall information following a single presentation of that information.

Table 1

Multivariate and Univariate Analysis of CVLT Measures

Group	Statistical Analysis		F	Significance of F
Recall Measures	Multivariate Hotelling T^2	DF (7,15) $p < .05$	90.45	$< .01$
	Univariate F-tests	Variables		
		1. Trial 1	373.39	$< .01$
		2. Trial 5	346.50	$< .01$
		3. List B	151.50	$< .01$
		4. Short Delay Free Recall	353.22	$< .01$
		5. Short Delay Cued Recall	230.47	$< .01$
		6. Long Delay Free Recall	366.39	$< .01$
		7. Long Delay Cued Recall	232.35	$< .01$
Learning Character-istics	Multivariate Hotelling T^2	DF (7,11) $p < .05$	8.93	$< .01$
	Univariate F-tests	Variables		
		8. Semantic	17.00	$< .01$
		9. Serial	2.52	.13
		10. Primacy	8.82	.01
		11. Middle	7.17	.02
		12. Recency	39.36	$< .01$
		13. Slope	30.52	$< .01$
		14. Consistency	29.62	$< .01$
Recall Errors	Multivariate Hotelling T^2	DF (3,19) $p < .05$	12.01	$< .01$
	Univariate F-tests	Variables		
		15. Perseverations	8.33	.01
		16. Free Recall Intrusions	6.10	.02
		17. Cued Recall Intrusions	17.57	$< .01$
Recognition Measures	Multivariate Hotelling T^2	DF (4,18) $p < .05$	118.64	$< .01$
	Univariate F-tests	Variables		
		18. Recognition Hits	0.67	.42
		19. False Positives	194.53	$< .01$
		20. Discrimin-ability	157.08	$< .01$
		21. Response Bias	56.47	$< .01$

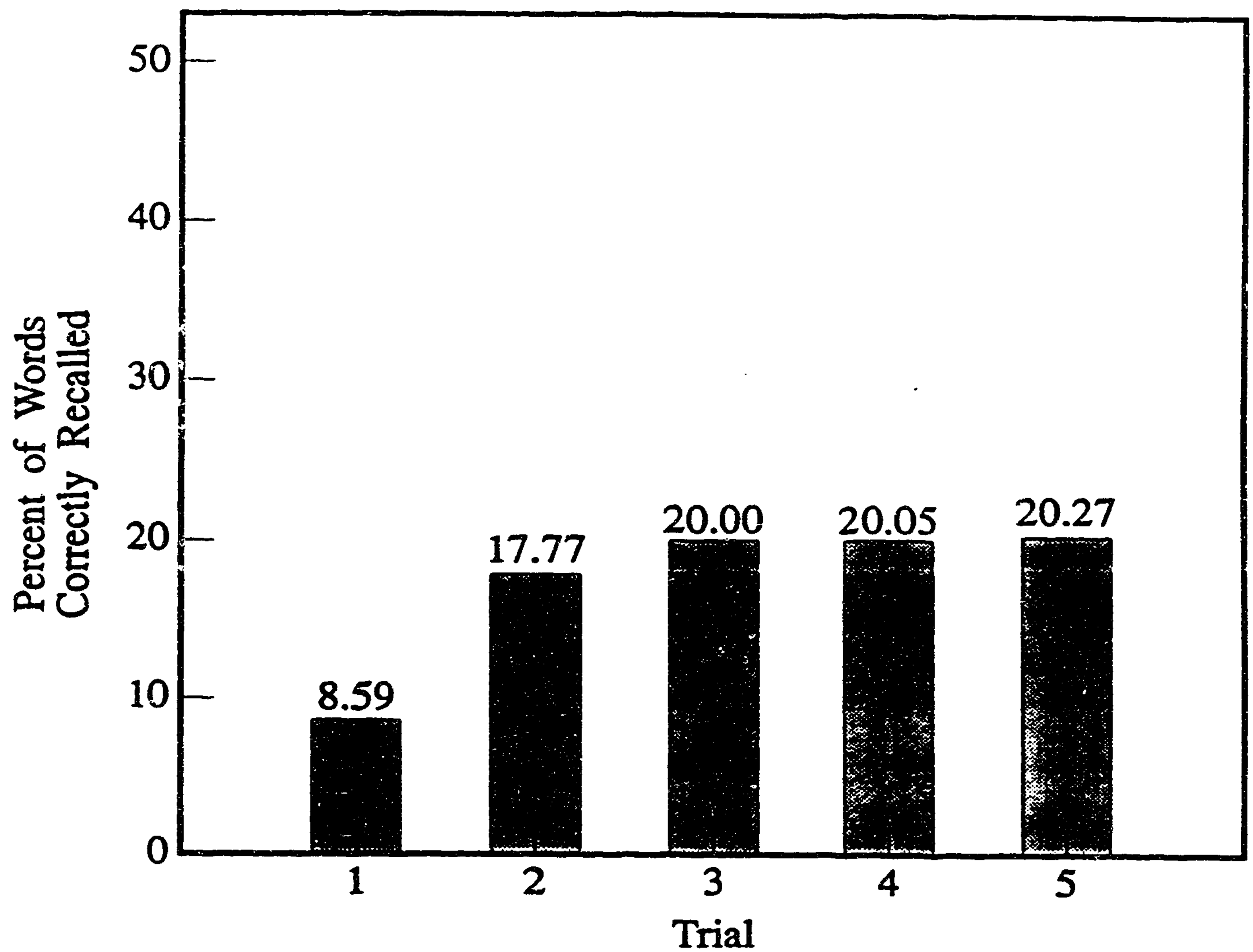
2. Trial 5

Trial 5 measures the amount of information recalled after five presentations of list A. The results reveal that SDAT subjects are significantly impaired relative to nonclinical elders in their ability to recall information following five presentations of the same information.

With the finding that SDAT subjects are significantly impaired in the amount of information recalled on the first and final presentations of List A, the next logical question is: "How much information, if any, are SDAT subjects actually recalling from List A?" Figure 6 shows the mean percent of words correctly recalled for each trial. The results reveal that although only 8.59% of the list is recalled after one presentation, 20.27% is recalled after the fifth presentation. New information was acquired in memory by SDAT subjects, albeit significantly less than was acquired by their nonclinical counterparts. These results also reveal that repetition is required to maximize the amount of information a SDAT subject can recall.

Figure 6

Mean Percent of Words Correctly Recalled for Each Trial of List A



3. List B

List B measures the amount of information recalled from a new list following five presentations of List A. The findings reveal that SDAT subjects are significantly impaired in their ability to recall words from the new List B.

The information processing model proposes that performance on List B may be adversely affected by the five previous List A trials, such that the learning of List A interferes with the new learning of List B (proactive interference). To test for proactive interference the performance of SDAT subjects on the first trial of List A was compared to their performance on List B. Findings presented in Table 2 demonstrate a significant difference between their mean performance on List A and List B, but with their performance on List B as superior to their performance on List A. These results contraindicate proactive interference effects.

Table 2

<u>SDAT Subjects' Performance on Trial 1, List A Compared to List B</u>

Variable	N	M	S.D.	T Value	DF	2-Tail Prob.
trial 1, list A	22	-2.45	0.60			
list B	22	-1.86	0.71	-3.78	21	< 0.01

$p < .05$

4. Short Delay Free Recall

This measure involved presenting the original List A after testing recall for List B. The "short delay" in the presentation of List A, refers to the prior presentation of List B. "Free recall" involves asking the examinee what he/she can recall without offering any retrieval cues. The results reveal that SDAT subjects are impaired relative to nonclinical elders on this measure.

To test for retroactive interference, where learning List B would have a decremental effect on remembering List A, a paired t-test was run. A comparison of the means of Trial 5 List A, and List A after a short delay period failed to reveal a significant difference between measures, thus contraindicating retroactive interference. The results of this paired t-test are presented in Table 3.

Table 3

SDAT Subjects' Performance on Trial 5, List A Compared to Short Delay Free Recall of List A

Variable	N	M	S.D.	T Value	DF	2-Tail Prob.
trial 5, list A	22	-3.00	0.76	-1.89	21	0.07
short delay free recall list A	22	-2.64	0.66			

$p < .05$

5. Short Delay Cued Recall

This measure involved assisting recall by providing the examinee with the categories to which the items belong, by saying, "Tell me all of the shopping items from the list that are fruits." The findings, presented in Table 1, demonstrate that SDAT subjects are significantly impaired relative to nonclinical elders in their ability to recall information from List A under cued recall conditions.

Comparing the SDAT subjects' cued recall performance with free recall performance provides evidence as to whether a memory problem reflects predominantly encoding or retrieval difficulties. Markedly better performance on cued recall than on free recall indicates more of a retrieval than an encoding problem. A paired t-test comparing SDAT subjects' mean free recall performance with their mean cued recall performance failed to identify any significant improvement in performance under cued recall conditions. These results, presented in Table 4, suggest that problems in encoding are contributing significantly to the memory dysfunction in this sample of SDAT subjects.

Table 4

SDAT Subjects' Performance on Short Delay Free Recall Compared to Short Delay Cued Recall

Variable	N	M	S.D.	T Value	DF	2-Tail Prob.
short delay free recall	22	-2.64	0.66	-1.50	21	0.15
short delay cued recall	22	-2.32	0.72			

$p < .05$

6. Long Delay Free Recall

Long delay free recall measures the ability to recall information after a 20-minute delay interval and reflects the examinee's ability to retain information over time. As with all other recall measures, the results presented in Table 1, reflect significant impairments in the SDAT group relative to nonclinical elders.

Comparing the SDAT subjects' short delay free recall performance with their long delay free recall performance provides evidence as to whether memory problems occur as a result of being unable to retain information in memory over time. A paired t-test comparing free recall after a short delay with free recall after a long delay failed to find a significant difference in performance for SDAT subjects. These results, presented in Table 5, failed to identify a delay period as a significant factor in the impaired memory functioning of this groups of SDAT subjects.

Table 5

SDAT Subjects' Performance on Short Delay Free Recall Compared to Long Delay Free Recall

Variable	N	M	S.D.	T Value	DF	2-Tail Prob.
short delay free recall	22	-2.64	0.66	-1.74	21	0.10
long delay free recall	22	-2.41	0.59			

$p < .05$

7. Long Delay Cued Recall

This measure involved assisting recall by providing the examinee with the categories to which the items belong by saying, "Tell me all of the shopping items from the list that are fruits." Testing occurred after a 20-minute delay interval. Relative to the norm group, SDAT subjects demonstrated significantly impaired performance on this measure as presented in Table 1.

As in the case of short delay free recall and short delay cued recall, comparing the SDAT subjects' cued recall long delay performance with free recall long delay performance provides evidence as to whether a memory problem reflects predominantly encoding or retrieval difficulties. Improved performance on cued recall relative to free recall would indicate more of a retrieval than an encoding problem. A paired t-test comparing SDAT subjects' mean free recall performance with their mean cued recall performance failed to identify any significant improvement in performance under cued recall conditions. These results, presented in Table 6, reinforce the previous suggestion that problems in encoding are primarily involved in memory dysfunction in this sample of SDAT subjects.

Table 6
<u>SDAT Subjects' Performance on Long Delay Free Recall Compared to Long Delay Cued Recall</u>

Variable	N	M	S.D.	T Value	DF	2-Tail Prob.
long delay free recall	22	-2.41	0.59	-1.07	21	0.30
long delay cued recall	22	-2.23	0.69			

$p < .05$

Summary

The results of the "recall measures" of memory reveal that, although memory functioning in SDAT is significantly impaired, the basic ability to acquire and retrieve new information remains intact. The fact that cueing failed to improve memory performance suggests that an encoding deficit contributed to the memory dysfunction in this sample of SDAT subjects. The results also indicate that neither proactive nor retroactive interference are involved in the memory performance of this sample. A time delay of either short or long (20 minutes) duration also failed to negatively impact memory performance.

Learning Characteristics

8. Semantic Clustering

The semantic clustering score indicates the degree to which an examinee uses the active learning strategy or reorganizing the words into categorical groups. Semantic clustering is associated with more efficient encoding into long-term memory (LTM). It also facilitates recall because retrieval can proceed from larger organization units (i.e. fruits) to their component elements (i.e. grapes, plums). Semantic clustering is a highly effective learning strategy and is correlated with superior recall performance. The results, presented in Table 1, reveal that SDAT subjects are significantly impaired relative to nonclinical elders in their use of semantic clustering.

9. Serial Clustering

The serial clustering score indicates the degree to which the examinee recalls the words in the same order as they were presented. The serial-order clustering strategy is less effective than semantic clustering, and correlates with poor performance on many of the other CVLT parameters. The findings of this study, presented in Table 1, demonstrate that SDAT subjects are NOT significantly different from nonclinical elders in their use of serial clustering.

A direct comparison of SDAT subjects' use of semantic and serial clustering was done through a paired t-test. The results, presented in Table 7 reveal that there is a significant difference between SDAT subjects' use of semantic and serial clustering, favoring the former. These results identify SDAT subjects' failure to semantically organize information in memory, and their reliance on less effective serial-order clustering as significant factors in the impaired memory functioning of this group of SDAT subjects.

Table 7

SDAT Subjects' Semantic Clustering Compared to Serial Clustering

Variable	N	M	S.D.	T Value	DF	2-Tail Prob.
semantic clustering	18	0.67	1.78	2.68	17	0.02
serial clustering	18	-0.67	0.69			

$p < .05$

10, 11, 12. Percentage of Total Recall from Primacy, Middle, and Recency Regions

Recalled words can be characterized in terms of their position on the list. Researchers have found that there is maximum recall for words at the beginning and end of the list in nonclinical samples. Words at the beginning of the list (primacy region) are more likely to be recalled because they are subject to rehearsal, which aids encoding into LTM. Words at the end of the list (recency region) are also more easily recalled because they can be reported directly out of STM without being further encoded. SDAT subjects who are impaired in encoding information into LTM would be expected to rely more extensively on STM. Subjects who rely on STM would be expected to recall a greater proportion of words from the recency region.

The results presented in Table 1 reveal that SDAT subjects are impaired in percent recalled from the primacy, middle, and recency regions of the list. Figure 3, displaying the box plots for percent recalled from primacy, middle, and recency regions, reveals that SDAT subjects, while recalling less than nonclinical counterparts from the beginning and middle of the list, recall more than nonclinical elders from the end of the list. Paired t-tests were done comparing the percent recalled by SDAT subjects for each region of the list to determine whether they are recalling a greater proportion of words from any one region of the list. Table 8 displays the results of these t-tests, and reveals that the percent recalled by SDAT subjects from the recency regions is significantly different from the percent recalled from both the primacy and middle regions. The fact that SDAT subjects recalled a greater proportion of words from the recency region demonstrates a reliance on STM. This reliance on STM occurs as a result of impaired ability to encode information into LTM.

Table 8

<u>A Comparison Between Percent Recalled for Primacy, Middle, and Recency Regions of List A for SDAT Subjects</u>

Variable	N	M	S.D.	T Value	DF	2-Tail Prob.
primacy	22	-1.18	3.39	0.57	21	0.57
middle	22	-1.77	2.25			
primacy	22	-1.18	3.39	-3.25	21	<0.01
recency	22	2.32	2.26			
middle	22	-1.77	2.25	-5.26	21	<0.01
recency	22	2.32	2.26			

$p < .05$

Comments made by SDAT subjects during memory testing support the fact that SDAT subjects relied on STM storage of information and failed to encode information into LTM. After repeating three or four words from the list that they had rehearsed in STM and were therefore able to recall, one examinee stated that the other words from the list "just wouldn't stick." Other examinees stated that the list items "disappeared" or "slipped away" from their memories. These examinees appear to be describing the fading of memory that occurs if information is not transferred into permanent LTM storage. Another examinee stated, "As I say one word I forget the next word I wanted to say." This SDAT subject was attempting to maintain information in STM through active rehearsal of that information. However, when rehearsal is interrupted and the information has not been transferred into LTM, the information is lost.

13. Slope

This measure quantifies the rate of learning across the five immediate recall trials, and is sometimes referred to as a "learning curve." In nonclinical samples, each additional presentation of specific information results in more information being obtained in memory. The results from this study, presented in Table 1, reveal that SDAT subjects learn relatively small amounts, as reflected by the slope or learning curve.

14. Consistency of Item Recall from Trial to Trial

Recall consistency refers to the recall of many of the same words from one trial to the next. High recall consistency reveals that information is effectively organized within memory, so that the recall of one word may cue the recall of the next word. Low recall consistency is indicated by different words recalled for each trial, and reflects a disorganized style of learning.

Test results presented in Table 1 indicate that SDAT subjects are significantly impaired in the consistency of their recall relative to nonclinical elders.

Summary

The results of the "learning characteristics" measures of memory suggest that the degenerative process in SDAT, as presented by this sample, appears to disrupt the subjects' ability to successfully encode new information into memory. SDAT subjects generally did not effectively process, reorganize, or transfer information into permanent LTM to ensure successful future recall. On the rare occasion when information was encoded into LTM, SDAT subjects failed to cluster words from the list into categorical groups with semantic organizational strategies. Instead, words were encoded in the order in which they were presented using ineffective serial clustering strategies. Recall consistency also suffered as a result of haphazard organization of information in memory. Testing observations of SDAT subjects correctly recalling a word ten minutes after the last presentation of the list support the notion that some words are, in fact, transferred into LTM. However, these words are not retrieved through the assistance of cueing or recognition, which again suggests that irregular, random, or nonsemantic encoding makes these words inaccessible. One subject described his experience of being unable to retrieve irregularly encoded words as: "some of the words from the list are still in my mind but I can't get them loose." A failure to semantically organize and encode information was also apparent in serial position recall results, where recall of words in the primacy and middle regions was severely impaired but recall of words in the recency region was superior to nonclinical elders. Research has recognized that fading of the primacy effect occurs as a result of a processing deficit where, if the first and middle words from a long list are not reorganized and transferred into LTM, they will not be retained. This was the case with this sample of SDAT subjects that recalled only recently presented items that were rehearsed in STM.

In summary, SDAT subjects were less likely than nonclinical elders to encode new information into LTM and to engage in the semantic processing that is necessary to do so.

Recall Errors

15. Perseverations

Perseverations are repetitions of previous responses within the same trial. The results presented in Table 1 indicate that SDAT subjects made significantly more perseverative errors than nonclinical elders. A high number of perseverations can occur for two reasons. If a word is repeated shortly after the original response (proximal perseveration), this reflects a problem in response inhibition, where the examinee is unable to inhibit repeating his most recent response. In contrast, if a response is repeated a considerable time after it was originally reported (distal perseveration), the examinee has forgotten that he had given the response earlier on the trial. In this study, SDAT subjects demonstrated distal perseveration, where a perseverative response was made due to no recollection of prior responses. This reflects reliance on temporary STM functioning where information is lost quickly. Permanent LTM processing would preserve the memory of a response after it was given, thus reducing perseverative responses.

16, 17. Intrusions (Free Recall and Cued Recall)

An intrusion error is a response given on a recall trial that is not on the correct list. While searching memory, an examinee may retrieve not only words from the correct lists but also incorrect words. A high number of intrusions may reflect a deficit in discriminating between the correct words and incorrect items. The results presented in Table 1 indicate that SDAT subjects made significantly more intrusion errors than nonclinical elders.

These results are consistent with previous research regarding the frequency of intrusion errors--particularly unrelated intrusions--in SDAT. The mechanisms underlying the occurrence of the intrusion errors described by Shinder, Caplan and Hier (1984) may also apply to this SDAT sample. According to Shinder, Caplan and Hier, the subject initiates an unsuccessful search throughout LTM for the correct word of phrase, he then selects from STM a recently heard word or phrase, and then after failing to inhibit the incorrect word or phrase the incorrect word or phrase is emitted. In so doing, the SDAT subjects appears unable to recognize the fact that his erroneous response has no relation to correct items.

This explanation for intrusion responses in SDAT fits well with the previously discussed test results demonstrating that this sample of SDAT subjects neglected LTM functions (semantic processing and reorganization) in favor of STM functions (rehearsal). In applying this line of thinking to intrusion errors, the SDAT subject could not locate the correct word in memory either because it was ineffectively encoded in LTM or was not encoded at all. The results of this ineffective encoding in LTM appears to be that the newly acquired information was not organized separately from previously learned information so that correct words became encoded with incorrect words previously stored in memory, and at recall could not be distinguished from each other. When the subject was unable to locate the correct word in LTM, he then selected a word from STM which was either a correct item that was maintained through rehearsal (usually a recently presented item) or an intrusional response which in no way was related to the memory testing, but was a word recently mentioned or thought of. Cued recall conditions designed to facilitate retrieval for nonclinical subjects, failed to accommodate the memory deficits of SDAT subjects. These results support the fact that encoding deficits are primarily responsible for memory impairments in SDAT. Information is either not encoded into LTM at all, or is encoded in such a way to render it inaccessible at the time of recall.

Summary

SDAT subjects in this study revealed a proclivity toward perseverational and intrusional errors. These erroneous responses are a manifestation of defective encoding processes where newly acquired information: is not encoded into LTM but is instead maintained through rehearsal in STM; is encoded into LTM on the basis of nonsemantic features (i.e. the order in which the information is presented); or is encoded into LTM without maintaining its distinctiveness from previously learned information.

Recognition Measures

18. Correct Recognitions (Hits)

In testing recognition memory, the subject was read a list containing the correct words and 28 incorrect "distractor" words. Subjects were to respond "yes" or "no" to each word based on whether they believed the word was on the original List A. Accurate recognition performance occurs when an examinee responds "yes" to a correct item. The results presented in Table 1 reveal that SDAT subjects are NOT significantly impaired in their ability correctly respond "yes" to the correct List A words.

19. False Positives

A false positive involves the examinee responding "yes" to an incorrect item. A high number of false positives may indicate one or both of the following: (a) a deficit in discriminating correct from incorrect items; and (b) a "yes" response bias in which case the examinee has a tendency to respond "yes" to all items.

The results presented in Table 1 reveal that SDAT subjects made significantly more false positive responses than nonclinical elders. The excessive number of false positive responses made by SDAT subjects may explain their seemingly unimpaired correct target recognition: if one responds "yes" to a majority of the words on the recognition list, one has a greater chance of correct responses (hits) as well as incorrect responses (false positives). In other words, a high hit rate does not necessarily indicate successful performance on the recognition test, because a high false positive rate may occur concurrently. This appears to be the case with this SDAT group.

A more detailed analysis of false positive errors provides deeper insight into the nature of the memory deficit in SDAT.

There are five distinct types of distractors on the recognition test:

1. List B - Shared, which are items from List B that are from the categories shared with List A ("fruits" and "herbs and spices").
2. List B - Nonshared, which are items from List B that are from the categories not shared with List A ("fish" and "utensils").

3. Neither List - Prototypical, which are items found on neither of the lists but which are prototypical of categories on List A (e.g., "apples" for "fruit").

4. Neither List - Phonemically Similar, which are distractors that are phonemically similar to words on List A (e.g., "drums" for "plums").

5. Neither List - Unrelated, which are distractors that share neither obvious semantic nor phonemic features with items on the two lists (e.g., "aspirin" or "rug").

Some types of false positives reflect a more serious recognition problem than others. A high number of "Neither List - Unrelated" false positives represents the most impaired performance, because these items should be the most conspicuous distractors, that is, they were never presented on the learning trials of the test, and they do not share obvious semantic or phonemic features with the target items. A high number of "Neither List - Unrelated" responses would suggest that information had been encoded in some random or unrecognizable fashion, without attention to either the meaning or the phonemic structure of the word. In contrast, a few "List B-Shared" false positive represent the least impaired performance, because these words have the potential to be the most confusing distractors; that is, they were previously presented during the testing and are semantically related to the correct target items. A high number of "Neither List - Phonemically Similar" false positives may reflect either a superficial processing strategy (more phonemic than semantic), or a hearing problem (i.e. reduced auditory acuity may cause an examinee to perceive "chimes" as "chives").

Analysis of type of false positive errors by this sample of SDAT subjects necessitates grouping the first three categories together and grouping the last two categories together in order to account for unequal opportunities to make each type of error. (There are four distractors from each of category one, two, and three, whereas there are eight distractors from each of category four and five).

The results of SDAT subjects' false positive error analysis is presented in Table 9. In examining the first three categories of distractors we find that, as a group, SDAT subjects responded "yes" to words during recognition testing that were never introduced during testing (Neither List - Prototypical) more frequently than words that were read from List B during testing (List B - Shared Categories or List B - Nonshared Categories). The words most frequently receiving "yes" responses from SDAT subjects were "prototypical" of the correct list, however, meaning that they were items from the same category as words on the list (i.e. fruit). For example, when asked whether the word "apple" was on the shopping list, one of the SDAT subjects responded, "Well, I'm not sure.....apples certainly could have been on the list....I'm not sure whether they were on this specific list, but yes, they could very well have been on this list." Another subject stated that "'apples' ring a bell" but he wasn't certain whether that was because this word was recently presented during testing or because the word was familiar. One insightful SDAT subject actually stated, "I think I said that word because it's familiar to me rather than because it was on the list. I'm not sure." Even with the maximum retrieval support afforded by recognition testing, they could not determine whether "apples" were encoded during the memory testing. They did, however recognize "apples" as an item that had been encoded in memory on previous occasions in their lifetime, and endorsed it, not as an item that was on the memory testing shopping list, but as an item that might be on a shopping list generally speaking. "Apples" were incorrectly recalled because they are a familiar item that is solidly maintained in memory. Whether apples were an item on the shopping list could not be recalled by SDAT subjects. While this type of false positive error could be made by anyone, this type of error would not normally be made more frequently than incorrectly endorsing words from the distractor list, List B. During recognition testing, the SDAT group endorsed items never mentioned during testing more frequently than items that were mentioned, and these results are inconsistent with typical errors made by nonclinical subjects.

Table 9

Means and Standard Deviations for the Following False Positive Errors Made by SDAT Subjects: List B - Shared, List B - Nonshared, and Neither List - Prototypical

Variable	N	Mean	S.D.
List B - Shared	22	59.09	34.11
List B - Nonshared	22	39.77	28.51
Neither List - Prototypical	22	67.05	28.23

Analysis of the last two categories of false positive error types yields more evidence the memory functioning is qualitatively different in clinical and nonclinical samples. The results presented in Table 10, reveal that for the SDAT group, the tendency was to respond "yes" to items that not only failed to be mentioned during testing, but items that were in no way related to items on the memory lists. Taken together with the analysis of the first three categories of false positive errors, we find that neither semantic or phonemic features assist in retrieving newly stored information by SDAT subjects due to irregular encoding of that information.

Table 10

Means and Standard Deviations for the Following False Positive Errors Made by SDAT Subjects: Neither List - Phonemically Similar and Neither List - Unrelated

Variable	N	Mean	S.D.
Neither List - Phonemically Similar	22	34.66	23.12
Neither List - Unrelated	22	51.14	33.39

Analysis of recognition testing adds a valuable piece of information in elucidating the defective process(es) responsible for the memory deficits in SDAT. Recognition testing is unique in that it provides maximum support for potentially-impaired retrieval processes. For these SDAT subjects, recognition testing failed to assist in correctly identifying target words. The fact that memory impairments persist under recognition testing conditions confirms that encoding rather than retrieval deficits are primarily responsible for memory dysfunction in SDAT.

20. Discriminability

Discriminability refers to the ability to distinguish correct items from incorrect or distractor items. A low discriminability score indicates that there is an impairment in differentiating correct items from incorrect items, and suggests that problems in encoding are responsible for the examinee's memory deficits.

The results presented in Table 1 reveal that SDAT subjects are significantly impaired relative to nonclinical elders in their ability to discriminate correct from incorrect information in memory. This inability to discriminate is a result of defective encoding mechanisms, where incorrect words are either not encoded into LTM or are encoded in a way that renders them inaccessible for later retrieval. This inability to distinguish correct from incorrect words explains the high rate of false positives, where the examinee responds "yes" to all words during recognition testing.

21. Response Bias

Response bias refers to the tendency to favor "yes" or "no" responses when the examinee is doubtful about the correct answer. The results reveal that SDAT subjects demonstrated a significant response bias relative to nonclinical elders. The box-plot presentation of the data in Figure 5 reveals that the SDAT group indicated a strong tendency toward responding "yes" to all items in recognition testing. For the SDAT subject, if the word was familiar (which most of the words on the list were) or if the word was one that might be found on a shopping list (which all of the words were), the SDAT subject responded, "yes" that the word was presented during the memory testing. In simple terms, SDAT subjects could not recall whether the word was on the memory test shopping list, because they could not locate it in memory due to irregular encoding. Therefore, they responded, "yes" to any word that might be on a shopping list, generally speaking.

Summary

The results of recognition testing reveal that SDAT subjects have difficulty discriminating between words that were presented as a part of memory testing and words that were not. In fact, they more frequently selected words that were never presented during testing than words that were presented during testing as incorrect distractors. Neither semantic nor phonemic retrieval cues assisted in locating the correct words in memory, which reveals that memory dysfunction in SDAT involves encoding processes. Newly acquired information could not be located in memory, either because it was not encoded or because it was encoded in some unrecognizable fashion. The fact that SDAT subjects cannot discriminate between correct and incorrect information relate to the fact that they cannot discriminate newly acquired information from previously acquired information. In keeping with these results, SDAT subjects made excessive false positive responses during recognition testing and demonstrated a "yes" response bias, which provides further evidence of their difficulty differentiating correct from incorrect information, due to impaired encoding of information.

Conclusion

The central research question asked in this study was: Is the memory deterioration in SDAT characterized by a failure in adequate encoding, retrieval or both, and how is it that these memory processes are impaired?

The fact that cued recall and recognition failed to accommodate the memory impairments of SDAT subjects, reveals that retrieval deficits do not explain the memory deterioration in this sample of SDAT subjects. Test results reveal that deficient encoding processes appear to be primarily responsible for memory impairments in SDAT, and that inadequate processing occurred in two main ways. Firstly, SDAT subjects generally did not transfer information into LTM for permanent storage. Instead they attempted to maintain information in STM through rehearsal of the information. Because of the limited capacity of STM, much of the information presented to them during testing was lost. Secondly, when information was encoded into LTM, it was done so in an ineffective manner based on sequence or some other irregular nonsemantic strategy, rendering the information inaccessible at the time of recall.

Error analysis reveals that more perseverative and intrusional errors were made by SDAT subjects than nonclinical elders. Intrusional errors are a manifestation of defective encoding processes and the tendency to maintain information in STM. After unsuccessfully searching for the correct information in LTM, the SDAT subject selected information from STM storage, which not only included rehearsed, correct information but other incorrect information that had entered the memory system during testing. Because the SDAT subject was unable to discriminate between newly acquired and previously acquired information, he/she risked selecting that information from STM that is in no way related to the memory testing--which is intrusional information.

With the deterioration of memory functioning well established, it should also be noted that the results of this study reveal that SDAT subjects can acquire new information in memory, if the information is repeated several times. However, relative to their nonclinical age-related peers the amount of information recalled is minimal and subject to many recall errors.

CHAPTER V

DISCUSSION

Discussion and Commentary on Results

Although there is considerable empirical support for memory impairments in SDAT, no clear consensus has emerged to support or refute the existence of a relationship between these noted deficits and any specific memory operation. The purpose of this study was to investigate how memory in SDAT is impaired in terms of particular memory structures and functions.

The theoretical approach for this study utilized the information processing model proposed by Atkinson and Shiffrin in 1968. The model assumes that information flow can be traced through several hypothetical stages or memory stores. The functional compartmentalization of memory into different components provides the most useful framework for the study of memory impairments by allowing for the assessment of specific components of memory. Using the information processing model, this study sought to determine whether the memory deterioration in early-stage SDAT is characterized by a failure in adequate encoding, storage or retrieval processes in both short-term (STM) and long-term memory (LTM).

The results of this study reveal that the degenerative process in SDAT, as presented by this sample, appears to disrupt the subject's ability to successfully encode new information into long-term memory (LTM). A closer analysis of the results reveals that encoding processes were compromised in two specific ways.

The first type of encoding deficit involved a basic failure to encode new information into LTM. SDAT subjects attempted to maintain information in short-term memory (STM) through constant rehearsal of the information, rather than transferring it into LTM for permanent storage. The disadvantages of attempting to maintain information in STM relate to both the limited capacity of STM, and the fact that STM is designed only for the temporary storage of information. Only a limited number of items can be stored in STM, and because the information presented to subjects in this study exceeded the limited capacity of STM, substantial losses of information resulted. Another disadvantage of attempting to maintain information in STM is that any information that was maintained in STM was highly subject to forgetting. Unless information was actively processed or rehearsed upon entering this store, it could remain there only for a matter of seconds, so any disruption of the rehearsal of the information resulted in a loss of this information. STM was not intended for long-term storage, and the basic failure of SDAT subjects to encode into LTM was one way that encoding processes were compromised.

Comments made by SDAT subjects during memory testing support the fact that SDAT subjects relied on STM storage of information and failed to encode information into LTM. After repeating three or four words from the list that they had rehearsed in STM and were therefore able to recall, one examinee stated that the other words from the list "just wouldn't stick." Other examinees stated that the list items "disappeared" or "slipped away" from their memories. These examinees appear to be describing the fading of memory that occurs if information is not transferred into permanent LTM storage. Another examinee stated, "As I say one word I forget the next word I wanted to say." This SDAT subject was attempting to maintain information in STM through active rehearsal of that information. However, when rehearsal is interrupted and the information has not been transferred into LTM, the information is lost.

A second encoding deficit identified by test results related to situations in which SDAT subjects did attempt to encode information into LTM, and involves how information was encoded. Decades of research into memory processes supports the fact that the organization of information in memory relates to recall success. In this study SDAT subjects organized and encoded information in LTM in a different, less effective way than nonclinical elders. SDAT subjects tended to encode information into LTM in the same order that the information was presented, rather than encoding information based on meaning or semantic significance. This irregular and ineffective encoding of information into LTM rendered the information inaccessible at the time of recall. Recall consistency also suffered as a result of haphazard organization of information in memory.

During memory testing in this study, the information that was most likely to be recalled by SDAT subjects was the information that was most recently presented, with information from the beginning and middle of the list poorly recalled. This pattern of serial-position recall is different from what occurs in nonclinical elders for whom there is maximum recall for words at the beginning and end of the list. Words at the beginning of the list (primacy region) are more likely to be recalled because they are subject to rehearsal, which aids encoding into LTM. Words at the end of the list (recency region) are also more easily recalled because they can be reported directly out of STM without being further encoded. The fact that SDAT subjects recalled a greater proportion of words from the recency region demonstrates a reliance on STM. This reliance on STM occurs as a result of impaired ability to encode information into LTM. This finding is consistent with Pepin and Eslinger (1989), who found a progressive fading of the primacy effect with the increasing severity of the dementia. They interpret their results as evidence that the degenerative process of SDAT disrupts the subject's ability to "apply an active learning strategy" to transfer information into LTM. Ober, Ross, Friedland, and Delis (1985) also found that mildly-impaired SDAT subjects recalled only recently presented information, thus demonstrating a reluctance to encode information from STM into LTM. Ober et al. (1985) also found this trend to vary depending on the severity of the dementia.

Analysis of the types of recall errors made by SDAT subjects further supports that fact that encoding deficits appear to be primarily responsible for the general memory impairment in SDAT. SDAT subjects made significantly more perseverative (repetitions of previous responses) and intrusion (responses not on the correct list) errors than their nonclinical counterparts. These results are consistent with those of Fuld, Katzman, Davies, and Terry (1982), who first suggested that intrusions are typical of SDAT. Shinder, Caplan, and Hier (1984) describe the mechanisms underlying the occurrence of intrusion errors in terms of a four-stage process: the subject initiates an unsuccessful search throughout LTM for the correct word, he/she then selects from STM a recently heard word, and then after failing to inhibit the correct word, the incorrect word is emitted. The SDAT subject could not locate the correct word in memory either because it was ineffectively encoded in LTM or was not encoded in LTM at all. A word was then selected from STM which was either a correct word that was maintained through rehearsal, or an intrusion response, which was in no way related to the memory testing, but was a word recently mentioned or thought of. These results, as well as the explanation provided by Shinder, Caplan, and Hier (1984) substantiate the notion that encoding deficits are primarily responsible for memory impairments in SDAT. Information is either not encoded into LTM at all, or is encoded in a way that it cannot be located for retrieval at the time of recall.

The results obtained in this study have also illustrated that retrieval processes are not significantly impaired relative to nonclinical elders. To isolate retrieval processes, this study compared free recall performance, cued recall performance, and recognition performance (Delis, Kramer, Fridlund, & Kaplan, 1990). Each of the recall conditions differ in their retrieval demands, with free recall placing the greatest demand and recognition placing the least demand on retrieval mechanisms. Markedly better performance on recognition than on cued- or free recall, or better performance on cued recall than on free recall would indicate more of a retrieval than encoding problem. The results of this study failed to find any significant improvement in performance under cued recall or recognition conditions, which suggests that the memory deficits noted in this sample of SDAT subjects are not attributable to impaired retrieval processes.

Further findings contraindicated proactive and retroactive interference in contributing to memory dysfunction. A time delay of either short or long (20 minutes) duration also failed to negatively impact memory performance. Neither interference with memory functioning nor time delays exacerbated memory impairments, given that the memory deficiency in SDAT is in the basic encoding of information into memory, rather than in factors extraneous to this process.

The findings of this study have demonstrated support for the existence of an encoding deficit in mild-moderately demented SDAT subjects, and have revealed information about this processing deficit that had, to date, been largely unstudied and misunderstood. However, much is still unknown about the nature of the memory deterioration, and more specifically the nature of the encoding deficit, and accordingly, continued investigations are warranted. The results presented in this study require further examination, and given the tremendous disability that results from SDAT, further research in this area should be given serious attention.

Implications for Further Research

Methodological inadequacies, particularly regarding accuracy of SDAT diagnosis and identification of disease severity, have plagued past research in this area. First, regarding diagnostic issues, patients with apparent memory impairments are by no means restricted to those suffering with SDAT. Dementias themselves result from a variety of etiologies and as such may well produce different patterns of dysfunction, emphasizing the importance of accurate diagnosis. This is not a simple task as it demands information from a range of sources together with skills of experienced medical and neurological clinicians. A second important variable in studying dementia is that of disease severity. SDAT is typically progressive, developing from a pattern of initial deficits that may possibly be quite specific to one of massive and general deterioration. Several studies (Pepin & Eslinger, 1989; Vitaliano, Breen, Albert, Russo, & Prinz, 1986; Ober et al., 1985) have found that the specific nature of the memory deficit in SDAT varies with disease severity, which suggests that all patients with this disease cannot be considered a homogeneous group, but rather must be distinguished in terms of the stage, and thus, severity of the disease. Further to this, severe cases are likely to show decrements on virtually any test used and, indeed, are likely to have great difficulty in even understanding instructions. Such cases are unlikely to provide insight into the detailed nature of the underlying psychological deficit, and for that reason studies are likely to be more informative if they focus on subjects at early stages of the disease.

It should also be recognized that a discussion of the changes in memory associated with SDAT cannot proceed without a recognition of normal age-related changes in memory. It is necessary for research studies in the area of memory deficits in SDAT to include a comparison group consisting of appropriately matched nonclinical elders to obtain information regarding the memory declines attributed to normal aging, demonstrated under identical testing conditions.

The results of this study have served to begin elucidating the nature of the memory dysfunction in SDAT. The results have demonstrated that an encoding deficit is primarily responsible for general memory impairment in mild-moderate SDAT. Information is either not encoded into LTM at all, or is encoded in a way that it cannot be located for retrieval at the time of recall.

Based on these results, investigations of encoding processes in SDAT and how these processes deviate from conventional encoding of information would be valuable to further elucidate the specific nature of the encoding deficits evident in SDAT. Wilson, Bacon, Kramer, Fox, and Kaszniak (1983) have suggested that patients with dementia often fail to encode important features of verbal material to be remembered, and that this defect in initial processing contributes to their subsequent poor recall on memory tasks. Future research needs to focus on what important features are neglected when SDAT subjects encode information and on the basis of what characteristics information is encoded. Further investigation is required to determine how ineffective encoding strategies gradually replace effective encoding strategies as part of disease progression.

This study revealed that SDAT subjects ignore semantic significance of information to be remembered in favor of the sequence of the information. These results are consistent with findings reported by researchers in the past (Craik & Simon, 1980; Smith, 1980), who found that age alone, plays a factor in how information is encoded. Based on their research findings, Craik and Simon (1980) proposed that older people fail to process information as "deeply" as their younger counterparts. It has be proposed that aging alone, possibly involves a breakdown of the process whereby information is encoded based on deeper semantic features. Perhaps the deterioration of encoding processes in SDAT is a quantitative extension of normal aging processes. Longitudinal studies focusing on encoding processes from first diagnosis of the disease may be valuable in tracing how encoding processes gradually deteriorate with disease evolution.

Based on the results of this study, investigations of ways to facilitate or accommodate encoding deficits in this population are important. How amenable are the encoding deficits to external manipulation and facilitation? Dick, Dean, and Sands (1989) attempted to determine whether SDAT subjects can be assisted to encode information more effectively. They provided SDAT subjects with "optimal conditions for effective encoding to occur" in order to reduce the processing demands inherent in encoding information into LTM. Their results revealed that all efforts to facilitate encoding operations were unsuccessful.

In other studies "orienting" or "priming" procedures, where subjects are given particular strategies to enable them to enter information in memory, have been incorporated to facilitate impaired encoding processes by inducing deeper levels of encoding (Simon, Dixon, Nowak, & Hultsch, 1982). Nebes, Martin, and Horn (1984) used orienting and priming tasks to provide insight into the encoding of information in memory in SDAT. In their study, a semantic-priming paradigm was used to examine whether the impaired encoding processes in SDAT could be facilitated by a "semantic prime", which involved preceding the word to be remembered with a word of similar meaning. Researchers measured the amount of time subjects took to name aloud a visually presented word which was preceded half of the time by a semantically associated word and half of the time by an unassociated word. Both associated and unassociated primes were randomly intermixed throughout the list. Results of both demented and nondemented groups revealed a positive priming effect; that is, their word-naming latency was shorter when the word was preceded by a semantically associated item than when it was preceded by an unassociated item. The presence of normal semantic priming in the demented patients suggests that the ability to effectively encode information in memory is at lease grossly intact, and that experimental manipulation can be used to maximize encoding potential. Further research of this type would prove valuable in elucidating the nature of the encoding impairment in SDAT, and how amenable these impairments are to facilitation. Any success in facilitating impaired encoding in SDAT will have direct relevance for intervention approaches by caregivers.

Clinical Implications

Psychological investigations into the memory processes of Alzheimer patients may not lead directly to a cure for the disease, but their contributions are nonetheless valuable. Attempting to elucidate "what" exactly it is in memory that is impaired and "how" exactly the process or structure is defective is the key to the early diagnosis of SDAT. Based on discoveries of deteriorative memory processes that differentiate SDAT from other dementing illnesses such as Multi-infarct Dementia and Korsakoff's Disease, and from normal aging processes, more sensitive diagnostic measures are developed. Early diagnosis allows for retraining using preserved cognitive abilities to accommodate impairments to minimize the dysfunction experienced. For example, knowing that individuals with SDAT often fail to encode information semantically, they may benefit from "orienting" or "priming" techniques where the information to be remembered is associated with something already familiar and already encoded in memory.

Implicit in the results of psychological investigations into memory deficits in SDAT are suggestions as to how family members and other caregivers may accommodate these deficits at early stages of the disease progression. For example, the results of this study reveal that repetition does maximize the amount of information that someone with SDAT recalls. Generally in conversation we present information only once. However, with individuals with SDAT two or three repetitions of the information is required for recall.

Another way that "regular" conversation should be modified to accommodate memory deficits in SDAT is in the amount of information that is presented. Persons with SDAT cannot be expected to recall large amounts of information. Research results reveal that they tend to recall only the most recently presented information and forget the rest. This means that if you tell a person with SDAT that you are going shopping and then tell them that the car needs repairs, by the end of the conversation they will have forgotten where you said you were going. Short, brief statements will be best recalled.

Other processing deficiencies in SDAT can also be accommodated by caregivers. The results of this study revealed that SDAT subjects failed to encode information into LTM in favor of constantly rehearsing information in STM. Rather than attempting to maintain information in STM, which only stores information temporarily, SDAT subjects can be coached to write the information down, so that if it is lost from memory it can be preserved on paper. It would be useful for people with SDAT to carry a small notepad for this specific purpose, given that small scraps of paper can easily be misplaced.

Given the findings presented and the knowledge we have to this point attained, family members and other caregivers can be trained to adapt to the memory impairments identified in SDAT. These strategies will not only assist people with SDAT to function at their optimal levels, but will reduce the frustration experienced by both people with SDAT and their caregivers.

Concluding Statement

Memory problems are among the first as well as the most disabling of the cognitive deficits in SDAT. Much remains unknown regarding the complexity of memory deterioration in SDAT, and therefore, this study has attempted to elucidate the nature of the memory impairments. The results of this study demonstrate that encoding processes appear to be primarily responsible for memory deficits in SDAT. Information is either not encoded into LTM at all, or is encoded in a way that it cannot be located for retrieval at the time of recall. Excessive intrusion errors are a manifestation of deficient encoding operations.

As researchers continue to investigate the memory deterioration in SDAT it is hoped that a clearer picture of the specific nature of the memory changes observed in early stages of SDAT will be obtained. Clinical tests employed in this research must address the complexity of memory processes by quantifying the numerous cognitive components of memory. Measurement instruments need to assess how learning occurs or fails to occur, in addition to measuring the amount of material learned. Error analysis is one aspect of memory measurement that should not be neglected, given the evidence suggesting that intrusion errors may be pathognomic of SDAT.

It is hoped that with a better understanding of the specific memory changes involved in early-stage SDAT that earlier diagnosis and treatment can occur. Information regarding memory deterioration in SDAT can also be used to help family members and other caregivers intervene in a way that minimizes memory defici and preserves functional at optimal levels. It is only with greater knowledge and understanding that we can enhance levels of functioning, and ultimately improve the quality of life of people with SDAT.

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Appendix A

Clinical Interview Questionnaire

CLINICAL INTERVIEW QUESTIONNAIRE

The following questions will be asked in determining the clinical history of the dementia ie.) onset, duration, progression, and fluctuation of symptoms. The history will be taken from a competent relative or someone who has been in close contact with the DAT patient.

1. When did you first notice changes in the patient? (How long ago?)
2. What was the first sign?
3. What happened next and when?
4. Would you describe the onset as gradual or sudden?
5. When was it first diagnosed by a doctor?
6. What was the diagnosis?
7. Do you remember what tests were done? (Ask specifically about CAT Scan and its findings).
8. What drugs have been prescribed for this condition?
9. What are the current medications the patient is taking?
10. Has the course of the disease been gradual or stepwise?
11. Has the patient had any surgeries in recent years?
12. Has the patient had any head injuries in recent years?
13. Has anyone else in your family had a problem like this?

Appendix B

Onset, Progression, Duration, and Fluctuation of Memory Problems in Various Disorders

ONSET PROGRESSION, DURATION, AND FLUCTUATION OF MEMORY PROBLEMS IN VARIOUS DISORDERS

Zarit, S., Orr, N., and Zarit, J. (1985)
The hidden victims of Alzheimer's Disease: Families under stress
N. Y.: University Press.

	DAT	MID	Delerium
A. Onset	Insidious	Sometimes sudden	Usually sudden
B. Duration	Months or years	Months or years	A few days or weeks
C. Progression	Gradual	Step-wise	Prodromal symptoms become severe in a few days
D. Fluctuations	Little fluctuation, usually worse at night	Some daily,even from hour to hour	Can be extreme

	Focal Brain	Depression	Normal Aging
A.Onset	Sudden, associated with brain trauma often abrupt	Coincides with life changes; onset changes; no specific aging pattern	Reactions to normal life
B. Duration	Dates from incident	Several months or years	
C. Progression	Not progressive	Not progressive	Minimal change over long periods of time
D. Fluctuations	Little	Typically worse in the morning	Mild situational fluctuation

Appendix C

Clinical Dementia Rating

CLINIC DEMENTIA RATING

Impairments in each category
are scored as 0.5, 1, 2, 3 according to level of impairment

	Healthy CDR 0	Questionable Dementia CDR 0.5	Mild Dementia CDR 1	Moderate Dementia CDR 2	Severe Dementia CDR 3
Memory	No memory loss or slight inconsistent forgetfulness	Mild consistent forgetfulness; partial recollection of events; "benign" forgetfulness	Moderate memory loss, more marked for recent events; interferes with everyday activities	Severe memory loss; only highly learned material retained; new material rapidly lost	Severe memory only fragments remain
Orientation	——fully oriented——		Some difficulty with time relationships; oriented for place and person but may have geographic disorientation	Usually disoriented in time, often to place	Orientation to person only
Judgment and Problem Solving	Solves everyday problems well; judgment good in relation to past performance	Only doubtful impairment in solving problems, similarities, difficulties	Moderate difficulty in in handling complex problems; social judgment usually maintained	Severely impaired in handling problems, similarities differences; social judgment usually impaired	Unable to make judgments or solve problems

Clinical Dementia Rating (CDR) Continued

	Healthy CDR 0	Questionable Dementia CDR 0.5	Mild Dementia CDR 1	Moderate Dementia CDR 2	Severe Dementia CDR 3
Community Affairs	Independent function at usual level in job, shopping, business and financial affairs, volunteer and social groups	Only doubtful or mild impairment, if any, in these activities	Unable to function independently at these activities though may still appear normal to casual inspection	No pretence of independent function outside of the home	
Home and Hobbies	Life at home, hobbies, intellectual interests well maintained	Life at home intellectual interests well maintained or only slightly impaired	Mild but definite impairment of function at home; more difficult chores or hobbies abandoned	Only simple chores preserved; very restricted interests	No significant function in home outside of own room
Personal	Fully capable of self care		Needs occasional prompting	Requires assistance in dressing, hygiene, keeping of personal effects	Requires much help with personal care; often incontinent

Appendix D

Results of Reliability Testing of the Clinical Dementia Rating

RESULTS OF RELIABILITY TESTING OF THE CLINICAL DEMENTIA RATING

Score	% Agreement	Weighted K*	Kendall K*	Tau B Correlation *
Overall Clinical Dementia Rating	80	74	87	91
Memory	84	80	88	92
Orientation	88	84	91	93
Judgment and problem solving	68	58	75	84
Involvement in community affairs	88	84	92	95
Involvement at home and in hobbies	88	85	94	95
Personal care	80	67	83	85
Sum of boxes	36	31	87	90+

* All significant at P< .00001.
+ Significant at P<.0001.

Appendix E

Informed Consent

INFORMED CONSENT

As outlined in the Canadian Code of Ethics for Psychologists, the process of obtaining informed consent ensures that the following points are understood by the research participants: "(the) purpose and nature of the activity, mutual responsibilities, likely benefits and risks, alternatives, the likely consequences of non-action, the option to refuse or withdraw at any time, over what period of time the consent applies, and how to rescind consent if desired" (point #17). Every effort was taken to ensure that subjects were informed in all of these areas prior to obtaining written consent. In cases with the DAT group where the Court had appointed a guardian due to mental incompetency, the appointed guardian was sought to provide informed consent consistent with point #24 of the Canadian Code of Ethics for Psychologists regarding vulnerable populations.