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MEMORY DEFICITS AND PSYCHOMOTOR SLOWING IN AIDS DEMENTIA COMPLEX PATIENTS

by

RUTH ELISE STEINMAN

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

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Abstract

MEMORY DEFICITS AND PSYCHOMOTOR SLOWING IN AIDS DEMENTIA COMPLEX PATIENTS

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RUTH ELISE STEINMAN

Adviser: *Dr. Martin Chodorow*

Experiments were performed to determine the extent of psychomotor slowing and memory deficits indicative of a dementing process. The groups compared were 10 patients diagnosed with probable AIDS Dementia Complex (ADC) and 10 undergraduates, who served as controls. Three reaction time tasks were used - simple, choice, and complex (Sternberg's short-term memory scanning). Explicit and implicit memory tasks were also examined to look for differences between the two groups. These included recall, stem completion (priming), and recognition. Results for the simple and choice RT tasks indicated a significant effect of task but not of group, although there was a trend in the direction of longer times for the ADC patients. Notably, there was no interaction between task and group. The memory scanning results showed a significantly higher Y-intercept for the ADC patients, which was interpreted as psychomotor slowing, and a steeper slope for the YES trials, which indicated dementia. Materials for the explicit and implicit memory tasks consisted of seven-word lists of abstract and concrete nouns presented auditorily and visually. A measure of free recall showed a main effect for group (ADC recall was lower than Control), as well as for Concreteness, Modality, and Position, but there

were no interactions between group and the other variables. For the recognition measure, another explicit memory task, there were no significant main effects or interactions, indicating a relative sparing of encoding in the ADC group. Combined with the recall results, the pattern suggests that the deficit is primarily in retrieval, rather than encoding. The ADC patients showed significantly less priming in the stem completion task compared to the Controls. This result contrasts with those reported in the literature for Korsakoff's, amnesics, and depressives. The set of tasks used here and the materials specifically designed for this study proved to be valuable in the determination of dementia and should therefore be included in a battery to test mental status, especially when testing time is limited.

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MEMORY DEFICITS AND PSYCHOMOTOR SLOWING IN AIDS DEMENTIA COMPLEX PATIENTS

Ruth Elise Steinman

I. INTRODUCTION

Statement of Research Questions and Their Rationale

The purpose of this dissertation is to study short-term memory functions and psychomotor slowing in individuals with AIDS Dementia Complex (ADC) resulting from the Human Immunodeficiency Virus (HIV). One objective of the project is to add to the development of a battery of psychological tests that may be able to distinguish demented HIV positive (+) patients from those with unipolar depression. Once the pattern of cognitive deficits in ADC is known, it can then be compared with those reported for Alzheimer's disease, Huntington's disease, and other dementias.

The following kinds of questions are addressed in this study: Do ADC patients perform differently from normal controls in tests of processing speed and short-term memory? Will differences also be found in measures of memory encoding and retrieval? Are the deficits restricted to explicit memory, or do they also appear in tests of implicit memory?

II. BACKGROUND

The Aids Dementia Complex

The AIDS Dementia Complex (ADC) was described by Navia, Jordon and Price (1986) as a combination of motor, behavioral, and cognitive deficits found in persons with AIDS for which there is no other available physiological explanation. These authors describe ADC as "the preeminence of progressive cognitive impairment

in the absence of impaired consciousness usually evolving over weeks to months, along with antecedent or accompanying motor or behavioral disturbances". The existence of these three major spheres of dysfunction - cognitive, motor, and behavioral (affective) - is the basis for the term AIDS Dementia Complex to describe the constellation of symptoms. From their autopsy study, Navia, et al. estimated the rate of dementia as two-thirds in preterminal AIDS patients, while at the time of the AIDS diagnosis only one-third had a severe form of dementia.

In 1993, the definition of AIDS dementia was changed to include terms like "possible" and "probable" dementia. The American Academy of Neurology AIDS Task Force altered the definition by giving emotional lability less weight than it had in previous definitions. They used terms like "HIV-1 associated minor cognitive/motor disorder." The group stated that neuropsychological tests are not enough by themselves to diagnose dementia, and they added a range of mild, moderate, and severe dementias to the list. Also, a new criterion for having AIDS was the subject's T-4 cell count.

ADC and Other Dementias

ADC is referred to as a "subcortical" dementia to be distinguished from the "cortical" dementias (e.g., Alzheimer's and Jacob-Creutzfeldt disease) (Cummings & Benson, 1984). Although the issue of whether or not there are two sorts of dementing illnesses (cortical vs. subcortical) is still being debated (Whitehouse, 1986), ADC is considered a subcortical-type dementia (Oechsner, Moller & Zaudig, 1993). Other examples of subcortical dementias include Parkinson's and Huntington's disease and Progressive Supranuclear Palsy. The terms cortical and subcortical are not used

as strict physiological labels of the site of brain damage, rather, they are used to describe two distinct clinical pictures of dementia that are beginning to emerge. "Subcortical dementia is a clinical, not an anatomical concept" (Cummings & Benson, 1984). The cortical dementias typically have language difficulty (aphasia) and amnesia as salient features, with relatively normal response time, gait and posture. The subcortical dementias, on the other hand, are characterized by motor deficits, mood, slowed processing time, forgetfulness (rather than amnesia) and a lack of severe language problems.

Even though the term subcortical dementia does not refer strictly to subcortical pathology, the most common loci of brain damage in ADC are the subcortical structures. These structures include the deep white matter, basal ganglia, thalamus, and brain stem (Navia, Jordan & Price,1986). The virus can be isolated from the brain, spinal cord and Cerebrospinal fluid (CSF), but these measures are not always consistent with the occurrence or severity of dementia. The most widely used measure of immune status, the number of T4 helper cells, is also not consistently related to the existence or severity of dementia. Patients with ADC usually do have low T cell counts, but many AIDS patients without dementia also have low T cell counts. Researchers are beginning to classify different types of brain pathology found in demented patients, and they have found three major types: macrophage and multinucleated cell infiltrates, white matter pallor, and vacuolar myelopathy of the spinal cord (Price & Brew,1988). Frequently, there is ventricular enlargement and cerebral atrophy in AIDS patients. One study combined behavioral measures with a Magnetic Resonance Imaging brain scan and found a correlation between increased amounts of CSF and slowed Reaction Time (RT). In other words, subjects with more

brain atrophy also performed more slowly on a RT task (Levin, Williams, Boruki et al., 1990). As more is learned about the anatomical and physiological substrates of ADC, the behavioral results obtained from neuropsychological test batteries will be useful to correlate the different symptom complexes of ADC with specific pathologies.

ADC and Depression

The symptoms of ADC include: cognitive disorders (short-term memory deficits, decreased attention and concentration, retrieval difficulties and psychomotor retardation); affective disorders (apathy, depressed mood, and social withdrawal); and neurological and motor disorders (seizures and ataxia) (Fernandez, 1989). Many of these symptoms are also typical of major depression (unipolar), thus making a definitive diagnosis difficult until the dementia has progressed towards the end stage (Ostrow, Grant & Atkinson, 1988). Symptoms of depression overlap with the problems often seen in AIDS and AIDS Related Complex (ARC) patients, such as sleep and eating disorders, apathy and withdrawal, and slowed response time and psychomotor speed. Many HIV+ patients are depressed about their serostatus and its effect on their lives. Besides psychological factors, there is also the risk of direct brain infection (Ho, Rota, Schooley et al., 1985) being responsible for some of the depression-like symptomology that has been reported (Oechsner, Moller & Zaudig, 1993; Van Gorp, Miller, Satz, & Visscher (1989).

The literature on Alzheimer's disease is filled with examples of what is called pseudodementia (Niederehe, 1982). Pseudodementia is a common form of depression that mimics dementia. Since depression itself results in some degree of cognitive

impairment, it is sometimes difficult to tell these two diseases apart. In many ways, this study seeks to replicate the attempt to disentangle the subcortical dementias from depression, much in the same way that the pseudodementia literature attempts to separate cortical dementias from depression.

As noted above, the symptoms of dementia and depression overlap (Ostrow, Grant & Atkinson, 1988), and many of the commonly used neuropsychological tests have not been able to detect the difference between the two syndromes (Van Gorp, Miller, Satz, & Visscher, 1989; Fitzgibbon, Cella, Humfleet, Griffin & Sheridan, 1989). However, a short-term memory scanning task, the Sternberg procedure (Sternberg, 1966, 1975), has been tested in demented patients, and the results have shown that the behavior of the two groups is qualitatively different from one another (Hart & Kwentus, 1987; Hart, Kwentus, Leshner & Frazier, 1985). The questions addressed in this study are: Do ADC patients perform differently from non-demented controls in tests of short-term memory? If so, does their performance also differ from that of reported for depressed patients? Will differences appear only in tests of processing speed, or will they also be found in measures of memory encoding, capacity, and retrieval?

The Importance of Differentiating ADC from Depression

In the past few years, there has been much debate about cognitive impairment in HIV infected individuals who have not yet developed serious illness. Some researchers (Grant, Atkinson, Hesselink et al, 1987) have found that 44% of asymptomatic patients have deficits, while others (McArthur, Cohen, Selnes et al., 1989) have found no significant cognitive impairment (Power, Selnes, Grim & McArthur, 1995). Oechsner, Moller & Zaudig, (1993) found ranges of dementia

from 6 to 66% summing up other researchers' work. The capabilities of those with more advanced stages of the disease have not been established uniformly, and the best method of assessment is on an individual basis. Although the frequency of frank dementia in asymptomatics is low (Sidtis & Price, 1990), the incidence of ADC in ARC patients is unknown (Janssen, Saykin, Cannon, et al., 1989). Therefore, it is crucial that tests which differentiate dementia from depression be investigated for their future application to groups at risk for an early dementia.

One reason it is important to be able to tell if an HIV+ patient is suffering from dementia, depression, or both, is because the treatment for the two syndromes is different. The treatment possibilities for a depressed HIV+ patient include various methods of group or individual therapy, electroconvulsive shock, and/or drug therapy. However, the drugs commonly used to treat depression can have untoward side effects (i.e., anticholinergic toxicity) in HIV+ patients, and must be used with caution. Furthermore, the new class of protease inhibitors cannot be taken with many commonly used psychiatric medications.

As the epidemic continues and larger numbers of HIV+ asymptomatic patients progress toward more severe stages of disease, methods for detecting early cognitive dysfunction will be much in demand. Before diagnostic procedures can be used in patients with earlier stages of HIV infection, we must first ascertain their applicability and ability to distinguish between depression and dementia (Kovner, Perecman, Lazar, Hainline, Kaplan, Lesser, & Beresford, 1989). It is important to look at the end-stage disease in AIDS, to see, for example, if there is increased scanning time in dementia, but not depression. If the findings of other researchers hold true, then future testing can be expanded to include groups in which diagnosis is uncertain, with the hope that this technique could add to the battery of tests that would enable a more definitive diagnosis and treatment regimen.

III. OVERVIEW

In addition to the practical importance of being able to distinguish ADC from depression, it is also of theoretical importance to compare ADC to other forms of dementia. Commonalities and differences in the abilities of patients with various diseases can provide valuable information about the nature of cognition and memory as these systems deteriorate and fail. Specifically, in this dissertation, ADC is assessed by some tests which measure psychomotor speed and by others which measure short term memory encoding and retrieval. The former are based on reaction times and the latter on response accuracy. Results will be compared to those of normal controls and to findings reported in the literature in studies of depression and of subcortical and cortical dementia. In a number of cases, there are gaps in the literature where it is not yet known how a patient population would perform on a type of test. Future work should be directed at filling in these missing pieces of the research picture.

IV. MEASURES OF REACTION TIME: SIMPLE REACTION TIME, CHOICE REACTION TIME, AND MEMORY SCANNING TIME

Reaction Time Tests

It has been suggested that in studying ADC, a neuropsychological battery should include timed, psychomotor tasks, as these seem to be the most sensitive to mental deterioration. Lundervold, Karlsen, and Reinvang (1994) studied four types of subcortical dementia using tests that included measures of verbal ability, verbal memory, visuospatial ability, visuospatial memory, digit span, and motor speed and function. It was the motor tests that most consistently showed differences between the patient groups and a normal population. Bloom (1991) describes the use of the RT measure as "the most sensitive behavioral indicator of Central Nervous System dysfunction and [it] may prove to be useful for quantifying the presence and progression of HIV-related Central Nervous System disease."

Perdices and Cooper (1989), Levin, Williams, and Boruki (1990), and Martin, Sorensen, Edelstein, and Robertson (1992) have shown significant slowing on simple and/or complex RT tasks in AIDS patients. In the simple RT task, participants are instructed to press a response key as quickly as they can when they see a visual target. In many experiments, this is a brightly colored square (e.g., red or green) on a black background. The complex (or choice) RT task can take a number of different forms. Martin et al. (1992) assigned one key to a square of one color (e.g., red) and a different key to a square of another color (green). Perdices and Cooper (1989) used a go/no-go procedure for their complex task. Subjects saw letter trigrams and were instructed to press a response key if the letters were consecutive in the alphabet (e.g., GHI) and to refrain from pressing if they were not (FLQ). The results of these studies have shown in simple RT tasks either no difference between AIDS patients and controls (Perdices and Cooper, 1989) or a small but significant slowing for the AIDS group (Martin et al., 1992). However, on the complex RT tasks, much larger differences are usually seen between the groups, resulting in significant group X task-difficulty interactions (but cf. Bornstein, Nasrallah, Para, Whitacre, Rosenberger, & Fass, 1993; and Worth, Savage, Baer, Esty, & Navia, 1993). Researchers have interpreted the larger RT difference found with complex tasks to be an indication of dementia (e.g., as in early Alzheimer's disease; Ferris, Crook, Sathananthan, & Gershon, 1976). Martin, et al. (1992) reported that symptomatic HIV+ patients show a greater increase in their complex task RT than asymptomatic ones. They also found that simple RT was correlated with depression scores but complex RT was not.

As noted above, simple and choice RT tasks have been used to study the effects of dementia and depression, but these tasks can differ markedly in the demands they place on the subject. This makes it particularly difficult to interpret differences across tasks. What would be greatly preferred is a single procedure for distinguishing the two syndromes. A short-term memory scanning task has produced

results which show that the behavior of demented patients and depressed patients is indeed qualitatively different.

The short-term memory scanning task was developed by S. Sternberg in 1966 and has since been used in a variety of clinical and experimental research settings. Participants are given a list containing from one to six items (e.g., digits) to memorize. Then they are shown a single digit, the probe. The task is to decide if the probe was, or was not, a member of the memorized set, and to press a "YES" or "NO" key accordingly as quickly as possible. Sternberg has shown that a linear relationship exists between the set size (the number of items in the memorized set) and reaction time to press the key. There are two important measures taken from the results of the regression line used to fit the data, the Y-intercept (the extrapolation of a set size of zero) and the slope of the function (the rate of increase in RT as set size increases). By estimating where the function crosses the Y-intercept, we have a measure of the time to scan zero items, i.e. the sum of the encoding/decision/motor response stages, without including the mental scanning stage. The slope of the function represents the time for the serial comparison of the probe to each of the items in the memory set, and is thus representative of pure mental scanning speed. The theory upon which the paradigm is based is called the additive factors method, which states that a complex task can be broken down into serial and additive substages that can be manipulated separately.

In order to focus on the symptoms common to both depressed and demented patients, Sternberg's paradigm is quite useful. It features both mental scanning of short-term memory and also the use of timed motor responses. While other reaction time tasks often confound mental and motor components, the Sternberg technique allows for the separation of mental scanning speed from non-scanning components. Therefore, this particular paradigm may be able to separate the motor/encoding

deficits found in a mental illness such as depression from the combined motor and cognitive slowing seen in dementia.

Researchers (Hilbert, Niederehe & Khan, 1976; Glass, Uhlenhuth, Hartel et al., 1981) have shown that depressed patients exhibited slowed encoding/decision/motor response stages (as measured by an increased Y-intercept), but that their rate of central information processing was not impaired (the serial scanning rate as measured by the slope of the function). Also, patients with "subcortical dementia" have shown an increase in their Y-intercept as well as increased scanning rates (an increased slope). These include Frederich's Ataxia, Parkinson's (Wilson, Kaszniak, Klawans & Garron, 1980), and Multiple Sclerosis patients (Rao, Aubin-Faubert & Leo, 1989). Those with Korsakoff's syndrome (Cermak, 1977), aphasics (Swinney & Taylor, 1971), and mental retardates (Phillips & Nettleback, 1984; Mosley, 1985) have also shown increased scanning rates, but are not considered to be subcortically demented groups. Boaz and Denney (1993) found steeper slopes and increased Y-intercepts in cases of mild Alzheimer's disease compared to normal elderly and young controls. Alzheimer's is often considered a prototypical "cortical dementia".

Recently, the Sternberg paradigm has been used to study cognitive impairments in asymptomatic HIV+ patients (Wilkie, Eisdorfer, Morgan, Lowenstein & Szapocznik, 1990) and those with full blown AIDS (Hart, Wade, Klinger & Hamer, 1990). The study that used the asymptomatic HIV+ group reported an increased Y-intercept (like that typically exhibited by depressed patients) without evidence of any slowing found in their mental scanning speed (the slope of the function). One flaw in this study is that it was conducted within six months of diagnosis of HIV serostatus. Therefore, the results (the Y-intercept increase), may have been contaminated with the data of patients who experienced a period of reactive depression during the testing period. Another study using the Sternberg task showed

a general increase in the intercept, but not a slope increase (Shor-Posner, Morgan, Wilkie, Eisendorfer & Baum, 1995).

The results from the Hart, et al. (1990) study using AIDS patients did show an increased slope in non-demented patients both on and off AZT, with those not taking AZT performing worse than those taking the drug. There was no correlation between increased slope and depression in these patients. One case report (Hart, Wade & Klinger, 1988) of a demented patient showed an enormous increase in slope (about fifty times a normal slope and five times more than the AIDS patients off AZT). This particular patient's scanning rates were also much slower than any other group of subcortically demented patients.

Two types of RT tests are included in the research battery presented below. One is based on simple and choice reaction time. In line with previous studies of depression and dementia, it is predicted that ADC patients will take significantly longer to perform the choice task than normal controls. The second type of test is the Sternberg short-term memory scanning paradigm. Here the prediction is that both the intercepts AND the slopes of the ADC group will be greater than those of the control group. Higher Y-intercepts would reflect psychomotor slowing, consistent with dementia and depression. Steeper slopes would suggest a reduced rate of central information processing in accessing short-term memory, an indication of dementia.

V. EXPERIMENTS

Participants

These experiments use a randomized groups design, with one group of ten ADC patients and the other of ten controls. Nine of the controls were White and one was Hispanic. Five of the ADC patients were White and 5 were African-American or Hispanic. All were native speakers of English or were English-fluent bilinguals. The control group consisted of Hunter College students enrolled in an undergraduate psychology course who volunteered to participate without pay. The ADC patients

were being treated in the Psychiatric Unit at the Roosevelt site of the St. Luke's/Roosevelt Hospital Center in New York City. Each had received a Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R) diagnosis of dementia by a staff psychiatrist. Because the patients had to be healthy enough to sit through a half hour of testing, any patients who exhibited the most severe form of dementia were excluded from the study. Therefore, only mild and moderate cases of ADC were tested, stages I and II according to the staging system developed by Price and Brew (1988). All testing of the patients was performed in a quiet room in physicians' private offices; the controls were tested in a quite lab room at Hunter College. Prior to testing, all participants signed a consent form (See Appendix B).

Table 1 contains demographic data on seven characteristics for the groups. There was a significant difference in the age of the two groups, $t(18) = 2.69$, $p < .05$, with the ADC patients older than the controls. Other factors, such as handedness, years of education, sex and premorbid verbal I.Q. (as measured by the Wide Range Achievement Test (WRAT) Reading subtest (1984) were relatively equal ($p > .05$). Another difference found was that the demented patients were not working or were getting ready to stop working, while the students remained active with jobs and school. Only the hospital patients took the Beck Depression Inventory (BDI) (Beck, Ward, Meridelson, Mock, & Erbaugh, 1961); it was not given to the Hunter students since the norms are well established in the literature. The mean depression score for the ADC group was significantly greater than a mean of 7, which would be expected in the general population. A score greater than 13 is often taken to be indicative of depression. Using this value as a criterion, half of the ADC group would be classified as depressed, a proportion comparable to the 44% found in a recent survey of 100 AIDS patients (Mijch & Judd, 1996).

Table 1: Demographic Data for Control and ADC Groups.

Group	*Age*	*Sex*	*Handed*	*Educ*	*BDI*[1]	*Work*	*WRAT*[2]
Control							
01	31	M	R	15	-	yes	110
02	29	M	R	16	-	yes	114
03	34	M	R	18	-	yes	118
04	33	M	R	17	-	yes	116
05	26	M	R	15	-	yes	110
06	22	M	L	13	-	yes	102
07	25	F	R	15	-	yes	108
08	32	F	R	17	-	yes	121
09	25	F	R	15	-	yes	102
10	32	F	R	15	-	yes	109
M	**28.9**			**15.6**			**111.0**
SD	**4.1**			**1.4**			**6.3**

Group	*Age*	*Sex*	*Handed*	*Educ*	*BDI*[1]	*Work*	*WRAT*[2]
ADC							
01	40	M	R	18	29	no	114
02	47	M	R	13	35	no	111
03	45	M	R	16	12	no	114
04	30	M	R	12	9	yes	74
05	40	M	R	20	13	no	117
06	55	M	R	16	32	no	115
07	34	M	R	16	6	yes	106
08	25	F	L	13	51	yes	100
09	34	F	R	14	21	no	106
10	28	F	R	10	10	no	97
M	**37.8**			**14.8**	**21.8**		**105.4**
SD	**9.6**			**3.0**	**14.6**		**12.9**

---

1 Scores on Beck Depression Inventory. Values greater than 13 are interpreted as indicating depression.

2 Standardized scores for premorbid verbal IQ, from the Wide Range Achievement Test, with population mean M = 100 and SD = 15.

General Procedure

This project was designed to minimize the demands placed upon the patients who were tested by keeping the session relatively short (less than half an hour). Informed consent was obtained from all subjects. Since all the ADC subjects were in the hospital for a psychiatric disorder, dementia, or were being seen as outpatients, it was likely that a lack of motivation and/or attention span could be encountered. Therefore, the tests were carefully selected to be varied in nature to reduce fatigue and boredom, and they did not involve very difficult tasks. The battery of tests included, in order: a simple and choice RT task, the Sternberg task, a word-list memory test consisting of recall/stem-completion/recognition parts, the WRAT, and the Beck Depression Inventory.

Materials and Procedures for Reaction Time Tests

The RT tests were run on a Toshiba laptop computer using customized software. Participants were tested individually. They sat approximately two feet from the computer screen, on which stimuli were presented. They responded by pressing designated keys on the keyboard. The computer recorded the RT in ms between the stimulus onset and the response.

The Simple-Choice RT task was administered first and provided training for the Sternberg procedure, which followed. In the simple RT task, subjects were instructed to press the "YES" key as quickly as possible when the word "YES" appeared at the center of the screen, and the "NO" key when the word "NO" appeared. A self-adhesive plastic label with the letter "Y" was attached to the M key, and one with "N" was placed on the N key. The right and left index fingers rested above the appropriate keys. First a block of 12 trials (2 practice and 10 experimental) of "YES" was administered, followed by a block of 12 trials (2 practice and 10 experimental) of "NO". In the choice RT task, the "YES"'s and "NO"'s were presented in a random order, and the task was to respond to the appropriate cue by

pressing the correct key. There were 22 choice trials in all (2 practice and 20 experimental). At the beginning of each trial, a plus sign (+) appeared for one second at the center of the screen as a warning. The "+" was displayed in the wide DOS font (6 mm X 7 mm), as were the letters of the stimuli. After the plus sign was erased, the screen remained blank for a variable interval between 500 and 1500 ms, after which the stimulus was displayed. As soon as a key was pressed, the stimulus was erased from the screen. The interval between trials was one second.

The Sternberg procedure was administered in its fixed set format. In the fixed set version, a subject is given a set of digits to memorize and then is tested on this one set for a specified number of successive trials. The other version that is more commonly used is called the varied set procedure, in which the participant is given a new set to memorize on each trial. The main reason for the selection of the fixed set procedure over the varied set procedure is that it is easier for compromised subjects to perform. Another reason is that in keeping with the literature, the studies that this experiment are based upon all employed the fixed set procedure. This variable was kept constant so that the results of the current experiment could be compared more directly to the work of other researchers.

At the beginning of each block of trials, participants were given a list containing either 1, 2, or 3 digits to memorize. This memory set was displayed at the center of the computer screen in the wide DOS font for 1 second. Then participants were shown a single digit (the probe digit) in the same font. The task was for them to decide if the probe was, or was not, a member of the memorized set of digits, and to press the "YES" or "NO" key accordingly as quickly as possible.

The test was arranged so that there were six experimental blocks of 12 trials each, and three practice blocks of four trials each. On half of the trials in each block, the probe was a member of the memory set and on half it was not. Data from the practice blocks was not used. The order of memory set sizes for the experimental

blocks was 1, 2, 3 and this ordering was then repeated. A warning stimulus "+" was presented at the center of the screen for one second prior to the probe. The probe for each set size on "YES" trials was selected an equal number of times from each position in the memory set.

The stimulus sets were selected from Fisher and Yates' Statistical Table (1974) list of random permutations of ten numbers. A criterion was set so that numbers in a specific position would not be repeated within the entire stimulus set to minimize possible contributions of priming. In addition, the occurrence of any two-digit sequence more than once was not allowed. The numbers were equated for frequency of occurrence.

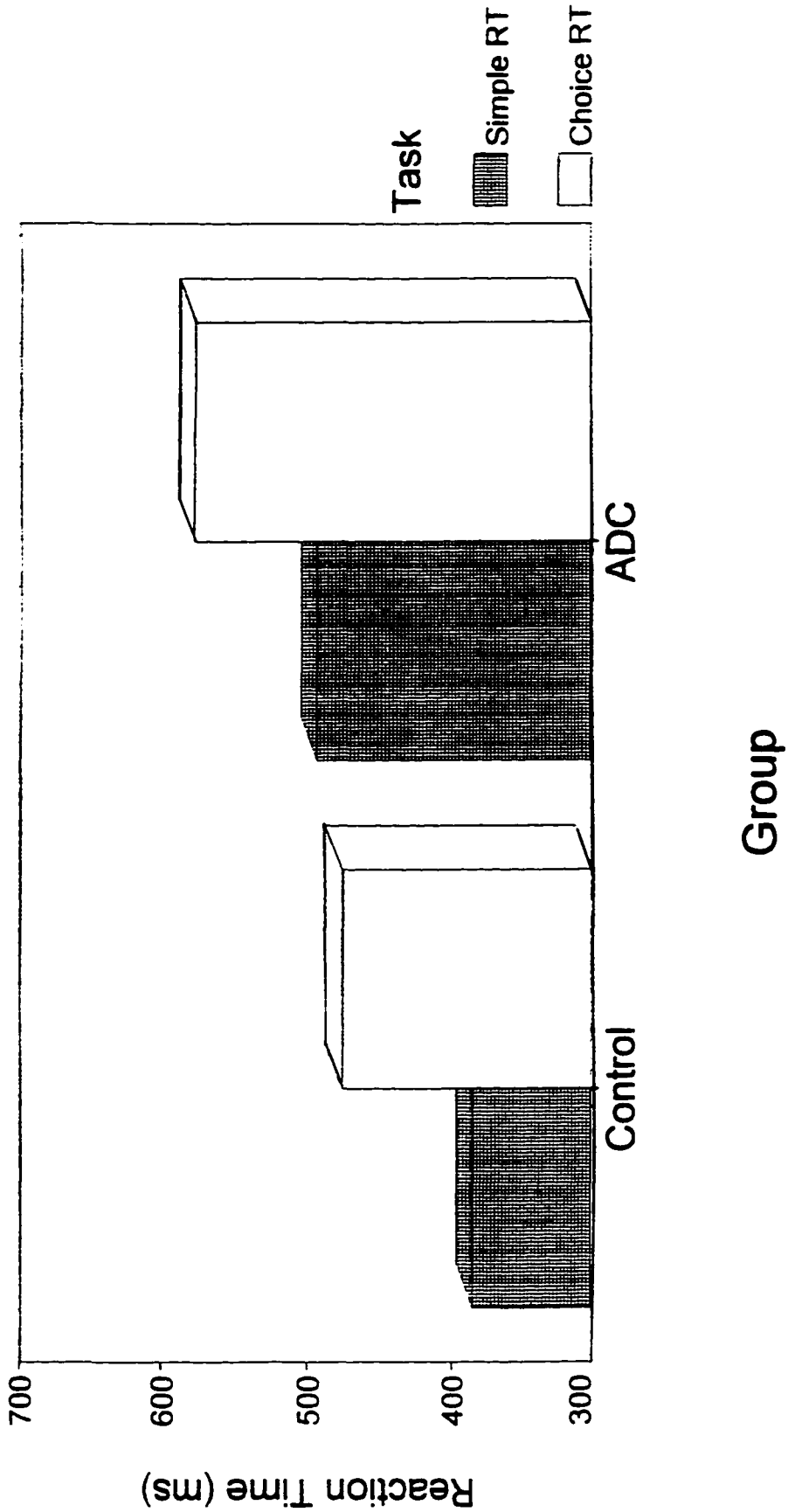
Results

Prior to data analysis on each of the tasks described below, the Dixon method was used to discard outliers as explained in Snodgrass, Levy-Berger, and Haydon (1985). For each participant, the mean RT on correct responses was computed for each test condition. The F-max test for homogeneity of variance was computed before t-tests and ANOVAs were performed. In each case F-max was less than the critical value.

The first matter to discuss is the results for the Reaction Time measures, shown in Figure 1. Since the simple YES and NO responses were similar, they were collapsed into one set of simple reaction time (SRT) scores. The design for the ANOVA consisted of one between subjects factor, Group (Control vs. ADC), and one within subjects factor, Task (Simple vs. Choice). The main effect for Group was marginal ($F(1,18) = 2.91$, $p = .10$), while that for Task was highly significant

($F(1,18) = 62.73$, $p < .001$). The interaction between Task and Group was nonsignificant ($F < 1$). Thus it took both groups longer to select between two responses, rather than simply selecting one response. Notably, the "cost" of making a choice (CRT - SRT) was the same for the two groups.

FIGURE 1: Simple - Choice Reaction Time



A separate t-test was performed on the participants' errors, to measure capacity of each group to perform equally well on the choice RT task. Results indicated no significant difference between the groups ($t(18) = 1.29$, $p > .05$), $M = 1.4$, $SD = 1.51$; and $M = .7$, $SD = .823$, for ADC and control groups respectively, corresponding to accuracy rates of 93% and 96.5%.

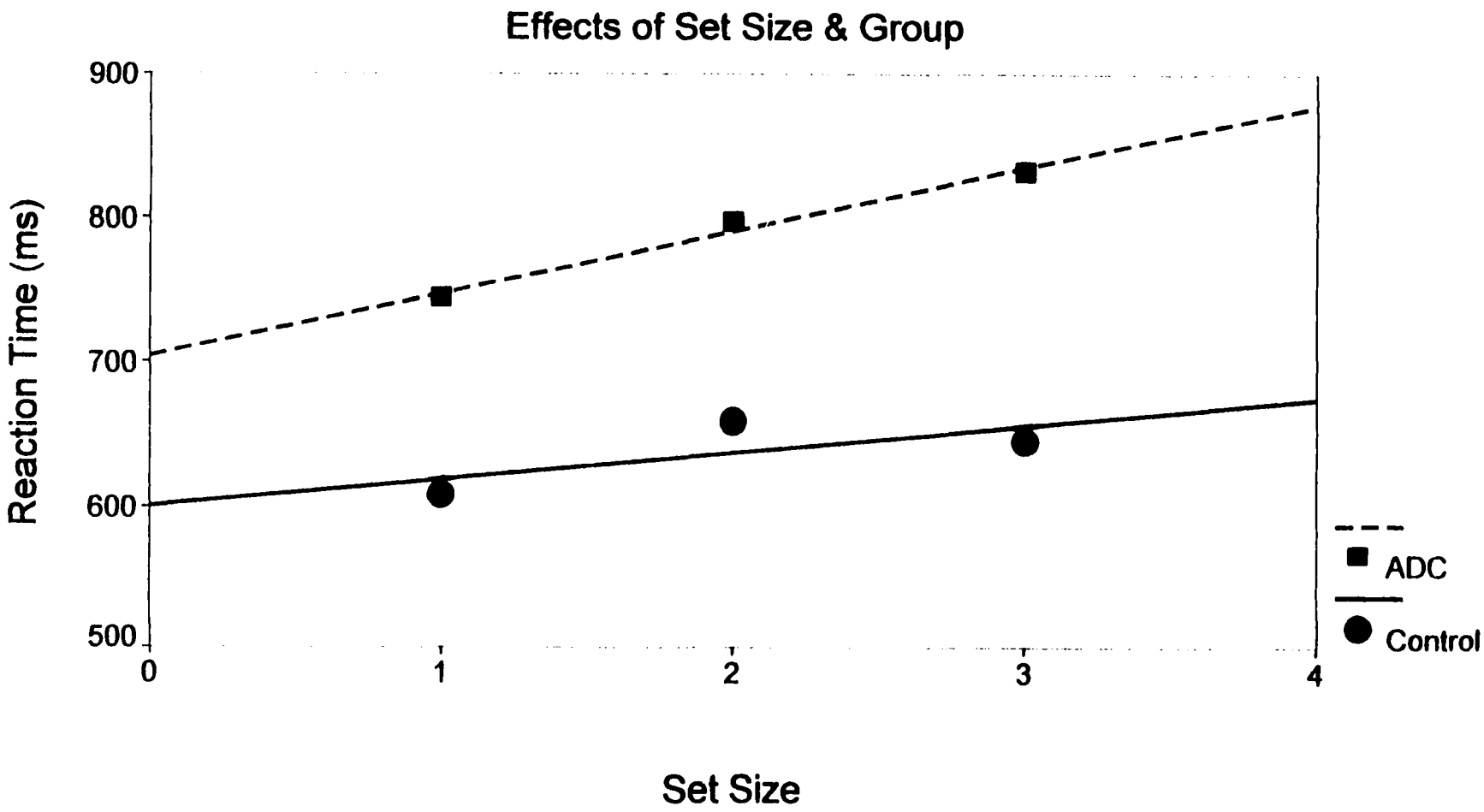
Previous researchers have suggested that SRT is related to depression but that the added processing time for choice responses is reflective of dementia. To measure the relationship between depression and SRT in the current study, a correlation was computed between the Beck Depression score of the ADC patients and their SRTs. One participant's data were not used in the calculation because the depression score was identified as an extreme outlier. For the remaining nine ADC subjects, the correlation was significant ($r(7) = .69$, $p < .05$). For these same nine participants, a correlation between their depression scores and the difference between CRT and SRT (the cost of making a choice) was not significant ($r(7) = .10$, $p > .5$). Of course, this failure to find a significant correlation should be interpreted with caution due to the small number of individuals tested.

The other reaction time task, Sternberg's complex RT memory scanning procedure, was analyzed in the following ways. For each participant, the mean correct RT was computed for each memory set size, collapsing over YES and NO responses. This conforms to common practice in the neuropsychological literature (Wilkie, et al., 1990; Hart, et al., 1990; Shor-Posner, et al., 1995). Next, the data points for each participant were fitted by a linear regression of reaction time on set size, and the resulting slopes and intercepts were compared for the two groups. As shown in Figure 2, the intercept for the ADC patients was significantly higher than

that of controls (M = 703.8, SD = 152.45; and M = 600.5, SD = 85.75, respectively), $t(18) = 1.87$, $p < .05$. There was a marginal difference in the slopes for the two groups, with the ADC patients showing a steeper slope than the controls (M = 43.25, SD = 43.97; and M = 18.33, SD = 23.60, respectively), $t(18) = 1.58$, $p < .10$.

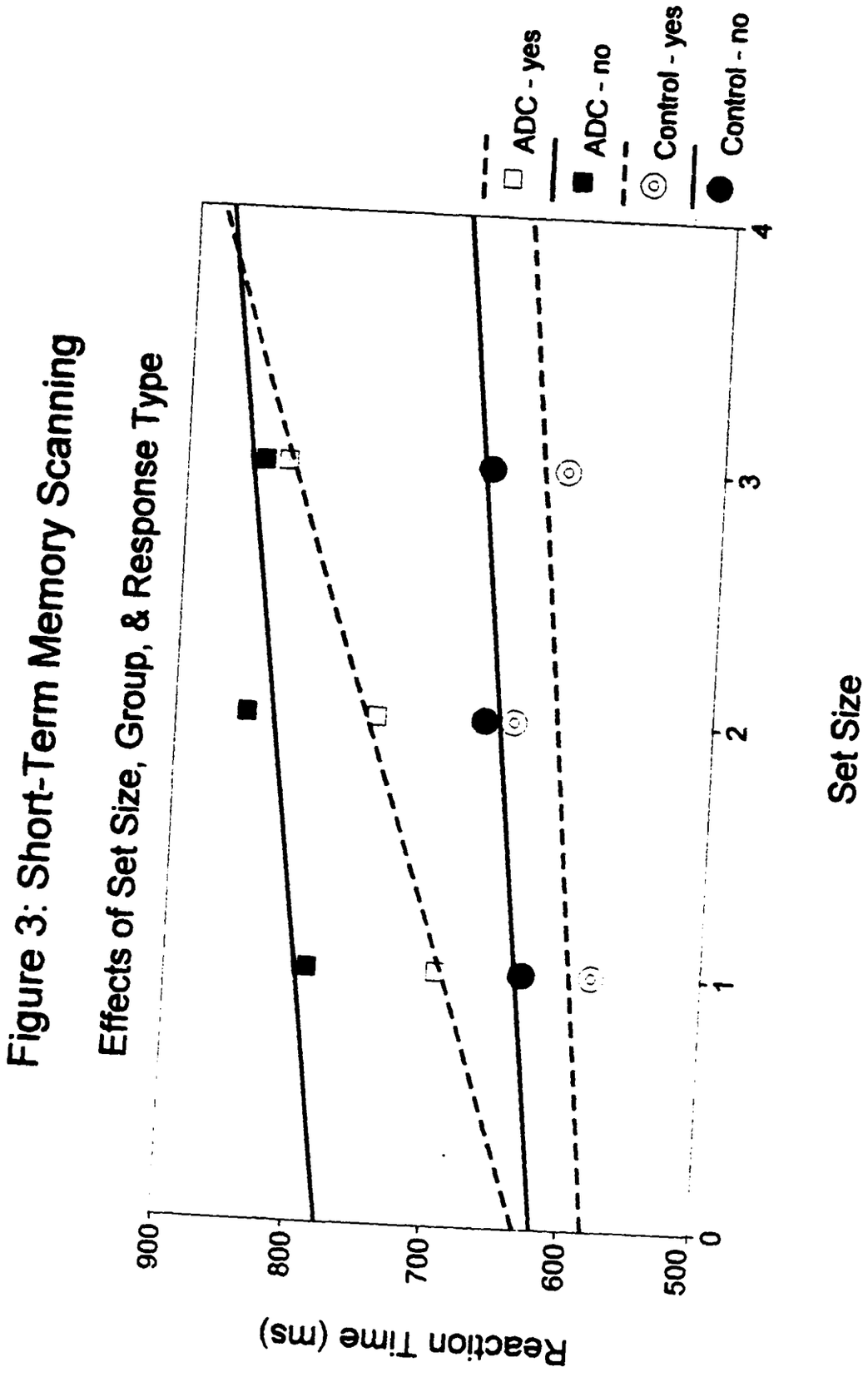
When the distinction between YES and NO responses is preserved in the data analysis, a somewhat different picture emerges. The RT data were analyzed in a mixed model, three-way (2x3x2) Analysis of Variance (ANOVA) with repeated measures on two factors. The design included differences between the two groups (ADC and controls as Factor A), set size (Factor B, repeated measure), and response type (Factor C, repeated measure) (Sokal & Rohlf, 1981).

Figure 2: Short-Term Memory Scanning



The main effect for groups was statistically significant, $F(1,18)=8.29$, $p < .01$. As expected, the controls were much faster than the AIDS group on the Sternberg Reaction Time test (M = 637 msec., SD = 94.4; and M = 790 msec., SD = 160.6, respectively). Thus the AIDS group showed the deficit of slowed speed, when compared to the control group. As expected, the main effect for memory set size (1, 2 or 3) was also significant, $F(2,36)=9.71$, $p < .001$. with slower RTs for larger memory sets (M = 676, SD = 137.2, for set size 1; M = 727, SD = 153.4, for set size 2; M = 738, SD = 161.0, for set size 3). The main effect for response type, YES and NO, was significant as well, $F(1,18)=18.56$, $p < .001$, with NO responses taking longer than YES (M = 742, SD = 161.5; and M = 686, SD = 137.9, respectively).

Figure 3 shows the interaction of group, set size, and response type, with the points for set size fitted to regression lines. The slopes of these regression lines are shallow, except for the AIDS group's YES trials. Here the slope is much steeper (62 msec per digit versus 20, 17, and 24). This suggests an interaction among the variables of group, set size, and response type. Figure 3 also shows a large difference in the intercept for the AIDS group's data on NO trials (776 msec. versus 631, 619, and 582), also consistent with a three-way interaction. In fact, the interaction of group, set size, and response type was highly significant, F(2,36) = 5.79, p < .01. No other significant interactions were found here.



A 2x3x2 mixed model ANOVA on the errors in the Sternberg task showed no significant main effects or interactions. Both groups performed with a high level of overall accuracy (97.2% for Controls and 96.5% for ADC).

Finally, the relation between depression and reaction time in the Sternberg task was assessed by computing correlations between the Beck depression scores of nine ADC patients (omitting the depression outlier) and their intercepts and slopes. In neither case was the correlation significant, $r(7) = .475$, $p > .25$ for intercept and $r(7) = .323$, $p > .25$ for slope. As noted above, these failures to find significant correlations should be interpreted cautiously.

Discussion

In the simple-choice RT tasks, as predicted, the group effect approached significance, and the effect for task was highly significant. What is surprising is the absence of an interaction between group and task. The cost of making a response choice was the same for both groups, about 80 msec. The reports in the literature of significant group X task interactions (Perdices and Cooper, 1989; Martin, et al., 199?) provide the basis for interpreting the slowing in SRT as a psychomotor effect and the additional slowing in CRT as due to dementia. But, as in the current experiment, other studies have failed to find such interactions (Worth, et al., 1993; Bornstein, et al., 1993). One possible explanation for the differences in results might be related to differences in the simple tasks used in the experiments. Interactions are found when the SRTs for ADC patients and normal controls fall in the 200-250 msec range, as in a simple detection of a brightly colored stimulus on a black background. However, when the SRTs of the controls are longer, in the neighborhood of 400 msec. as in the current experiment, no interactions are found. For example, in Bornstein, et al. (1993), the simple task took controls 446 msec. and ADC patients 567 msec. For each group, the choice task took about 50 msec. longer. This suggests that a floor effect among normals may actually have caused the interactions

in Perdices and Cooper (1989) and Martin, et al. (1992), as the normal group was already operating at the lower limit of their SRT capability.

The SRTs of the ADC group were significantly correlated with depression, reflecting perhaps the effects of pseudodementia. In light of the preceding discussion, it is not surprising that this is the case. Over all, the simple and choice task results provide evidence for psychomotor slowing but not for dementia. On the other hand, a complex reaction time procedure, such as Sternberg's memory scanning paradigm, might prove to be a more sensitive measure of dementia. Worth, et al. (1993) report that, in a battery of reaction time tests, the best discriminator of normals versus ADC patients was the RT from a task (SQRT2) in which the subject must press a key if the digit just shown is less than the digit being held in memory. The test battery did not include Sternberg's task, but the SQRT2 test has many features that are similar to the short-term memory scanning technique.

The three main independent variables in the memory scanning experiment were patient group, response type, and set size, while the dependent variable was the performance on the test as measured by reaction time. When means were computed over YES and NO response types, there was a significantly higher Y-intercept and a marginally steeper slope for the ADC group than for the controls. Previous studies have reported significant differences in slope but not intercept (Hart, et al., 1990) or significant differences in intercept but not slope (Wilkie, et al., 1990). In the current experiment, when the YES / NO distinction was used as a factor in the analysis, there were significant three-way interactions among group, set size, and response type. The intercept was higher for ADC patients' NO responses, and the slope was steeper for their YES responses. The data suggest both psychomotor slowing and an effect on the speed of memory search.

Based on the finding of a steep slope, only the AIDS patients show any evidence of dementia in this experiment. For the controls, the slopes were quite

shallow, about 18 msec per digit, compared to the original results of 38 msec. per digit reported by Sternberg (1966). A number of differences in the procedure might account for the faster scanning rate in the present study. Most notably, the task was shortened to include only the three smallest set sizes (1, 2 and 3) instead of six, as in Sternberg's experiment. Despite the fact that the set sizes were small, each additional digit cost the ADC group 62 msec in search time in the YES condition, although their slope for the NO condition (25 msec.) more closely resembled that of the controls. Neither the intercepts nor the slopes for the ADC patients were significantly correlated with depression. The overall pattern suggests that Sternberg's complex RT task is indeed sensitive to the effects of dementia.

VI. MEASURES OF EXPLICIT AND IMPLICIT MEMORY: RECALL, RECOGNITION, AND STEM COMPLETION

On each trial of the preceding experiments, participants were shown one to three stimuli, drawn from the well known, closed sets {YES, NO} and {0,1,2,3,4,5,6,7,8,9}. The conditions were, in some sense, optimal for encoding and retrieval, as reflected in almost errorless performance for both groups. But what does memory performance look like when more items are presented on each trial (seven) and each is drawn from an open set (common English nouns)? Do differences between ADC patients and controls emerge in tests of explicit memory? In some dementias (e.g., Korsakoff's), explicit memory is diminished but implicit memory is spared. Is this also true of ADC?

Explicit memory is memory that the individual is aware of having (Schacter, 1987). It is typically measured with direct tests, such as recall and recognition. One factor known to affect explicit memory in normals is the modality of presentation. Auditory presentation typically yields better recall performance than visual. If the stimuli are lists of words, auditory presentation is more likely to produce superior recall at the end of the list, a recency effect, while visual presentation typically shows

little or no advantage at the end as compared to the middle of the list. There have been numerous attempts to account for this Modality Effect (e.g., Crowder & Morton, 1969; Campbell & Dodd, 1980; Glenberg, 1984; Manning & Robinson, 1989; Manning, Koehler, & Hampton, 1990; Nairne, 1988) and for the shape of the serial position curve in general. Of primary importance to the present study are the differences that ADC patients might show in their explicit memory for auditorily and visually presented materials, and in the shape of their serial position curves. Alzheimer's patients display some primacy and recency, though, over all, the level of performance is much lower than that of elderly controls (Manning, Greenhut-Wertz, & Mackell, 1996).

Currently, there are no reported studies of serial recall in ADC patients using visually presented lists, but there are studies with auditory presentation. ADC patients recalled significantly fewer words than controls when they were read a list of sixteen items and asked for immediate free recall (Peavey, Jacobs, Salmon, Butters, Delis, Taylor, Massman, Stout, Heindel, Kirson, Atkinson, Chandler, and Grant, 1994). The general shape of the serial position curve for both groups was a U; the beginning and end portions were recalled better than the middle (Peavey, et al., 1994; Mitrushina, Satz, Drebing, Van Gorp, Matthews, Harker, & Chervinsky, 1994). When the same list was presented a total of five times, the ADC group's overall immediate recall continued to lag behind that of normals, and this difference was also found in their long-delay free recall (Peavey, et al., 1994). In the same study, a test of delayed recognition for the words of the list (after five presentations) showed high levels of accuracy for both ADC patients (95%) and controls (97%), though the small difference between the groups was statistically significant.

Peavey, et al. (1994) compared the pattern of performance in ADC with that of Alzheimer's and Huntington's patients. All three show reduced free recall, relative to controls, but only the Alzheimer's patients failed to display considerably better

recognition. (Manning, et al. (1996) also report a lesser performance for recognition than recall in Alzheimer's disease in a task involving a short delay.) Peavey, et al. concluded that ADC presents substantial evidence of subcortical dysfunction, similar to Huntington's disease, rather than cortical dysfunction, as in Alzheimer's. Most studies that compare memory in controls and depressives show poorer free recall for the latter group but no difference between groups in accuracy on recognition tests (Brand, Jolles, & Gispen de Wied, 1992; Ilsley, Moffoot, & O'Carroll, 1995). However, some investigators have reported differences in recognition performance as well (Golinkoff & Sweeney, 1989), making the picture for depressives quite unclear with respect to their recognition ability.

A common interpretation of recall and recognition data (Mitrushina, et al., 1994; Peavey, et al., 1994) rests on the following assumptions: (1) Recall requires both the encoding and retrieval of stimuli. (2) Recognition requires stimulus encoding, but retrieval operations are largely circumvented by having the stimulus present at the time of testing. In these terms, the results cited above suggest that ADC patients have, for the most part, intact encoding but deficient retrieval. If this is indeed the case, then a variable which affects retrieval might be expected to have a greater impact on the recall performance of ADC patients than of controls. One such variable is stimulus concreteness.

Paivio's (1969) work established concreteness as the source of a robust memory effect, the advantage of concrete nouns over abstract ones in tests of recall. Paivio based his explanation for the effect on the dual-coding hypothesis, which posits the existence of two memory systems, one for visual-spatial phenomena and one for verbal-symbolic information. Abstract words are represented as the latter, whereas concrete words can be coded by both systems (via image and symbol). The existence of two codes facilitates retrieval for concrete words. Rissenberg and Glanzer (1986) explored Alzheimer's patients' ability to use a free recall paradigm with abstract and

concrete items. They found significantly poorer performance with abstract nouns than concrete ones. Mackell and Manning (1990) also report a similar effect in ordered recall of lists.

In contrast to explicit memory, implicit memory does not require the individual to be aware that he/she remembers (Schacter, 1987). Implicit memory is generally considered an automatic process, and is measured by indirect tests such as stem completion, fragment completion, or perceptual identification. The existence of priming is an indication of implicit memory. It is a facilitation (in speed and/or accuracy) of processing due to prior exposure to the same or a related stimulus. (Implicit memory tests are data-driven, emphasizing the perceptual nature of the memory trace, while explicit tests tend to be conceptually driven (Blaxton, 1989)). One of the most important discoveries of the last thirty years is that the implicit memory system is independent of the explicit one and can continue to function even in cases of severe amnesia (Warrington and Weiskrantz, 1968; Graf and Schacter, 1985).

In general, studies of depressives have shown reduced recall relative to controls but no differences in stem completion performance (Roediger & McDermott, 1992; Danion, Willard-Schroeder, Zimmerman, & Grange, 1991; Bazin, Perruchet, de Bonis, & Feline, 1994; see Elliot & Greene, 1992, for some contradictory results). The literature on implicit memory and Alzheimer's disease seems less clear, but a recent meta-analysis by Meiran and Jelicic (1995) on 36 published experiments showed (1) there is significant impairment on implicit memory tests with long delays, but (2) under many conditions, performance is equal to that of controls, if the delays are short.

The experiments described below examined explicit memory using recall and recognition tests on words from stimulus lists. These explicit tests can, at least potentially, provide evidence that encoding, retrieval, or both are impaired in ADC.

Depressives seem to have impaired retrieval but largely intact encoding, while Alzheimer's patients show impairment of both sorts. Stimulus concreteness (abstract vs. concrete) and stimulus modality (auditory vs. visual) are also manipulated. Interactions of these variables with group might indicate, for example, a disproportionate difficulty with abstract words in ADC patients or a relative sparing of their memory for auditory stimuli. The list recall data can also be used to construct serial positions curves for purposes of comparison.

Short-delay word-stem completion was the implicit memory test used in the study. If one or both of the explicit tests show an impairment in the ADC group but their performance on stem completion is equal to that of controls, then the experiment will have demonstrated a dissociation between explicit and implicit memory. However, evidence of impairment in stem completion would clearly distinguish this group from depressives and possibly also from Alzheimer's patients (because the test is administered at a short delay).

VII. Experiments

Procedure

The materials consisted of four lists of seven words each, balanced for syllables and word length (see Table 2). Two lists contained concrete (C) nouns, and the other two lists were comprised of abstract (A) nouns. Within each category (abstract or concrete), all words were equated for imagery and meaningfulness by using the extensive list constructed by Paivio, Yuille and Madigan (1968), and across categories, all words were equated for frequency. The order of list presentation was arranged so that the two abstract lists were presented first as many times as the concrete lists were. The orders were A-C-C-A and C-A-A-C.

Table 2: Stimulus words used in Abstract/Concrete Modality Task Concreteness ratings are taken from Paivio, et al., 1968.

ABSTRACT NOUNS	*Concreteness*
List 1	
FATE	1.46
HONOR	1.75
THEORY	1.9
STRENGTH	2.9
ADVICE	2.08
MIND	2.6
QUALITY	2.13
	M=2.11
List 2	
ATTITUDE	1.83
CHANCE	1.5
INSTANCE	2.87
DUTY	2.32
MORAL	1.39
HOUR	2.93
SAFETY	2.25
	M=2.15
CONCRETE NOUNS	
List 1	
APPLE	7.0
PLANT	6.87
DIAMOND	6.94
SHIP	6.93
COFFEE	6.89
BIRD	6.96
MAGAZINE	6.8
	M=6.91
List 2	
LIBRARY	6.87
DOOR	7.0
BOTTLE	6.94
MOUNTAIN	7.0
PALACE	6.73
GRASS	6.96
FLAG	6.94
	M=6.92

The participants received one abstract list and one concrete list auditorily (read by the experimenter). The other two lists, one abstract and one concrete, were displayed visually a word at a time on 3" X 5" flash cards. In each modality, the words were presented at a rate of one per second. The order of modalities was fixed with auditory presentation preceding visual. Immediately after each list, participants were instructed to recall as many words as possible in any order. They wrote their free recall responses on paper.

Next, the stem completion task was given in which the participant completed each of six or eight three-letter stems (see Appendix A) using "the first word that came to mind." No mention was made by the experimenter of any relation between stems and the recalled list. Either three or four of the stems were taken from words on the list just given for recall, and the other three or four were stems from filler items not previously presented to the participant. Those that had been in the list were taken either from its beginning or its end, in order to balance for list position. The stems were printed on a response sheet in the same type font and size as the stimulus words on the flash cards. A maximum of two minutes was allowed for the subject to complete the stems.

After stem completion, the sheet was turned over to reveal six or eight additional words (see Appendix A), half of which were the remaining words from the list just presented (i.e., those not used as stems). This was the recognition task in which the subject was asked to place a check mark by any word that he/she remembered from the previous list. Once again, the same font and size was used for the test items.

After the recall, stem completion, and recognition tests were administered for one list, the next list was presented and its tests were given. The total time for presenting and testing the four lists was about 10 minutes.

Results

In each test - Recall, Recognition, and Stem-Completion - the dependent variable was proportion correct and the ANOVA model was mixed, with one between-subjects factor, Group (Control and ADC) and two within-subjects factors, Modality (auditory and visual) and Concreteness (abstract and concrete). The results for the recall test will be described first.

In Recall, the main effect for Group was significant, with the controls recalling more words over all than the ADC patients, $F(1,18) = 7.70$, $p < .05$. The mean proportion recalled by the control group was $\underline{M} = .750$, $\underline{SD} = .119$, and by the ADC group, $\underline{M} = .610$, $\underline{SD} = .105$. There was a highly significant effect of Modality, $F(1,18) = 25.96$, $p < .0001$. As expected, recall of auditory stimuli was better than recall of visual, $\underline{M} = .760$, $\underline{SD} = .148$, and $\underline{M} = .599$, $\underline{SD} = .147$, respectively. The main effect for Concreteness approached significance, $F(1,18)=4.21$, $p < .06$, as concrete words showed an advantage over abstract ($\underline{M} = .700$, $\underline{SD} = .120$, and $\underline{M} = .660$, $\underline{SD} = .153$, respectively). There were no significant interactions among these variables (all **F**'s < 1.7). Most notably, there were no interactions with Group, i.e., the patterns were similar for controls and ADC with regard to the concrete - abstract difference and the auditory - visual difference.

A second ANOVA was performed on the recall data, with the added factor of word Position in the list (1 to 7). In addition to main effects for Group, Modality,

and Concreteness, there was also a main effect for Position, $F(6,108) = 14.46$, $p < .0001$, and significant interactions between Position and Modality, $F(6,108) = 2.62$, $p < .02$, and Position and Concreteness, $F(6,108) = 4.43$, $p < .001$. Figure 4 shows the serial position curves for the two groups. The Position X Modality and Position X Concreteness interactions are found in Figures 5 and 6. There were no other interactions among the variables (all F's < 1.1), and once again it is interesting to note that recall for the two groups was affected in similar ways by all of the experimental manipulations.

FIGURE 4: RECALL BY SERIAL POSITION FOR CONTROL & ADC GROUPS

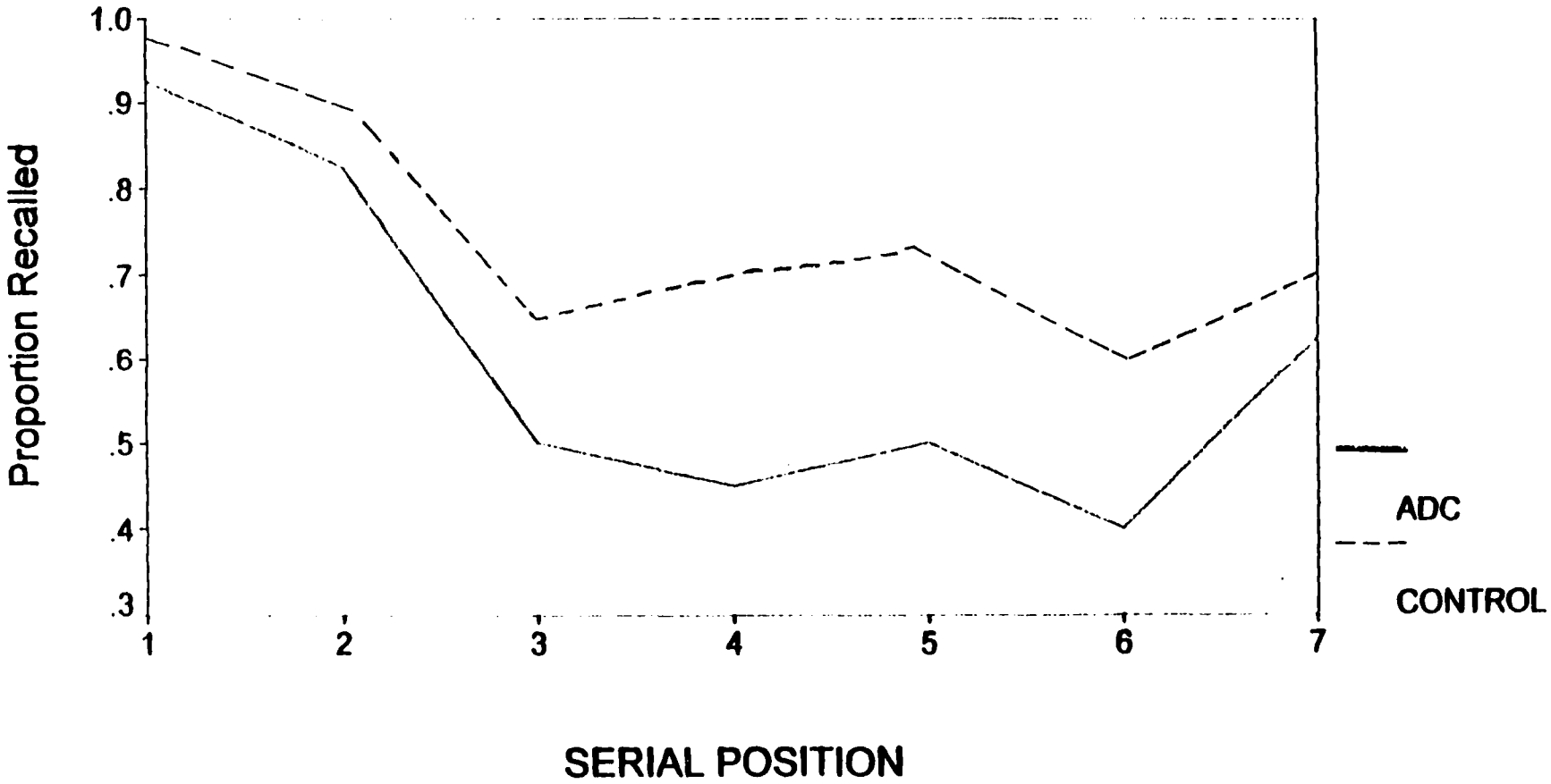


FIGURE 5: RECALL BY SERIAL POSITION AND MODALITY

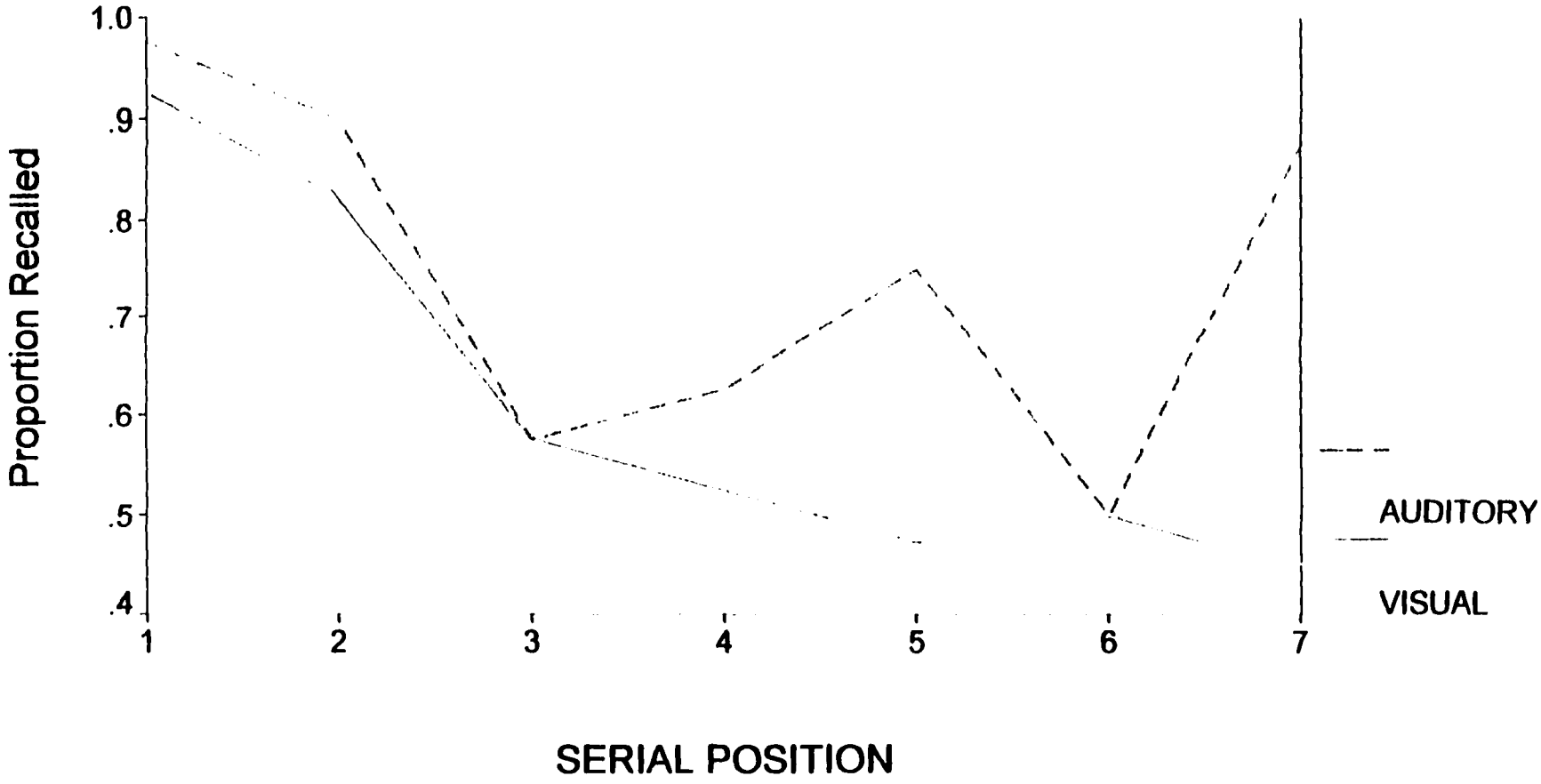
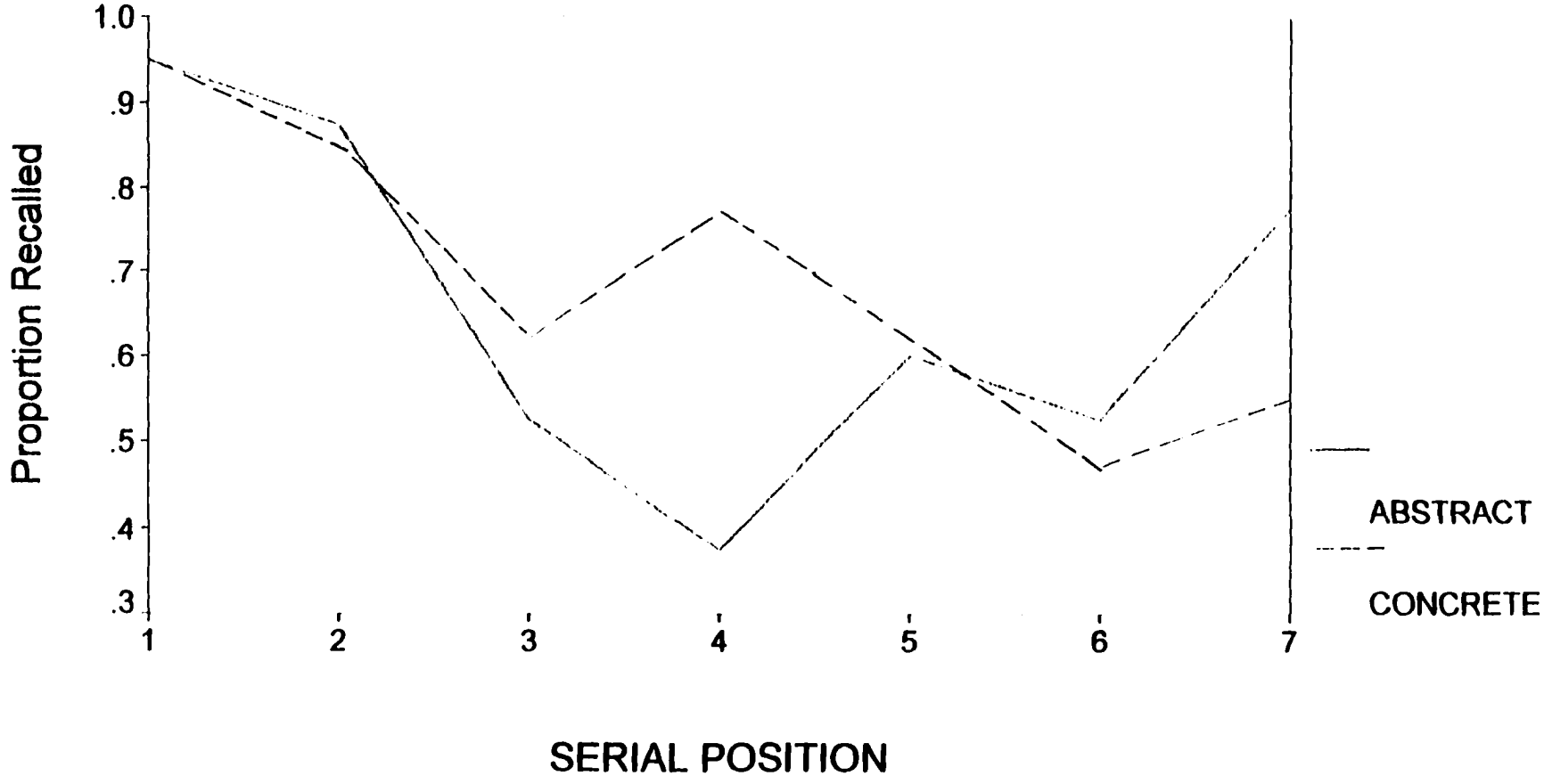


FIGURE 6: RECALL BY SERIAL POSITION FOR ABSTRACT & CONCRETE



In the Recognition test, there were no significant main effects or interactions, although there was a trend for the Controls to outscore the ADC patients, $F(1,18)=2.26$, $p < .15$. Performance of both groups was quite good (for Controls, M = .823, SD = .074, and for ADC. M = .755, SD = .124). One possibility to consider is that a ceiling effect might have prevented the test from showing a real difference. This seems unlikely, however, because no participant was correct on all the items; in fact only one subject in each group scored higher than .90.

For Stem Completion, there were two significant main effects and no interactions. The difference between Groups was highly reliable, $F(1,18) = 15.61$, $p < .001$ (for Controls, the mean proportion of stems completed with words from the previous list was M = .770, SD = .100, and for ADC participants, M = .550, SD = .148). Also significant was the Concreteness difference, $F(1,18) = 7.55$, $p < .05$ (for concrete words, M = .759, SD = .246, and for abstract words, M = .561, SD = .210). The modality advantage for auditory presentation, which was observed in recall and recognition, disappeared in the stem completion test. In fact, there was a small, nonsignificant reversal, so that visual presentation led to slightly more stems completed with list items than auditory presentation did (M .692, SD = .178, and M = .627, SD = .238, respectively).

VIII. DISCUSSION

Recall

The main effects for Group, Modality, Concreteness, and Position were all as expected, based on prior studies. In fact, the existence of these effects is an indication that the particular materials and procedure employed in the study were

sensitive to the relevant cognitive variables. Furthermore, a typical Modality Effect can be seen in the interaction of Modality X Position (Figure 5) where there is considerable recency with auditory presentation and none with visual. In light of this, the failure to find interactions with Group is all the more interesting. With respect to the manipulated variables, the ADC patients, as a whole, appeared simply to be a set of quite poorly performing normals. In particular, the ADC participants did not show selective sparing of auditory processing over visual, nor were they disproportionately less able to recall abstract words than concrete ones. The switch from auditory to visual led to a decrement of about .16 in both groups, and the proportion of abstract words recalled was approximately .04 less than the proportion of concrete, in both groups. The Group X Position interaction (Figure 4) shows that ADC subjects recalled fewer words at all seven serial positions. Levels of performance are roughly parallel. (The somewhat greater difference between the groups at the middle positions was not sufficient to produce a significant interaction.)

An unexpected interaction, not involving Group, is that of Concreteness X Position (Figure 6). Here, recall of concrete words was better in the middle positions, and abstract was superior at the final position. Perhaps it is not so surprising that there was a concrete word advantage in the middle positions, where encoding and retrieval are most difficult, but the abstract advantage at the end remains something of a puzzle.

Recognition

In this test, the ADC patients most closely resembled the Controls, as their performance was not reliably less accurate, though there was a trend in that direction.

Failure to find a difference could not be attributed to ceiling effects. As noted earlier, no participant in either group showed perfect performance. Here, then, is evidence that encoding is largely intact in ADC, even though retrieval, as measured by recall, is significantly impaired. The pattern contrasts with that reported for Alzheimer's patients, who typically show large deficits in both recall and recognition.

Stem Completion

The main effect for Group indicates a deficit in implicit memory (priming) in the ADC patients. Such a deficit distinguishes them from depressives (Roediger & McDermott, 1992; Danion, et al., 1994) and, possibly also Alzheimer's patients, who often show priming in short delay, data-driven tasks (Meiran & Jelicic, 1995). One potential explanation for the Group difference might be that both sets of participants tried to recall items from the preceding list to help them complete the stems. When a short delay is used, as in the current study, subjects might be even more likely to notice the connection between the list items and the stems. Since there is a group difference in recall, this would explain the difference in performance on stem completion. One reason to doubt this explanation is that a main characteristic of recall, the advantage of auditory presentation over visual, is not reflected in the stem completion results. In fact, stem completion for both groups was slightly worse for words that had been presented auditorily.

IX. SUMMARY

The majority of the test battery results showed evidence of cognitive deficit for the ADC group. Often the differences were subtle and resembled the performance of the controls, though at a lower level. For example, the recall curves for serial

position retained the characteristic U shape, and most of the patterns for speed and accuracy mimicked those of the control group, although the ADC group remained a step behind in both types of measurement. The particular patients tested in this study were very ill, in an advanced stage of their disease. As noted earlier, most of them were unable to work, and most lived only about one year beyond the time of testing. This makes the degree of similarity of between the two groups a surprising result. The following summarizes the overall findings.

1. Simple-Choice Reaction Time (Figure 1)

Over both tasks, the ADC group was marginally slower than the Controls. For ADC participants, simple RT was correlated with Beck Depression scores, but the difference between simple and choice RT was not related to depression. This indicates that psychomotor slowing may be attributed to either depression or dementia.

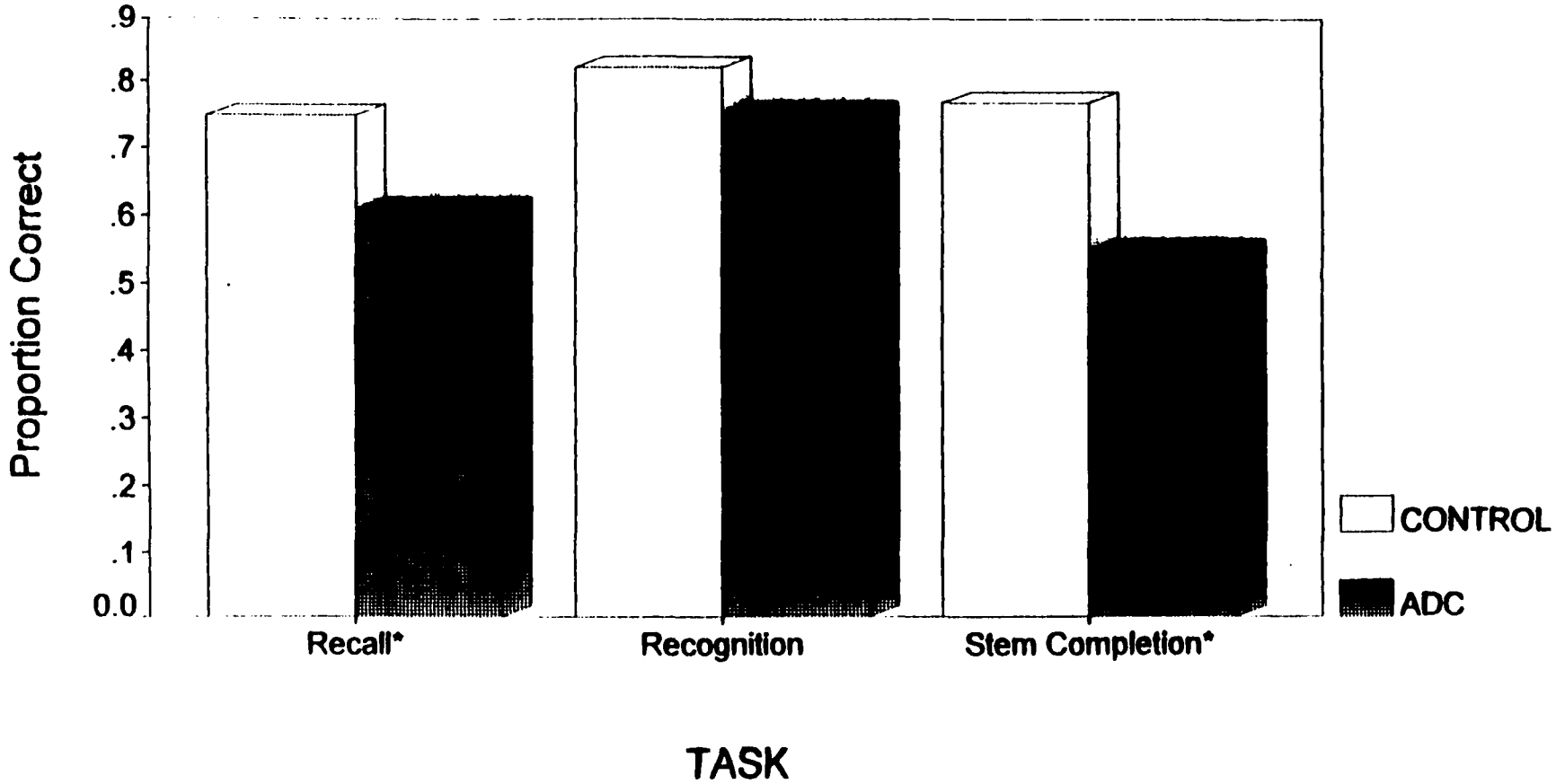
2. Sternberg Short-Term Memory Scanning Time (Figures 2, 3)

The slope for the ADC patients was double that of the Controls, and their Y-intercept was also substantially higher. When responses were broken down into YES and NO categories, the higher intercept was found to be associated with NO responses, and the steeper slope with YES. The higher Y-intercept means that it took ADC patients longer to encode the stimulus, decide which key to press, and actually press it. This is another example of psychomotor slowing. The steepness of slope suggests a slowing in memory retrieval, a finding that has been reported in other demented groups.

3. Recall (Figures 4, 5, 6, 7)

The ADC patients showed a significant deficit in recall, but the failure to find any interactions between Group and the other variables supports the view that these participants were performing like controls, simply at a lower level. Modality and Concreteness effects were replicated, and this indicates that the materials and procedure were sensitive to relevant cognitive processes. Performance of the ADC participants could be consistent with pseudodementia, as depressives are also known to show such a deficit.

FIGURE 7: EXPLICIT & IMPLICIT MEMORY IN ADC & CONTROLS



4. Recognition (Figure 7)

There were no differences between the groups on recognition, suggesting that encoding is largely intact in ADC. This contrasts with results in the literature for Alzheimer's patients, who show diminished recognition ability.

5. Stem Completion (Figure 7)

The Group difference on stem completion is perhaps the most astounding finding in the current study. Unlike other groups with dementia (including severe amnesics and "Wet Brain" Korsakoffs), these patients showed impaired implicit memory at short delay. Alzheimer's patients fail to prime (with long delays), but even for these individuals, the research literature is mixed when it comes to short-delay tasks.

The pattern of results is a curious one. There is evidence for psychomotor slowing and slower memory scanning, for impaired explicit memory (recall) and deficient implicit memory (priming). Yet in the midst of all this, encoding (recognition) is spared, and other variables of presentation (modality) and content (concreteness) do not interact with the deficits. The picture is of a condition that does not match depression alone or the other studied dementias.

X. CONCLUDING NOTE

The incidence of psychiatric and psychological problems in HIV infected individuals has not received as much attention as the dramatic medical and ethical issues surrounding the disease have. The typical picture, seen so often on all AIDS units, is that of young men and women staring into space, unable to speak and walk, incontinent and totally dependent on others. Since at least half of all AIDS patients

end up with some degree of dementia, and new medications allow patients to live in such a state for longer periods of time, the need to increase our knowledge of psychological aspects of AIDS will become apparent as time goes on. This dissertation has sought to address one of the more perplexing and troublesome issues faced by clinicians dealing with all stages of HIV infection, that of distinguishing between depression and dementia. If future research confirms the findings reported here of qualitatively different patterns on tests for depressed and demented individuals, then the possibility of using these procedures in patients with earlier stages of HIV infection to signal the beginning stages of dementia would be of great clinical utility.

APPENDIX A

STEMS AND RECOGNITION ITEMS

Abstract Nouns List 1

FRE____	TRU____
ADV____	STR____
MIN____	QUA____
CUS____	SOU____

IDEA	HONOR
THEORY	FATE
OCCASION	MOMENT

Abstract Nouns List 2

EXC____	DRE____
MET____	CHA____
INS____	ATT____

DUTY	JUSTICE
SAFETY	MORAL
VIRTUE	THOUGHT
HOUR	MEMORY

Concrete Nouns List 1

FOR____	CLO____
PLA____	APP____
SHI____	STA____
HOS____	DIA____
MAGAZINE	COFFEE
TREE	RIVER
CATTLE	BIRD

Concrete Nouns List 2

FLA____	PAL____
GRA____	FLO____
SHO____	COR____
DOOR	LIBRARY
POTATO	STEAM
HOUSE	WATER
BOTTLE	MOUNTAIN

APPENDIX B

CONSENT FORM FOR MEMORY SCANNING IN DEPRESSION AND AIDS DEMENTIA PATIENTS

You have been invited to participate in a research study as an out-patient. The purpose of the study is to measure differences in the speed of mental processing found in groups of patients with different illnesses. The two groups of patients that this study focuses on are those with Depression and those with HIV infection. The HIV+ patients health falls along a continuum from an asymptomatic stage to those with later stage illness. Control subjects are also included for comparison.

Since your involvement is voluntary, you may stop your participation at any time without fear of penalty. The whole test takes about a half-hour, and there are no benefits offered for your participation. Your name will be kept in a secure, locked place and will never be associated with your test performance or used in publication. You will be assigned a coded number, and from here on your data will be referred to by that number and not with your name. Since these tests are still in the experimental stage, you will not be provided with a detailed description of your performance. If your doctor requests a repetition of the test at some point in the future, you will have the choice to participate again, if you are interested in doing so.

The test itself involves a group of short simple tasks. Some require that the subject press a computer key when he sees a number or word on the screen. Others involve pencil and paper and remembering a few words. In general terms, the test is similar to an easy game show or puzzle.

If you have any questions, Ruth Steinman, can be reached at (212) 744-0133 for more information. There are no significant risks involved in your participation in this study. CONFIDENTIALITY IS OF UTMOST IMPORTANCE TO THE RESEARCHERS INVOLVED IN THIS STUDY AND WILL BE RESPECTED AT ALL TIMES.

I VOLUNTARILY AGREE TO PARTICIPATE IN THE STUDY WITH THE KNOWLEDGE THAT I MAY WITHDRAW AT ANY TIME WITHOUT MY CARE BEING AFFECTED.

Patient/Control Subject's Signature Date

Experimenter's Signature Date

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