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PERFORMANCE ON THE GERIATRIC LEARNING AND MEMORY BATTERY BY PERSONS WITH MILD AND MODERATE STAGE ALZHEIMER'S DISEASE

by

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ABSTRACT

The purpose of this study is to examine the usefulness of the Geriatric Learning and Memory Battery (G-LAMB) for assessing learning and memory performance in persons with Alzheimer's Disease (AD). Individuals with AD often perform so poorly on standard memory tests that assessing learning and memory strengths and weaknesses or tracking changes over time is, at best, difficult. The G-LAMB is a recently developed test composed of a Paragraph and a simple Figure and was designed specifically to help assess and monitor verbal and visuospatial learning and memory performance in people already diagnosed with cognitive deficits. One group for whom this test may have particular utility are people with AD who experience both verbal and visuospatial learning and memory changes and who can live for extended periods of time post-diagnosis. Alongside efforts to identify an etiology and cure for AD, there is an emerging emphasis on quality of life issues for both those living with AD and their caregivers. In this context, the ability to assess deficits, prescribe treatment and then monitor changes becomes critical. In the current study, the G-LAMB verbal (Paragraph) and visuospatial (Figure) subtests were administered to individuals with mild and moderate stages of AD. Findings suggest that the G-LAMB is a useful tool for assessing learning and memory performance in those with AD. First, the scores of individuals with Mild AD are high enough to allow one to monitor changes in learning and memory, at least into the moderate stages of the disease. Second, it is possible to differentiate the performance levels of those with Mild and Moderate AD, particularly on the Paragraph subtest.

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Acknowledgement

The desire and decision to conduct this study arises from many years of volunteering and working with older adults and particularly those with cognitive difficulties. It is my unshakable conviction that the older generation, which has sacrificed in so many ways to build our society, deserves not only our respect and thanks but also the means to enjoy the best quality of life possible. I hope that in some small way this research will make it possible for people living with Alzheimer's Disease to live happier and more satisfying lives.

I would like to thank my thesis supervisor, Dr. Anita Hubley, for providing me with the opportunity to pursue research in the field of memory and aging and for fostering a research and learning environment that I am sure is second to none. Anita's guidance, support and encouragement helped make the last two years both challenging and enjoyable. I hope and expect that our collaboration both as friends and colleagues will continue in the years to come.

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INTRODUCTION

Alzheimer's Disease (AD) is a dementia; that is, an acquired, persistent impairment in mental functioning affecting memory, language and visuospatial skills along with emotion, personality and judgement. Unlike reversible dementias which sometimes accompany thyroid problems, infections, depression and inappropriate medication use, AD is an irreversible dementia with no known cause or cure. Although, as recently as 1991, only 28% of Canadians were familiar with AD, today, over 50% of Canadians know someone with Alzheimer's Disease. Currently, more than 253,000 Canadians are suffering from AD with the number expected to triple by the year 2030 (Canadian Study of Health and Aging, 1994a).

With such a major impact on the Canadian population, it is not surprising that an increasing amount of research on Alzheimer's Disease is taking place. In the past, most research was directed at finding the cause and cure for AD. However, a shift has taken place with a newer and increasingly critical area of investigation now being treatment and management of the disease (i.e., improving quality of life). This is particularly important given the fact that individuals with AD currently live an average of 8 years, but as long as 20 years or more, after diagnosis (Barclay, Zemcov, Blass & Sansone, 1985; Cummings & Benson, 1992; Treves et al., 1986).

The following research addresses one aspect of treatment; in particular, the need for a memory test designed specifically to assess and track memory changes in individuals already diagnosed with AD. Prior to elaborating the

specifics of the research, background information on dementia and, specifically AD, is presented followed by a brief survey of learning and memory changes expected in AD.

CHAPTER ONE

Literature Review

Dementia

Dementia is an acquired (i.e., not congenital) persistent impairment of intellectual performance with deficits in at least three of the following areas of mental functioning: memory, language, visuospatial skills, emotion or personality, and cognition (e.g., abstraction and judgement) (Cummings, Benson, & LoVerme, 1980). Some dementias can be reversible such as those caused by metabolic problems (e.g., hypothyroidism), inappropriate medication use, infections, environmental toxins, and depression. Because treatment is possible in the case of reversible dementias, it is critical that the source of a suspected dementia be identified as quickly as possible. Other dementias such as AD, vascular dementia (VaD), Parkinson's Disease, Huntington's Disease and Pick's Disease have no known cure and are characterized as irreversible (Cummings & Benson, 1992). AD is the most common type of irreversible dementia accounting for as much as 65% of total cases (Canadian Study of Health and Aging, 1994a; Terry & Katzman, 1983).

Alzheimer's Disease

Alzheimer's Disease is a progressive, degenerative, and irreversible brain disorder that impairs a person's ability to think, remember, make decisions, understand and use language. AD becomes more prevalent as people age, generally affecting those 65 years and older, although people in their thirties, forties and fifties can acquire the disease. A person with AD, especially in the

early stage, may feel afraid, angry or frustrated because he/she is no longer able to do all the things that were possible before the onset of the disease. As the disease progresses, the ability to live independently is lost and, because there is no known cure, death inevitably follows. Although much research is underway to uncover the etiology of AD, there is currently no definitive diagnostic test that can be administered while the patient is still living. A definite AD diagnosis can be made only after death utilizing information provided by an autopsy. Such autopsies reveal changes in the brain that include unusual knots or tangles in nerve cells (called neurofibrillary tangles), clusters of debris from broken down nerve cells (called senile plaques) and a general shrinkage in brain tissue due to the destruction of so many nerve cells (Alzheimer Society of Canada, 1991; Cummings & Benson, 1992).

The etiology or cause of AD is also unknown. A number of possible causes have been suggested including chemical changes in the brain, a virus, environmental toxins, aluminum poisoning and genetic factors. None of these possible causes has been definitively confirmed (Cummings & Benson, 1992). However, there are some identified risk factors such as increased age, family history of AD, presence of Down's syndrome, and prior head injury. Recent research (Canadian Study of Health and Aging, 1994b) has also found preliminary associations between risk of Alzheimer's Disease and occupational exposure to glues, fertilizers and pesticides. The same study revealed that higher levels of education were a protective factor but further study is required as education may not be the actual source of the protection. For example, it may

be that a good diet reduces the risk of getting AD and that people with a higher education can afford to eat better foods than those with a lower education level.

NINCDS-ADRDA Clinical Diagnostic Criteria

The fact that AD has no known cause or cure and that it can only be confirmed at autopsy poses substantial difficulties in diagnosis. Until the mid-1980's, 20 percent or more of cases thought to be AD were found, at autopsy, to be other diseases. In addition, lack of uniformity in diagnostic criteria caused problems when comparing the results of research conducted by different investigators. In order to address this situation, a working group on the diagnosis of Alzheimer's Disease, established by the National Institute of Neurological and Communicative Disorders and Strokes (NINCDS) and the Alzheimer's Disease and Related Disorders Association (ADRDA), produced some standard clinical diagnostic criteria for AD (McKhann et al., 1984). The NINCDS-ADRDA criteria for *probable* AD include: dementia established by clinical examination and documented by a mental status screening test and confirmed by neuropsychological tests; deficits in two or more areas of cognition; progressive worsening of memory and other cognitive functions; no disturbance of consciousness; onset between ages 40 and 90, most often after age 65; and, absence of systematic disorders or other brain diseases that in and of themselves could account for the progressive deficits in memory and cognition. This probable diagnosis can be supported by: progressive deterioration of specific cognitive functions such as language, motor skills, and perception; impaired activities of daily living and altered patterns of behaviour; family history

of similar disorders; and, laboratory results indicating normal lumbar puncture and EEG or signs of cerebral atrophy on a CT scan with progression documented by serial observations.

In arriving at a *probable* AD diagnosis, perhaps one of the most difficult tasks is to rule out any other disorders that may account for the deficits in memory and cognition. Of particular importance are screening for depression, fronto-temporal dementia and vascular dementia, which can also cause cognitive impairment and may be confused with Alzheimer's Disease. Other conditions to consider include psychiatric disorders involving delusions and hallucinations and diseases such as Huntington's and Parkinson's (Cummings & Benson, 1992). In addition to meeting the *probable* AD criteria, researchers should also specify features that may differentiate subtypes of AD such as familial occurrence, onset before age 65, presence of Down's syndrome and coexistence of other conditions such as Parkinson's disease (McKhann et al., 1984).

A *definite* Alzheimer's diagnosis requires meeting the above clinical criteria for probable AD as well as histopathologic evidence obtained through autopsy or biopsy. Clearly, a definite diagnosis cannot be employed in this study but, in order to establish with as much certainty as possible that participants in the current study do have AD, the NINCDS-ADRDA criteria and guidelines for probable AD will be closely adhered to. As a result of employing the NINCDS-ADRDA criteria, misdiagnosis is now less than 10% (Miller, 1997). However, there is one notable shortcoming in relying on these criteria: individuals at early stages of AD are often missed (Cahn et al., 1997; Feldman, 1998; Tuokko,

Kristjansson & Miller, 1995).

Learning in Alzheimer's Disease

The process of learning involves the acquisition, consolidation and storage of information prior to remembering. Even at the early stages of AD, learning is impaired (Huppert, 1994; La Rue, 1992). Problems exist in both encoding and consolidation. In particular, individuals with AD show a failure to learn, even over repeated trials and, thus, exhibit a flat learning curve (Butters, Delis & Lucus, 1995). The rate of learning is slower, less information is acquired and the level of retention is lower than in healthy older adults. These deficits appear to occur in both visual and verbal learning (Welsh, Butters, Hughes, Mohs & Heyman, 1991).

In contrast to healthy older adults, those with AD benefit little from encoding enhancement activities during the learning process (Knopman & Ryberg, 1989). For example, having the opportunity to learn a word list by first making up sentences about the words provides a semantic context (i.e., meaning) that aids learning in normal older persons (La Rue, 1992). However, in AD, such learning aids appear to be of little value. Further, the learning style of persons with AD can be characterized as passive as exemplified by the tendency to recall items from the end of a word list (Delis, Kramer, Kaplan, & Ober, 1987). Rapid loss of information, even when retrieval demands are minimal, suggests deficits in information storage (Zec, 1993).

Memory in Alzheimer's Disease

Memory deficits are also apparent in very early stages of AD and, along

with the connected learning problems, are one of the first indications to the individual with AD, and to their families, that something is wrong.

Free recall, cued recall and recognition. In assessing memory, three types of procedures are potentially employed: free recall, cued recall and recognition. Free recall requires the individual to remember previously acquired information completely unaided (e.g., "Draw the picture you saw 10 minutes ago."), thus, placing high demands on search and retrieval processes. Cued recall utilizes the same search and retrieval processes as free recall but the individual is provided with a cue about the information to be remembered (e.g., "Remember the picture of the farmyard you saw 10 minutes ago? Please draw it now."). Finally, recognition is the least demanding memory task requiring only a familiarity judgement (e.g., "Pick out the picture you saw 10 minutes ago from among these 4 pictures.").

As with healthy older adults, persons with AD find recall (both free and cued) more difficult than recognition and free recall more difficult than cued recall. In the early stages of AD, memory deficits are most noticeable with free recall tasks, but AD patients also score below normative levels on both cued recall and recognition tasks (Huppert, 1994; Incalzi, Capparella, Gemma, Marra & Carbonin, 1995; La Rue, 1992). The deficits AD patients exhibit with recall and recognition tasks (in comparison to age-related norms) are present in both verbal and visuospatial memory (Sahakian et al., 1988).

Verbal memory. Tests of verbal memory are relatively more "pure" in form than visuospatial memory tests which often include visual, spatial and

constructional components that can be hard to tease apart. Typical verbal memory tasks would include learning and remembering word lists, paired word associates (e.g., fruit/apple) and short stories. In persons with AD, it is semantic memory deficits (acquiring and remembering an item based on its meaning) that appear to have a major impact on verbal memory. If one cannot encode the meaning of a word, it is likely that remembering the word will be more difficult. The source of semantic deficiencies in AD patients is not yet identified. Is verbal memory loss due primarily to encoding, consolidation or retrieval problems? Are encoding deficits caused by attentional or semantic deficiencies? In addition to these unanswered questions, another problem is the large amount of variation in the verbal memory abilities of those with AD. This range of capability, whether due to premorbid ability, the stage of the disease or neuropsychological heterogeneity (indicating possible subtypes of AD), makes it difficult to identify a clear cut profile of verbal memory deficits in persons with AD (Strite, Massman, Cooke & Doody, 1997).

Visuospatial memory. Deficits in visuospatial memory are generally acknowledged as one of the earliest signs of Alzheimer's Disease (Robinson-Whelan, 1992; Sahgal et al., 1992). Although clinically helpful, there remain many questions about what, precisely, visuospatial memory tests are measuring. Unlike verbal memory, where relatively pure measures have been developed (e.g. word lists and short stories), investigating visuospatial memory appears to be more complex. Typical visuospatial memory tasks include visual reproduction (copying and remembering a design or group of designs) or visual paired

associates (e.g., matching a design with a colour). Pictures of identifiable objects can also be used but tend to encourage verbal encoding and, therefore, confound an assessment of verbal and visuospatial memory. Geometric figures which have been designed using components that are not easily encoded verbally or semantically have been relatively successful in dealing with this problem. However, difficulty teasing out the visuo-perceptive component (i.e., applying meaning to a visual array), the visuospatial component (i.e., the ability to process spatial relationships in visual information) and the visuoconstructional component (the ability to construct a visually presented item) of visuospatial memory remains a problem (Ricker, Keenan, & Jacobson, 1994). In fact, it has been suggested that performance on visuospatial memory tests by AD patients may reflect more on visual-perceptual, constructional and executive abilities than on memory (Taylor, 1994).

Keeping these concerns in mind, it is perhaps not surprising that there is some equivocation amongst researchers as to precisely which components (i.e. visual, spatial or constructional) are affected in mild AD. Robinson-Whelan (1992) suggests that it is visual memory that is affected early in the disease with visuospatial and visuoconstructional abilities affected later on. However, Kaskie and Storandt (1995) propose that there are visuospatial deficits even in very mild AD. In their research, Ricker, Keenan & Jacobson (1994) have determined that the relationship between visuospatial abilities and memory performance is more robust in clinical AD samples than in non-demented older persons. One explanation presented is that the greater amount of variability among demented

patients facilitates the detection of relationships that can be obscured in the normal population where performance is more homogeneous.

The heterogeneity of memory deficits in persons with AD makes it difficult to identify a single visuospatial (or verbal) memory profile. For example, Massman et al. (1993) have presented a visuospatial memory profile with three subgroups of AD patients including: 1. those who performed better on verbal tests; 2. those who performed better on visuospatial tests; and 3. those who had equivalent performance on each. More recently, Strite, Massman, Cooke and Doody (1997) have confirmed asymmetry (individual differences) in verbal and visuoconstructional deficits across all stages of AD. Huppert (1994) suggests that, rather than being AD profiles, the apparent subgroups could simply represent predisorder differences. Whatever the origins of possible subgroups within an AD population, it would appear that this heterogeneity should be taken into account when assessing verbal and visuospatial memory rather than simply evaluating the mean memory level of a given sample.

Rate of forgetting. Rate of forgetting refers to the rate at which information is lost independent of the amount or rate at which it is acquired. In other words, the fact that one individual may learn more words on the list than another or may learn a word list at a faster rate than another, does not necessarily have any impact on the rate of forgetting. The baseline for determining forgetting rates is the amount of information learned by the end of training (i.e., learning trials). Starting from this point, another measurement is taken, after a specified time delay, to determine how much information has been

lost. The rate at which an individual has forgotten learned material can then be calculated. Subsequent measurements can also be taken after increasingly longer delays and further rates of forgetting can be determined.

In the literature, there are a variety of methods used to determine rates of forgetting. One method is to ensure that both groups have acquired the same amount of information at the conclusion of the learning trials (i.e., 80-90% of the material) but without attaining the maximum score. Measurements of information forgotten are then taken at one or more delay intervals with rates of forgetting calculated in terms of absolute number of items lost. The logic for not reaching maximum score is that, at maximum, it will not be possible to differentiate between those who have overlearned the material and those who have just learned it at the end of the last acquisition trial.

Rates of forgetting can also be evaluated by looking at relative decline in the number of items remembered over time (i.e., comparing slopes). In this method, groups can start at different levels of acquisition because the researcher's interest is in whether the difference between the groups stays the same or varies significantly across different delay intervals. Another approach, deriving difference scores, can also be used. Difference scores are calculated by subtracting a measurement taken after a delay interval from one taken at a the end of acquisition (i.e., the last learning trial). These difference scores are then compared to determine if there is a statistically significant difference between the difference scores of each group.

Finally, another derived score known as a savings score (or percent

retained) can be calculated by dividing the delay score by the final acquisition score and multiplying by 100. There is a problem that arises with savings scores that is of particular concern when assessing persons with low acquisition scores such as may be the case in Alzheimer's disease. Specifically, when raw scores in one group are substantially lower than those in the second group (after completion of learning trials), the percentage saved (after a delay interval) in each group can appear to be markedly different even if the number of items forgotten is, in fact, the same.

With regard to Alzheimer's Disease, the findings regarding rates of forgetting are equivocal. Research in which forgetting rates have been measured after relatively longer intervals (i.e., a minimum of 10 minutes and usually longer) has found no difference between the forgetting rates of AD patients and normals (Knopman, 1991; Kopelman, 1985). Most of these studies were conducted using recognition memory tasks (Huppert & Piercy, 1978) in which the subjects need only make a familiarity judgement. However, studies using the Huppert and Piercy method, but with delay intervals under 10 minutes, found sharp increases in forgetting immediately after the last learning trial (La Rue, 1992). Similarly, other research using recall rather than recognition has also shown a sharp decline in recollection immediately following learning (Butters, Delis & Lucus, 1995). These findings, taken as a whole, suggest that there may be acquisition and/or consolidation deficits rather than a retrieval problem in Alzheimer's Disease. That is, if there is a sharp decline in what is remembered immediately after learning has taken place, it would seem that the

problem is less likely to be an inability to locate and retrieve the information from memory but rather that the item to be remembered did not make it into memory in the first place.

In terms of evaluating rates of forgetting, an additional problem has arisen using recall tasks with demented subjects. Specifically, when tests are too difficult, initial levels of learning are extremely low (showing floor effects), thus making it difficult to evaluate either difference or savings scores in those with AD. Therefore, a memory test simple enough that the cognitively impaired do not "bottom out" would be helpful in reaching a more definitive conclusion regarding rates of forgetting in AD.

Problems with Current Tests of Memory

Use of current memory tests with older adults. Most currently available memory tests have not been designed to address the assessment needs of older adults. Rather, most tests (e.g., Wechsler Memory Scale - Revised, Benton Visual Retention Test, California Verbal Learning Test) were created with the objective of evaluating memory performance over the entire adult lifespan. These tests are usually administered under standardized conditions with everyone, regardless of age, given the same instructions and time limits. While this may seem the best approach in terms of standardization and test reliability, there are instances, such as with older adults, where this methodology tends to decrease the validity of test results. For example, because standardized memory tests do not take into account the slower processing and learning abilities of older people (Powell, 1979; Salthouse, 1982), their memory abilities

can be seriously underestimated.

Often memory tests are too difficult and older adults become anxious and frustrated because they do not perform well. This may, in turn, decrease the individual's motivation causing them to expend less effort during testing or to become noncompliant. As a result, the older adult may learn less information which makes the interpretation of retention levels problematic. In fact, an older adult's performance on some memory tests may be so low that monitoring retention and change over time is very difficult. These problems are further magnified with a cognitively impaired population (Hubley, 1995; La Rue, 1992).

Use of current memory tests for persons with Alzheimer's Disease. Persons with AD tend to score poorly on traditional learning and memory tests. The result is 'floor-effects' where scores are so uniformly low that it is difficult to measure further decline or to differentiate one individual's score from another. For example, if persons with AD score an average of 2 out of a possible 20 points on a memory test, it is difficult to measure further deterioration because there is no room on the scale to account for additional decline. In other words, there is a lack of range or differentiation of scores because everyone does poorly. This does not, however, mean that there are not differences between individuals taking the test. Nor does it mean that further memory changes do not take place over time. It simply means that the testing instrument being used is not sensitive to these differences or changes.

The bottoming-out of memory scores has practical implications for the care and treatment of those with AD. Because clinicians may be unable to

provide meaningful learning and memory scores beyond the fact that AD individuals perform very poorly, test results afford little assistance to those determining treatment protocols and making ongoing lifestyle and treatment decisions.

Research suggests that individuals with dementia of the Alzheimer's type often score so poorly on standard memory tests that tracking the course of memory changes is simply not possible (Eslinger, Damasio, Benton & Van Allen, 1985; LaRue, D'Elia, Clark, Spar & Jarvik, 1986; Welsh, Butters, Hughes, Mohs & Heyman, 1991). Even those individuals with mild Alzheimer's Disease (AD) can exhibit severe memory deficits such as remembering fewer than two items in immediate recall of a short story (Butters, Granholm, Salmon, Grant, & Wolfe, 1987), reproducing only two of ten geometric designs and show almost no evidence of learning difficult, abstract, or unrelated word pairs such as spirit/interest (LaRue et al., 1986). In addition, low scores and an essentially flat learning curve have been reported when administering the Rey-Auditory Verbal Learning Test (R-AVLT) and the Rey-Osterrieth Complex Figure Design (R-O CFD) to early stage AD patients (Bigler, Rosa, Schultz, Hall & Harris, 1989).

It can, therefore, be seen that the use of standard memory tests for AD patients results in scores at the lower extremity of the test range and, generally, does not allow for discrimination among different degrees of dementia nor for tracking memory changes over time (Blackburn & Tyrer, 1985; Miller, 1981). Taking all of these potential shortcomings of standard memory tests into account, it is clear that there is a need for the design and testing of a memory

instrument created specifically for older adults, and especially for the cognitively-impaired.

CHAPTER TWO

Current Research

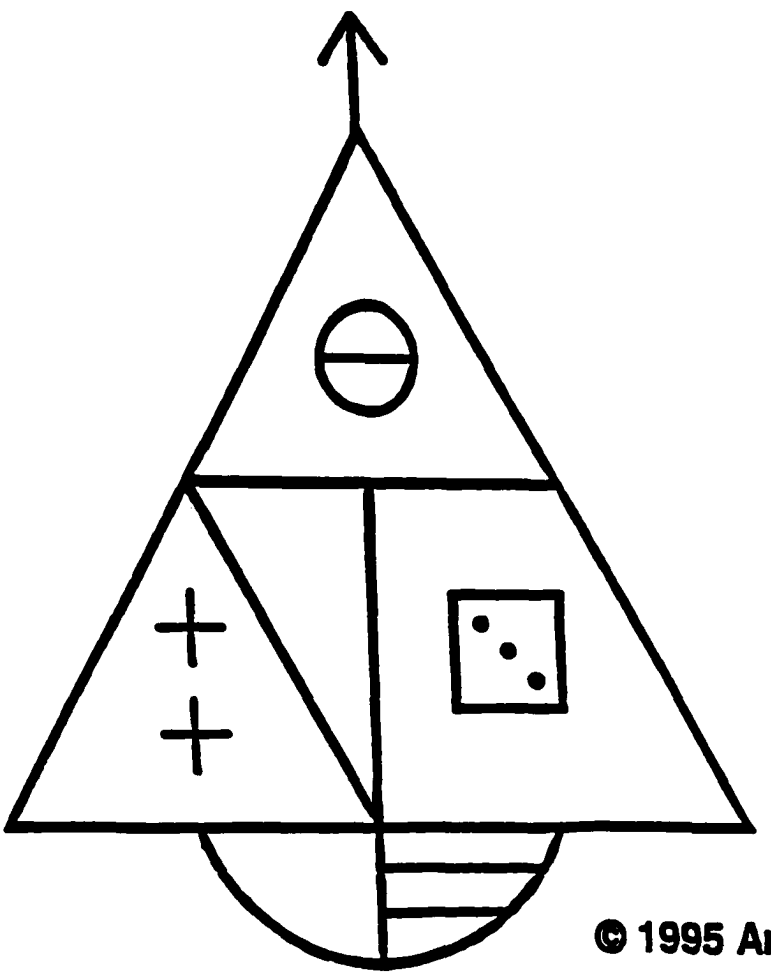
The current research focuses on the appropriateness of a recently developed test, the Geriatric Learning and Memory Battery (G-LAMB; Hubley, 1995), for an Alzheimer's population. The G-LAMB, which is composed of two relatively easier tasks than standard memory tests, is specifically designed to help monitor verbal and visuospatial memory in people already diagnosed with cognitive deficits. In particular, the G-LAMB is expected to allow for the range of scores missing from the performance of cognitively-impaired persons on many standardized memory tests and, because of this, is meant to permit differentiation among different levels of impaired performance. The G-LAMB is composed of a simple story (Paragraph) for assessing verbal memory and a simple geometric design (Figure) for assessing visuospatial memory (see Figure 1, next page). Stories and designs are commonly used to assess memory. However, the G-LAMB Figure is much simpler than the traditionally used Rey-Osterrieth Complex Figure and the Paragraph is made even simpler than most by including a self-read procedure in its administration. This provides the individual with the opportunity to use other memory strategies beyond those available when the tester *only* reads the story aloud.

The G-LAMB has already been normed on 180 community-dwelling adults aged 55-85 years (Hubley, 1995). With a healthy community sample of older adults, the level of learning on the G-LAMB met the expected goals -- that is, at

Figure 1.

G-LAMB Paragraph and Figure

On Sunday, Jane and her five-year-old brother went to a circus in Paris. At 4:15, when they were buying their tickets, it started to rain. As they were running for the animal tent, the boy tripped and cut his leg. A clown gave him two balloons, and phoned his mother.



least 90% of material was learned by the last acquisition trial. Such high acquisition levels in a cognitively intact sample are expected to allow for a relatively "high" enough level of performance (and range) in persons with cognitive deficits and, in particular those with AD, that clinicians and researchers will be able to more easily differentiate among different levels of performance and track type and rate of changes in performance over time using this test.

Being able to identify changes in memory capacity (usually declines, but sometimes improvements) is not only important in determining a person's strengths and weaknesses in both verbal and visuospatial memory but is also invaluable in designing treatment regimes based on these strengths and weaknesses. For example, if a person does particularly poorly on the Figure, a decision could be made that reorganizing the furniture of his or her living quarters or planning a move to a new home might not be appropriate because the capability to remember a new layout is compromised. At the same time, verbal memory may remain relatively stable and so the present ability to give the person short verbal instructions about something (e.g., an exercise to be repeated during physiotherapy, information about an appointment later in the day) may be preserved. Such information can assist caregivers, both in the home and in care facilities, to design their interventions more effectively by placing more emphasis on a person's strengths and less on their weaknesses. As a result, individuals with cognitive impairments can be afforded a better quality of life.

In terms of clinical application, it is expected that the G-LAMB will provide

a *brief* measure of verbal and visuospatial memory that will permit a wide enough range of scores to obtain a sensitive measure of level of performance and change over time among individuals with Alzheimer's disease. Furthermore, the G-LAMB should allow clinicians to obtain useful information about the strengths, weaknesses and relative rate of decline in an individual's verbal and visuospatial memory. This information should assist in placement decisions as well as evaluating, designing or modifying approaches to any treatment or therapy (such as physiotherapy, occupational therapy, speech therapy, and pharmacological interventions) and generally assist in setting realistic expectations about the individual's abilities at any given point.

The specific objectives of the proposed research are: (1) to determine whether the average performance on the G-LAMB of persons who have mild to moderate Alzheimer's Disease (AD) will be high enough to permit assessment of change (usually declines) over time, and show enough range to be sensitive to differences among cognitively impaired individuals, (2) to compare verbal and visuospatial memory performance of individuals with mild to moderate AD with the norms for healthy community-dwelling older adults, and (3) to examine the relationship of the G-LAMB subtests to similar tests within an AD sample. Although designed as a tracking test, the current research on the G-LAMB involves a one-time test only in order to determine if participants will score high enough to allow for the range necessary for assessment over time. The tracking of memory performance over time demands the use of multiple geometric figures and paragraphs of equivalent levels of difficulty so that practice effects from

using the same materials will not be a confounding factor in the scores obtained. However, multiple equivalent test materials will not be developed until the utility of the existing G-LAMB subtests can be shown.

Hypotheses

Total AD Group versus normative sample.

1. The learning, memory, and visuospatial constructional performance of persons with AD on both the verbal (Paragraph) and visuospatial (Figure) G-LAMB subtests is predicted to be significantly lower than the norms derived from a healthy population of older adults. Rate of forgetting on both G-LAMB subtests is expected to be significantly higher for persons with AD than for the normative group.

Mild AD Group versus Moderate AD Group.

1. It is expected that the average scores of participants with mild levels of cognitive impairment on both the verbal (Paragraph) and visuospatial (Figure) G-LAMB subtests will be high enough (i.e., will not show floor effects) that there will be room to identify changes in verbal and/or visuospatial learning and memory over time.

2. The learning and memory performance of persons with Mild AD on both G-LAMB subtests, as well as visuospatial construction scores on the Figure, are predicted to be significantly higher than the performance of persons with Moderate AD. Rate of forgetting on both subtests is expected to be significantly higher for the Moderate AD group than for the Mild AD group.

Relationship of G-LAMB subtests to similar tests within an AD sample.

1. Statistically significant, positive correlations are expected between the G-LAMB Paragraph and the other verbal tests administered (i.e., LAMB Word List B, Verbal Fluency (FAS and Animals) and the Boston Naming Test).

2. Statistically significant, positive correlations are expected between the G-LAMB Figure and the other visuospatial tests administered (i.e., LAMB Simple Figures and the Clock Test).

The following associations will also be examined, although no specific hypotheses are presented: (1) the relationship between performance on the G-LAMB Paragraph and Figure within an AD sample, and (2) the relationship of the age, education and mental status scores of the AD sample to performance on the G-LAMB subtests.

CHAPTER THREE

Method

Participants

Fourteen persons with Alzheimer's Disease were selected to participate in the study on a volunteer basis. The Mild group included three men and four women whereas the Moderate group was composed entirely of women. Tables 1 and 2 (see next page) provide additional demographic information on the Mild and Moderate groups, respectively. Informed consent was obtained from the participant and/or conservator as applicable (see Appendix A).

Norms. Normative data (Hubley, 1995) referenced throughout the study was based on a sample of 169[1] healthy, community-dwelling older adults (77 men and 92 women) who ranged in age from 54 to 85 years (M = 69.7, SD = 8.63). Education levels varied from 8 to 16 years (M = 12.3, SD = 2.01) and Mini-Mental State Examination (MMSE) scores (Folstein, Folstein & McHugh, 1975), which ranged from 25 to 30, were all above the accepted cut-off score of 24.

Recruitment of clinical sample. Participants were recruited in Prince George and the surrounding area through a variety of methods (see Appendix B). Initially, local and regional Alzheimer organizations and care facilities were approached. In the latter case, facility staff approached the families of potential study participants first in order to obtain permission for the researcher to contact the family members directly (see Appendix C). Local and regional media

[1] Although the norms were originally derived from a sample of 180 healthy, older adults (see page 18), the normative sample for the current study included only those individuals within the age and education range of the AD sample; thus, n = 169.

Table 1

Demographic information for Mild AD group (n=7)

Variable	Mean	Std Deviation	Range
Age	70.4	9.93	54 - 80
Education	11.3	2.50	8 - 16
MMSE	27.7	1.60	25 - 30
GDS	6.9	4.10	2 - 12

Note. Education is reported in years; MMSE = Mini-Mental State Examination (max. score = 30; higher score = less likelihood of cognitive impairment); GDS = Geriatric Depression Scale (max. score = 30; higher score = greater severity of depression).

Table 2

Demographic information for Moderate AD group (n=7)

Variable	Mean	Std Deviation	Range
Age	84.3	7.95	72 - 93
Education*	8.5	2.59	6 - 13
MMSE	21.4	1.72	19 - 23
GDS	8.6	3.87	5 - 14

Note. Education is reported in years; MMSE = Mini-Mental State Examination (max. score = 30; higher score = less likelihood of cognitive impairment); GDS = Geriatric Depression Scale (max. score = 30; higher score = greater severity of depression).
*n=6; a woman with no formal education (but who was home schooled) was excluded from the education calculation.

coverage followed. In addition, research information and/or posters (see Appendices D and E, respectively) were delivered to physicians in an area bounded by Williams Lake in the south and Mackenzie in the north to McBride in the east and Burns Lake in the west. Pharmacists in Prince George, Quesnel and McBride were also contacted. A presentation was made to the Prince George Regional Hospital (PGRH) Research Review Committee as well as to the hospital's Psychiatric Outpatient Clinic staff. Study information was available in the PGRH emergency department and medical/geriatrics area. The Psychogeriatric Outreach Assessment Team, the Canadian Mental Health Association, and Home Support Services were provided with information about the study as well. Finally, local seniors' organizations, including senior housing developments, were contacted. As a result, individuals from Prince George, Fort St. John, McBride and Quesnel participated in the study. Out of town subjects were tested in their own locales.

NINCDS-ADRDA Criteria

Study participants were required to meet the NINCDS-ADRDA criteria for probable AD (McKhann et al., 1984). NINCDS-ADRDA requirements include estimating the level of cognitive impairment, confirming deficits in memory and at least one other area of cognitive functioning and ruling out other systemic disorders or brain disease. These requirements were assessed as follows:

1. Estimation of cognitive impairment

a. The Mini-Mental State Examination (MMSE: Folstein et al., 1975) was administered in order to estimate the severity of overall cognitive

impairment. Based on research by Welsh, Butters, Hughes, Mohs & Heyman (1991) with an AD sample, mild impairment is defined as MMSE scores of 24 or greater with moderate impairment consisting of scores between 19 and 23. Scores of 14 to 18 indicate moderate/severe impairment and scores less than 14 are designated as severe impairment.

2. Deficits in two or more areas of cognitive functioning (one of which must be memory)

Deficits in cognitive functioning were assessed as follows:

a. memory: delay trials for the Learning and Memory Battery (LAMB) Word List B (Hubley,1995) and the LAMB Simple Figures (Schmidt & Tombaugh, 1995; Tombaugh & Schmidt, 1992);

b. visuospatial skills: copy trials for The Clock Test (Libon, Malamut, Swenson, Sands, & Cloud,1996; Rouleau, Salmon, Butters, Kennedy, & McGuire, 1992) and the LAMB Simple Figures (Schmidt & Tombaugh, 1995; Tombaugh & Schmidt, 1992);

c. language skills: Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983) and the Verbal Fluency Task (FAS and Animals; Borkowski, Benton, & Spreen, 1967).

When assessing test performance, selecting the cut-off score necessary to meet the criteria for a cognitive deficit is a critical issue. In this context, one of the growing concerns of researchers studying the diagnosis and treatment of AD is how to detect and evaluate those individuals who are at a very early stage of the disease and for whom neuropsychological tests are often not sensitive

enough to identify the disease (Cahn et al., 1997; Feldman, 1998; Tuokko et al., 1995). This is of particular importance if early stage individuals are going to have the opportunity to benefit from new treatments (e.g., drugs such as Aricept). In this regard, the gold standard NINCDS-ADRDA criteria themselves may need refinement or supplementation in order to include individuals in the early stage of AD (Feldman, 1998). However, until other criteria are established or neuropsychological tests more sensitive to early signs of cognitive decline are developed, the NINCDS-ADRDA referents remain the accepted diagnostic tool for AD research. It is within this context that the more liberal one standard deviation below normal peer performance has been adopted in the current study as the appropriate cut-off to meet the NINCDS-ADRDA criteria for deficits in cognitive functioning (Rediess & Caine, 1996; Rissenberg & Glanzer, 1987).

3. Ruling out other systemic disorder or brain disease

In addition to studying charted patient histories, the following tests were administered in order to help rule out other systemic causes for patient symptoms:

a. The Revised Hachinski Ischemic Scale (Hachinski et al., 1975; Rosen, Terry, Fuld, Katzman, & Peck, 1980) was used to assess the likely presence of vascular dementia (i.e., dementia due to stroke or a series of small ischemic incidents). Individuals with a score of 3 or more were excluded from the study.

b. The Geriatric Depression Scale (Yesavage et al., 1983) was administered to screen for depression. Individuals in the depressed range

(i.e., scores > 14) were excluded from the study.

Patient charts, supplemented by discussion with the physicians and families (and, where possible, the participants themselves), were used to verify progressive worsening of memory and other cognitive functioning, to identify any history of head injury resulting in loss of consciousness, to estimate the age of onset of dementia (which should be approximately 40 to 90 years), and to identify any prescribed medications. Individuals who were taking medications producing substantial sedative or cholinergic effects or who had a known history of neurological disease, psychiatric distress, or head injury were excluded from the study.

Meeting the Diagnostic Criteria

As a result of the wide range of recruitment methods employed, 65 prospective participants, or their family members, contacted the Aging and Memory Laboratory regarding participation in the current study. It was then necessary to determine whether each potential subject met the previously outlined criteria.

A preliminary screening was conducted by telephone with each individual or family contact. The purpose of this initial contact was to identify and screen out individuals who were clearly not suitable candidates for the study. For example, some people indicated that they had no symptoms whatsoever but were concerned because there was a history of AD in their family. Others had been diagnosed with another type of cognitive impairment altogether (e.g., brain injury) but thought it would be similar enough to AD to warrant their participation

in the research. These individuals (10 in total) were informed that they would not be appropriate participants for this particular study but were invited to have their names placed on a list for future research regarding memory and/or aging.

A medical and demographic information sheet and/or the Revised Hachinski Ischemic Scale were then completed for each of the 55 remaining prospective participants. Information was obtained from the individuals themselves (where possible), from family members, and from charts (for those living in care facilities). People were deemed ineligible if their medical and demographic history provided information that either ruled out a probable AD diagnosis or suggested a co-existing neurological condition (e.g., history of alcohol abuse or stroke), indicated severe perceptual problems (e.g., significant vision or hearing loss), revealed an advanced stage of AD with serious communication problems that would preclude testing, or suggested the need for testing in a language other than English. Once again, the 15 excluded individuals were approached regarding placement on a list of potential participants for future research. Thus, prior to beginning any formal testing, the potential sample size was reduced from 65 to 40.

The testing process was initiated with the remaining 40 participants. Fifteen of these individuals were unable to complete the testing regime either due to illness (n = 3) or because of their own unwillingness or inability to finish (n = 12). Therefore, 25 subjects completed the entire test battery. However, successful completion of all tests did not guarantee inclusion of an individual in the final research sample. In fact, tests other than the G-LAMB Paragraph and

Figure were included in the study primarily in order to determine if participants met the NINCDS-ADRDA criteria for probable AD (McKhann et al., 1984) and, specifically, whether deficits in two or more areas of cognitive functioning (including memory) could be identified. Upon completion of test scoring, seven individuals were immediately excluded: two had elevated depression scores and five displayed no cognitive deficits.

The remaining 18 participants were divided into the following categories for further consideration:

1. mild: those with an MMSE score equal to or greater than 24 accompanied by at least two areas of cognitive deficit;
2. moderate: those with an MMSE score of 19 to 23 inclusive accompanied by at least two areas of cognitive deficit;
3. moderate/severe: those with an MMSE score of 14 to 18 inclusive accompanied by at least two areas of cognitive deficit;
4. severe: those with an MMSE score less than 14 accompanied by at least two areas of cognitive deficit.

Figures 2 and 3 present performance on the learning, memory and copy trials of the G-LAMB Paragraph and Figure respectively for each individual participant in the previously-mentioned categories[2].

Although the study was focused primarily on those people with mild to moderate AD who clearly met the research criteria, two moderate/severe and two severe individuals were tested in order to evaluate the (lower) limits in the

[2] Because the performance of the moderate/severe and severe groups cannot be easily differentiated, these groups are combined and labelled "severe" to improve visual clarity in Figures 2 and 3.

potential utility of the G-LAMB. As Figures 2 and 3 indicate, the performance by individuals in the moderate/severe and severe groups show floor effects suggesting that the G-LAMB would not be particularly useful in differentiating these groups from each other or from the moderate group. Thus, these four individuals were also excluded from the final sample. Therefore, although the research began with 65 potential participants, the number of subjects meeting all the necessary criteria, and providing useful data with which to evaluate the G-LAMB, was 14: seven individuals with mild AD and seven individuals with moderate AD[3].

Procedure

Study participants who met the study criteria were individually administered a series of cognitive and memory tests 1 1/2 hours in length. If participants found the testing too long for one sitting, it was divided into two shorter sessions. Testing occurred in several different locations including private resident rooms in care facilities, designated testing rooms in care facilities, in the homes of participants and, finally, in the Aging and Memory Laboratory at UNBC. In each environment, strict measures were taken to prevent outside interruptions to the testing procedure.

The sequence of test administration is of particular importance in this study. Not only are there the usual considerations required in order to accommodate delay intervals for those tests with delay trials but there is the

[3] This is not an epidemiological study and thus no inference should be drawn regarding the incidence or prevalence of AD in Northern B.C. based on the number of potential participants who did or did not meet all study criteria.

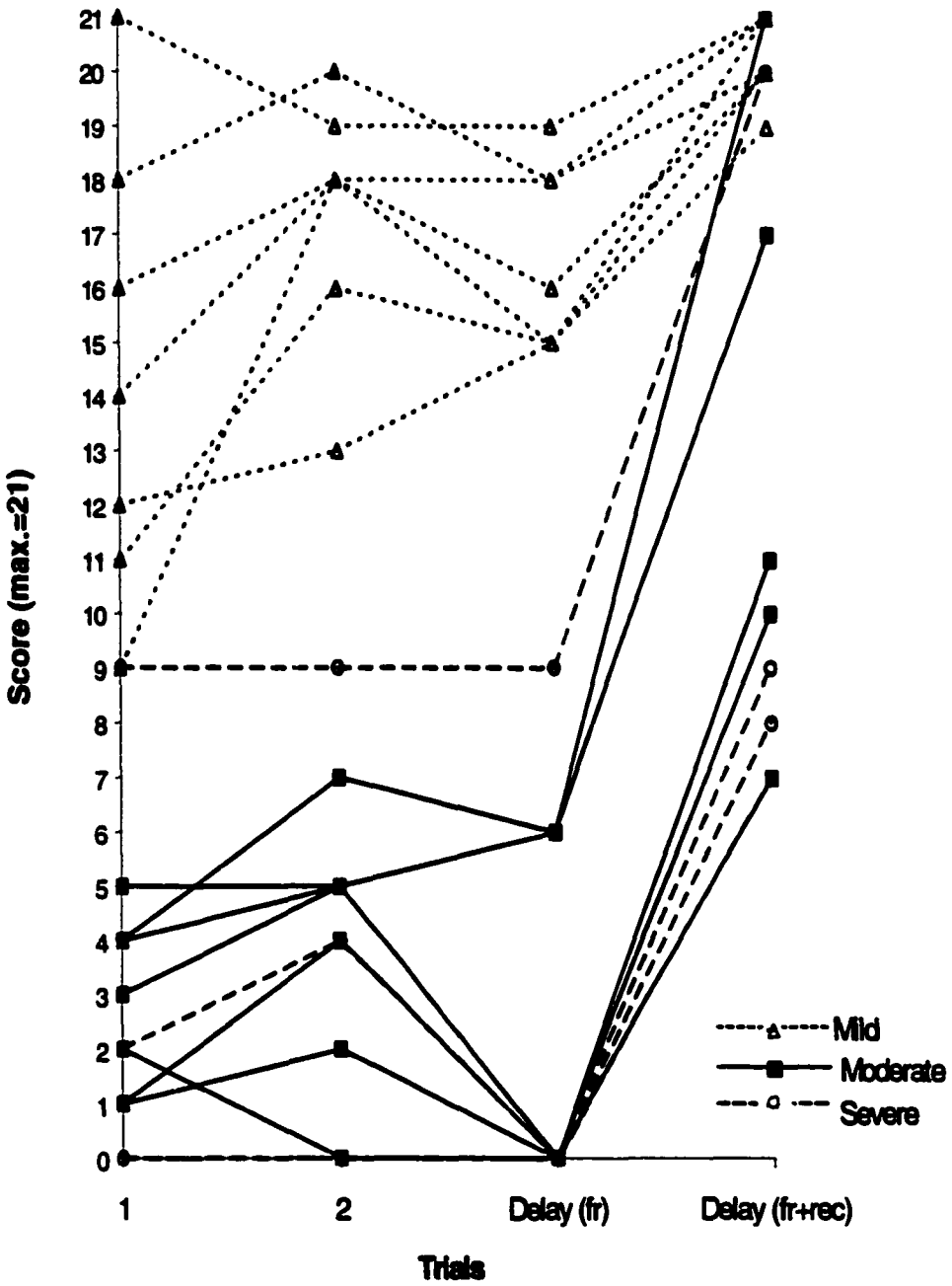


Figure 2. Individual performance on G-LAMB Paragraph Trials for AD groups: Mild (n=7), Moderate (n=7), Severe (n=4).

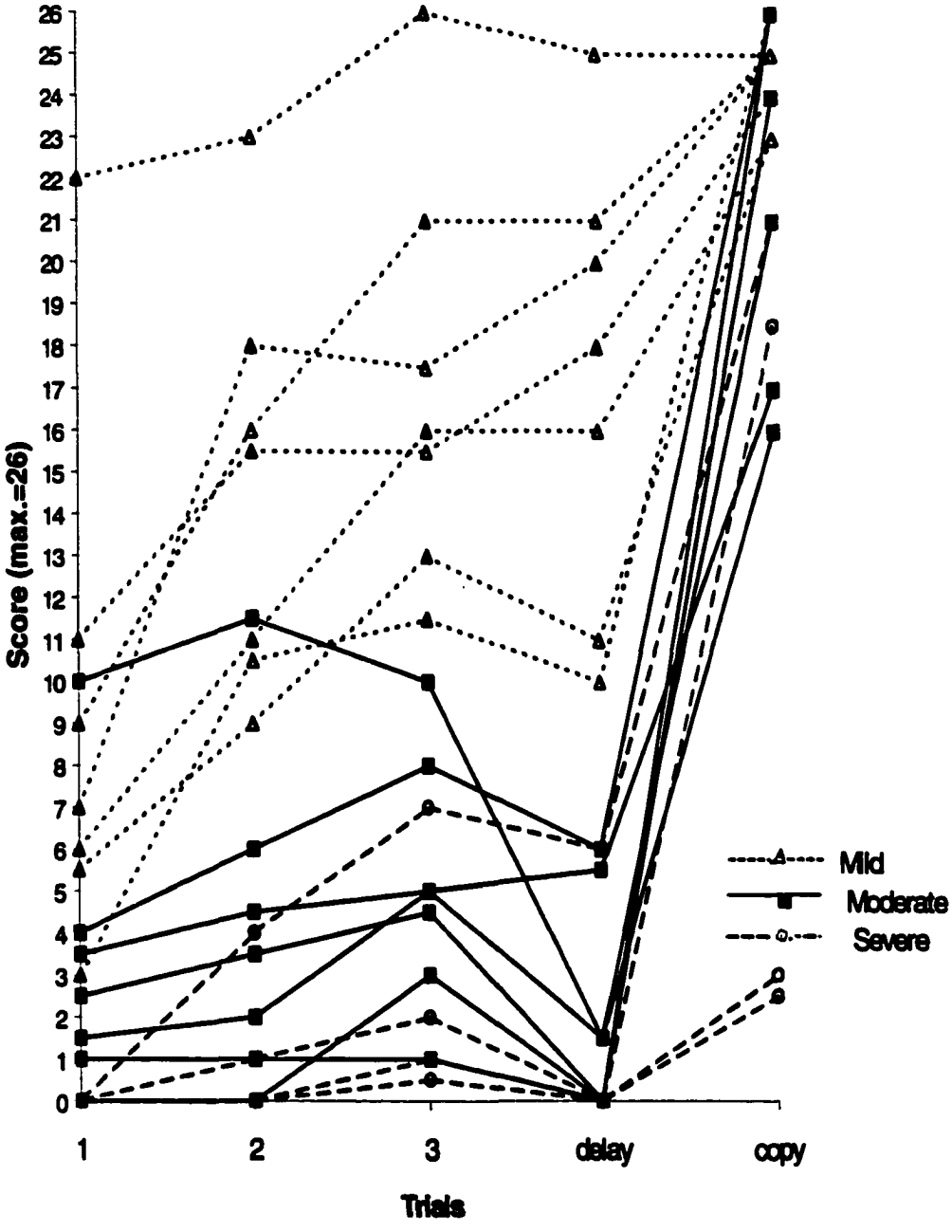


Figure 3. Individual performance on G-LAMB Figure Trials for AD groups: Mild (n=7), Moderate (n=7), Severe (n=4).

added difficulty of testing a group that may be unable to complete all of the tests or may require a second sitting. Because of these potential problems, tests have been sequenced not only to provide appropriate delay intervals but also to ensure that the tests most critical to the success of this research are completed as early as possible in the session. With this rationale in mind, the following test order was employed:

1. Mini-Mental State Examination
2. Geriatric Depression Scale
3. G-LAMB Paragraph (learning - 2 trials)
4. G-LAMB Figure (learning - 3 trials)
5. G-LAMB Paragraph (memory and recognition)
6. The Verbal Fluency Task (FAS and Animals)
7. G-LAMB Figure (memory and copy)
8. Hubley Depression Scale (filler task)
9. LAMB Simple Figures (learning - 3 trials)
10. LAMB Word List B (learning - 5 trials)
11. The Clock Test
12. LAMB Simple Figures (memory and copy)
13. LAMB Word List B (memory and recognition)
14. Boston Naming Test

Note: The Revised Hachinski Ischemic Score was determined from information provided by participants, family members, family physicians and/or medical charts; thus, it was completed before testing began.

Testing Materials

G-LAMB Paragraph (Hubley, 1995): The Paragraph from the G-LAMB is administered using an intentional learning procedure which means that the participant is informed of the memory component to the task. The Paragraph is read aloud to each subject by the tester, following which the participants have 30 seconds to read and study the story themselves[4]. Subjects are then asked to recall all they can remember about the story. There are two acquisition (i.e., learning) trials. After a 10 minute delay interval, the subject is again asked to recall all he or she can remember about the Paragraph. For each of the learning trials and the delayed interval trial, the maximum possible free recall (FR) score is 21 points. After the free recall portion of the delay trial, subjects are given a recognition task in which they are asked four-option multiple choice questions about any parts of the Paragraph they could not remember or that they recalled incorrectly. The maximum possible score for free recall plus recognition (FR + rec) is also 21 points.

G-LAMB Figure (Hubley, 1995): As with the Paragraph, the Figure from the G-LAMB is administered using an intentional learning procedure. The Figure is presented to each subject for 30 seconds. The Figure is then removed and participants are given 2 minutes to draw as much of the Figure as they can from memory. There are three acquisition trials. After 10 minutes, a delay trial is administered in which subjects are again asked to draw as much of the Figure as possible from memory without viewing the Figure first. Finally, a copy trial is

[4] If subjects are unable to read to themselves, the paragraph is read to them again.

administered in which subjects are asked to copy the Figure while it is in front of them. The maximum possible score for any trial is 26[5].

Mini-Mental State Examination (MMSE -- Folstein et al., 1975): The MMSE is a quick screening test of cognitive functioning. It is administered to assess the level of cognitive functioning in the AD subjects. The 100-point, modified MMSE (3MS) was not selected because recent research has shown that adding additional items and modifying the scoring system has not significantly improved the test's sensitivity and specificity (Tombaugh, McDowell, Kristjansson & Hubley, 1996).

Geriatric Depression Scale (GDS -- Yesavage et al.,1983): The GDS is a 30-item questionnaire designed to screen for depression in the elderly using a yes/no format. The scale has been renamed the "Life Satisfaction Scale" in order to counteract potential social desirability bias in responses.

The Revised Hachinski Ischemic Scale (IS - Hachinski et al., 1975; Rosen et al., 1980): The revised IS, an 8-item clinical assessment tool, is used to help distinguish vascular dementia (VaD) from AD dementia. Although some recent research questions the discriminative ability of the IS (Swanwick & Coen, 1995), it remains the best option for differentiating VaD from pure examples of AD (Tatemichi, Sacktor & Mayeux, 1994; Verhey, Lodder, Rozendaal & Jolles, 1996).

[5] The reader should be aware that no cross-cultural research has been conducted with either of the G-LAMB subtests and thus, familiarity or lack of familiarity with the type or content of test materials could have an impact on performance.

Hubley Depression Scale (HDS -- Hubley, 1994): The HDS is a 16-item questionnaire, with a yes/no format, designed to screen for depression in the elderly. In the present study, the scale is retitled the "CMAR Life Satisfaction Scale" in an attempt to avoid a social desirability bias in responding. The HDS is in the development stage and is not validated; thus, it was used as a filler task only and was not included in the analyses.

LAMB Word List B (Hubley, 1995): This 15-item word list, used to assess verbal learning and memory, is first read aloud to subjects who are next asked to verbally recall the words in any order. There are 5 acquisition trials in which both free and cued recall are used. There is a 20-minute delayed recall trial followed by a recognition trial. Maximum score on any trial is 15.

LAMB Simple Figures (Schmidt & Tombaugh, 1995; Tombaugh & Schmidt, 1992): This test is used to assess visuospatial learning and memory. A card containing four simple designs is presented for 15 seconds. The card is removed and the subject is asked to draw all four figures in the same order in which they appeared on the card. There are three acquisition trials followed 20 minutes later by a free recall trial and finally a copy trial. Maximum score on any trial is 16.

Boston Naming Test (BNT -- Kaplan, Goodglass, & Weintraub, 1983): The Boston Naming Test assesses language deficits (specifically, anomia) by requiring subjects to name each of 60 line drawings of objects ranging in familiarity from "bed" to "protractor". If the person is unable to correctly name the drawing, a stimulus cue can be given (e.g., for "bed" - it is something you sleep

on). If the individual is still unable to name the object, a phonemic cue is given (e.g., for "bed" - it starts with the sound of "b"). In the present study, the 30-item empirical version of the BNT was used (Williams, Mack & Henderson, 1989). This short form was empirically derived to maximally discriminate between Alzheimer patients and normal controls. The 30-item empirical version has been found to correlate 0.97 with the 60-item BNT (Tombaugh & Hubley, 1997).

The Clock Test (Rouleau et al., 1992): The Clock Test is a two-component measure of visuospatial constructional performance with both command and copy conditions. In the command condition, the participant is given a blank sheet of paper and asked to draw a clock, putting in all the numbers and drawing the hands to read 10 after 11. Next, the subject is shown a clock drawing that is three inches in diameter, with all numbers in place and the hands set to 10 after 11. The participant is given another piece of paper and asked to copy the model while continuing to view it. A quantitative scale (Scale 1) is used to evaluate inclusion, and accuracy, of basic clock components in both command and copy conditions (Rouleau et. al., 1992). Maximum possible score is 10. A qualitative scale (Scale 2) assesses graphomotor errors, hand/number placement, and executive control errors in each condition (Libon et al., 1996). One point is given for each error committed up to a maximum score of 10.

The Verbal Fluency Task (FAS and Animals -- Borkowski, Benton & Spreen, 1967): The Verbal Fluency Task (FAS and Animals) has been shown to be sensitive to brain injury and is administered as a measure of language ability. In the phonemic component (FAS), participants are instructed to say as many

words as possible that begin with a letter of the alphabet, excluding proper nouns. The letters F, A, S are presented in that order and, in each case, the subject has 60 seconds to list as many words as possible that begin with the letter presented. In the semantic component (Animals), participants are given 60 seconds to name as many animals as possible. In both test components, one mark is given for each correct word produced. Scores received for F, A, and S are summed to arrive at the phonemic score. The total number of animals correctly named is the semantic score.

Data Analysis

Data analyses were conducted to compare performance on the G-LAMB Paragraph and the Figure between : (1) the entire AD sample and the norms, and (2) those with mild AD and those with moderate AD. These analyses looked at performance in terms of learning, memory, rates of forgetting, and, in the case of the Figure, visuospatial constructional skills. Two-way mixed, repeated measures ANOVAs, with one between-group factor (group) and one within-group factor (trials), were conducted to evaluate patterns of learning across acquisition trials. Independent sample t-tests were used to compare levels of memory performance on delay trials. Difference scores (i.e., the difference between the last acquisition trial and the free recall delay trial) and savings scores (i.e. the percent of information retained from the last acquisition trial to the free recall delay trial) were calculated and appropriate t-tests performed in order to assess rates of forgetting. Visuospatial construction was examined by conducting independent sample t-tests on the Figure copy trial scores.

In addition, an examination of the level and range of scores obtained by AD participants on both the verbal and visuospatial subtests of the G-LAMB was carried out to determine if floor effects, often exhibited by persons with AD on memory tests, had been avoided. Results are reported primarily in terms of descriptive statistics (e.g., mean, standard deviation, minimum and maximum) and through the use of graphs.

The relationships between the G-LAMB Paragraph and other verbal tests (e.g., LAMB Word List B and the Verbal Fluency Tasks) were examined by computing Pearson product moment correlations. In the same vein, correlations were used to assess the relationship between the G-LAMB Figure and other visuospatial tests (e.g., LAMB Simple Figures and the Clock Test) and to compare AD group performance on the Paragraph to performance on the Figure. Finally, demographic information (i.e., age, education, and MMSE score) of the AD group was correlated with performance on the G-LAMB subtests.

Throughout the results section, partial eta-squared (eta-sq) is noted for each significance test as a measure of effect size. Effect size provides a means of describing the size or magnitude of an effect that is less dependent on sample size than the p-value (Kirk, 1996; Zumbo & Hubley, 1998). The presence of substantial effect sizes can assist in the verification of real effects even in small samples. Thus, with the relatively small sample in the current study, the reporting of effect size is of particular importance. The criteria for evaluating

partial eta-sq is presented by Kirk[6] (1996) as follows: a small effect is .010 to .058, a medium effect is .059 to .137 and a large effect is greater than .137. Complete results of the data analyses are presented in the next chapter.

[6] Although Kirk presents these criteria to evaluate omega-squared, according to Zumbo (personal communication, June 1998), partial eta-squared provides a similar measure of strength of association as does omega-squared and, thus, the criteria are appropriate for both measures.

CHAPTER FOUR

Results

Comparison of Total AD Group to Normative Sample

It may seem a foregone conclusion that there will be differences in performance between the clinical (i.e., AD) and normative samples on both the verbal and visuospatial G-LAMB subtests, particularly given the ceiling effects in scores attained by healthy older adults in the normative study (Hubley, 1995) and the well-documented memory deficits integral to AD. However, it is necessary to examine this relationship and confirm these expectations before proceeding with the analysis of the clinical sample that is the primary focus of the current research.

1) G-LAMB Paragraph (Verbal)

Figure 4 presents the trial by trial performance on the G-LAMB Paragraph for the Total AD group and for the normative sample. Learning was examined using a 2 x 2 Group (AD or Norms) x Trials repeated measures ANOVA. The Group x Trials interaction was not significant, $F(1,181) = 1.01$, n.s., partial eta-sq = .006, meaning that the effect of one factor (i.e., group) is not dependent on the other factor (i.e., trials) or vice versa. A significant within-subjects main effect for Trials was found, $F(1,181) = 102.99$, $p = .000$, partial eta-sq = .363. In other words, there was a statistically significant difference (increase) in performance between Trial 1 and Trial 2 for both the normative sample and the Total AD group. A significant between-groups main effect was also identified, $F(1,181) = 52.62$, $p = .000$, partial eta-sq = .225, with the normative performance higher

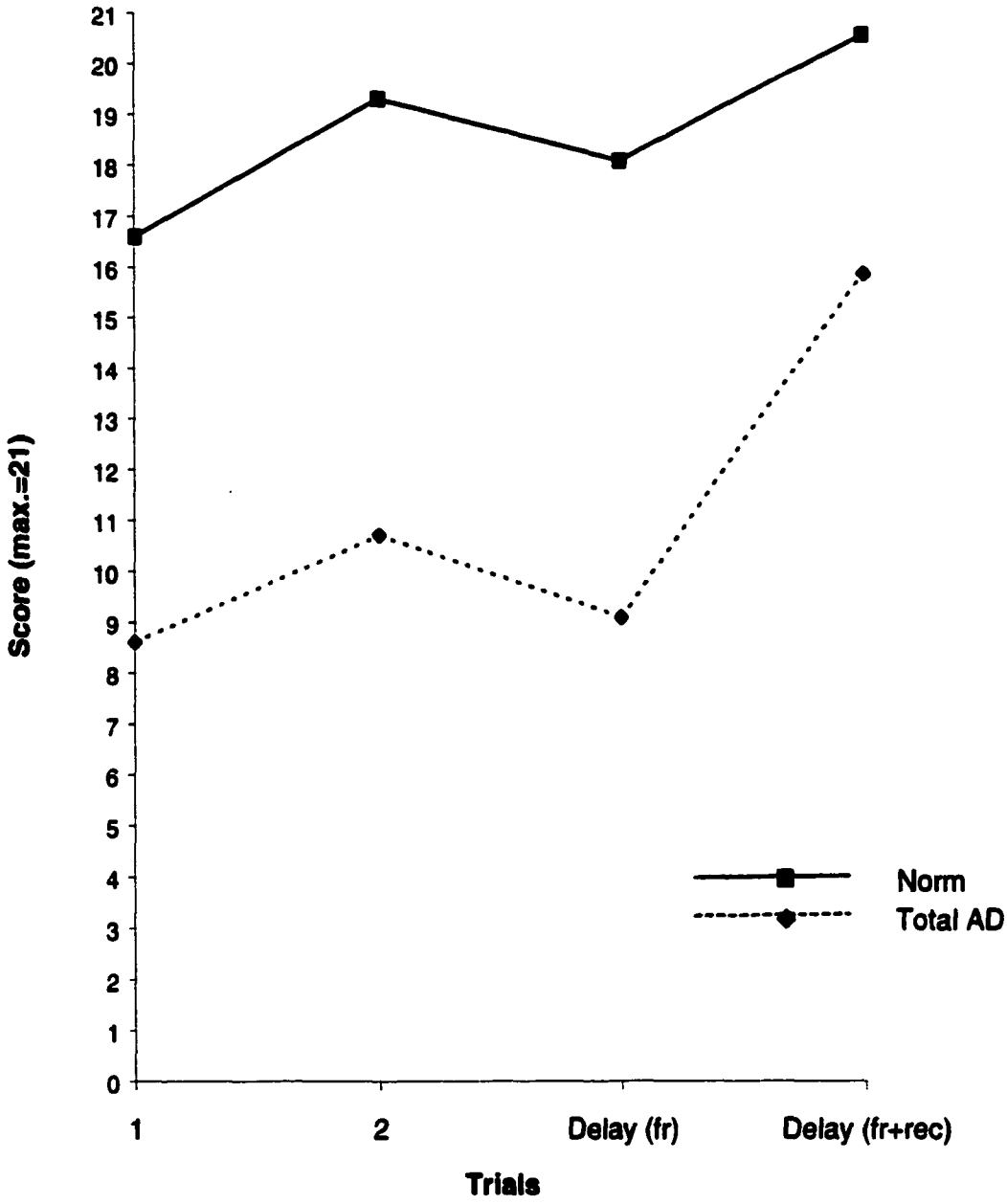


Figure 4. Mean performance on G-LAMB Paragraph Trials for Norms (n=169) and Total AD group (n=14).

than the performance of the AD group on both trials (Trial 1: Norm: M = 16.6, SD = 3.07; AD: M = 8.6, SD = 6.73; Trial 2: Norm: M = 19.3, SD = 2.13; AD: M = 10.7, SD = 7.31).

Memory for the Paragraph was examined by conducting independent sample t-tests on the free recall (FR) and free recall plus recognition (FR + rec) trial scores that were obtained following a 10-minute post-acquisition delay interval. In the FR condition, the mean performance of the Total AD group (M = 9.1, SD = 8.05) was significantly lower than that of the norms (M = 18.1, SD = 2.71), t(181) = 9.53, p = .000, partial eta-sq = .334. Investigation of the FR + rec condition also revealed a significant difference in performance between the Total AD group (M = 15.7, SD = 5.96) and the normative sample (M = 20.6, SD = 0.70), t(181) = 9.93, p = .000, partial eta-sq = .352.

Rate of forgetting was examined using two methods: (a) difference scores and (b) savings scores (i.e., percent retained). When difference scores were employed, independent sample t-tests indicated that there was no statistically significant difference in forgetting between the norms (M = 1.2, SD = 1.79) and the Total AD group (M = 1.6, SD = 2.14), t(181) = 0.71, n.s., partial eta-sq = .003. Use of savings scores, however, revealed a significant difference in the percent of information retained for the norms (M = 93.7%, SD = 10.3%) versus the Total AD group (M = 67.5%, SD = 48.0%), t(180) = 5.75, p = .000, partial eta-sq = .155[7].

In support of the hypotheses presented, performance of the normative

[7] One moderate AD participant was excluded from the savings score analysis as this individual had a score of zero on both the final acquisition and delay trials of the Paragraph; thus, df = 180.

sample on Paragraph learning and memory tasks was consistently and significantly higher than that of the Total AD group. The one exception was the lack of a significant difference between norm and AD group performance when rate of forgetting was examined using the difference score method.

2) G-LAMB Figure (Visuospatial)

Trial by trial performance on the G-LAMB Figure for the Total AD group and the normative sample is presented in Figure 5. Visuospatial construction is always examined to determine whether deficits in learning and memory are the result of visuospatial constructional difficulties (such as hemineglect). This did not appear to be the case for any of the study participants. Using an independent samples t-test to examine mean differences between the normative sample and the Total AD group on the Figure copy trial, results indicate that the performance by the Total AD group (M = 23.4, SD = 3.25) was significantly lower than that of the normative sample (M = 25.9, SD = 0.44), t(13.04) = 2.88, p = .013, partial eta-sq = .388[8]. However, both groups performed at a high level given the maximum possible score of 26 on the copy trial.

A 2 x 3 Group (AD or Norms) x Trials repeated measures ANOVA was used to investigate learning. The Group x Trials interaction was not significant, F(2, 362) = 0.72, n.s., partial eta-sq = .004. However, there was a significant within-subjects main effect for Trials, F(2,362) = 87.21, p = .000, partial eta-sq = .325 and a significant between-subjects main effect for Group, F(1,181) = 146.84, p = .000, partial eta-sq = .448. Posthoc paired sample t-tests were

[8] Due to a difference in group variances > 5:1 (Howell, 1995), the unequal variance t-value and df were used.

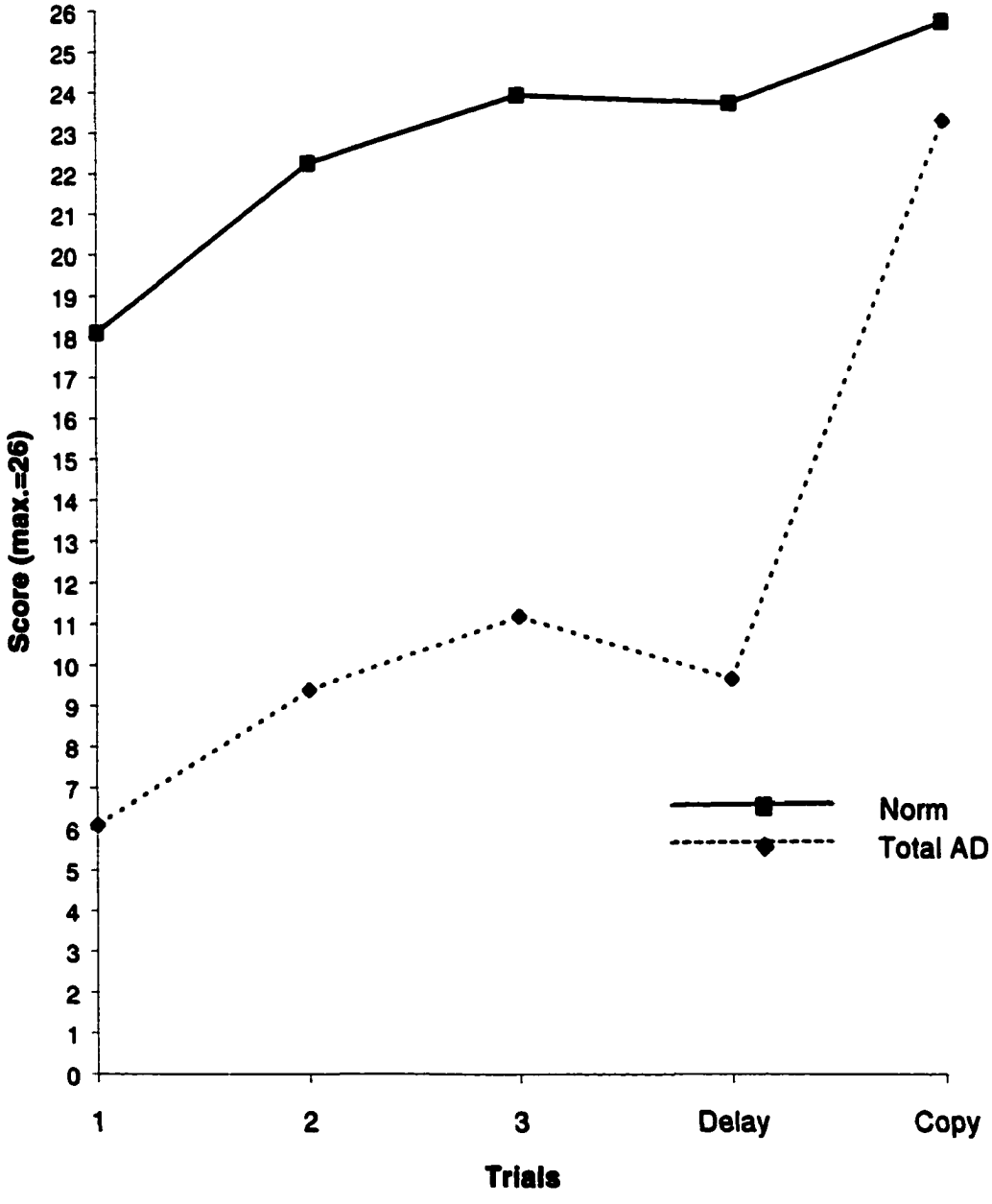


Figure 5. Mean performance on G-LAMB Figure Trials for Norms (n=169) and Total AD group (n=14).

conducted to further investigate the rate of learning from one trial to another. A Bonferroni correction (alpha = .025) was used to control for the Type 1 error rate (Tabachnick & Fidell, 1996). Results indicate that a significant amount of information was acquired from Trial 1 to Trial 2, $t(183) = 17.83$, $p = .000$ as well as from Trial 2 to Trial 3, $t(183) = 9.3$, $p = .000$[9]. Thus, regardless of group membership, there was a statistically significant increase in learning from both Trial 1 to 2 and Trial 2 to 3, even though scores of the normative sample were consistently higher than those of the Total AD group (see Table 3).

Table 3

Means and Standard Deviations for G-LAMB Figure Learning Trials (Norms vs Total AD Group)

	Norms (n = 169)		Total AD (n = 14)	
Trials	Mean	Std Deviation	Mean	Std Deviation
Trial 1	18.1	4.52	6.1	5.68
Trial 2	22.3	4.01	9.4	6.97
Trial 3	24.0	2.80	11.2	7.36

Evaluation of memory performance on the Figure was conducted using an independent sample t-test to compare the 10-minute delay trial scores for

[9] Effect sizes for the posthoc paired-sample t-tests are not provided as there is no widely accepted measure recognized at this time (Zumbo, personal communication, June 1998).

each group. Results show that the mean performance of the Total AD group (M = 9.7, SD = 8.9) was significantly lower than that of the normative sample (M = 23.8, SD = 3.1), t(181) = 13.31, p = .000, partial eta-sq = .495.

Rate of forgetting was assessed using both difference scores and savings scores. The independent sample t-test of difference scores for the Total AD group (M = 1.6, SD = 2.83) and the normative sample (M = 0.2, SD = 1.47) was statistically significant, t(181) = 3.11, p = .002, partial eta-sq = .515, suggesting that those with AD had a higher rate of forgetting than those without the disease. Savings scores revealed a similar significant result, t(13.07) = 2.77, p = .016, partial eta-sq = .484[10], with the Total AD group (M = 65.6%, SD = 45.6%) retaining a smaller percentage of learned information than the normative sample (M = 99.3%, SD = 8.25%) after a brief delay.

Thus, as proposed in the hypotheses, the normative sample performed significantly better than the AD participants on all G-LAMB Figure learning, memory and visuospatial constructional trials.

Comparison of Mild and Moderate AD Groups

With the overall context provided by the initial comparisons between the Total AD group and the normative sample, attention can now be directed toward evaluation of the performance of the clinical sample. The current study was designed precisely to determine the potential utility of the G-LAMB for assessing and tracking learning and memory performance in people with AD as well as differentiating the performance level of those individuals with mild or moderate

[10] Due to a difference in group variances > 5:1 (Howell, 1995), the unequal variance t-value and df were used.

stages of AD. As such, the analyses of primary interest are those involving the performance of the Mild and Moderate AD groups.

1) G-LAMB Paragraph (Verbal)

Figure 6 provides the trial by trial performance of the Mild and Moderate AD groups on the G-LAMB Paragraph. With this visual display providing an initial glimpse at the range of scores and level of performance for the clinical sample, a more in-depth evaluation of learning, memory, rates of forgetting and the relationship of the Paragraph subtest to other verbal tests, was undertaken.

A 2 x 2 Group (Mild or Moderate AD) x Trials repeated measures ANOVA was conducted to examine learning performance between participants with mild versus moderate AD on the Paragraph. The Groups x Trials interaction was not significant, $F(1,12) = 1.59$, n.s., partial eta-sq = .117[11]; thus, any significant main effect for Group and/or Trials is independent of the other factor. In fact, analysis did reveal a significant within-subjects main effect for Trial, $F(1,12) = 7.93$, $p = .016$, partial eta-sq = .398 as well as a significant between-groups main effect for Group, $F(1,12) = 94.52$, $p = .000$, partial eta-sq = .887. In other words, there is a significant change (increase) in scores from Trial 1 to Trial 2 for both groups (i.e., learning is taking place) but the Mild AD group (Trial 1: $\underline{M} = 14.3$, $\underline{SD} = 4.20$; Trial 2: $\underline{M} = 17.4$, $\underline{SD} = 2.30$) performs consistently higher than the Moderate group (Trial 1: $\underline{M} = 2.7$, $\underline{SD} = 1.57$; Trial 2: $\underline{M} = 4.0$, $\underline{SD} = 2.31$).

Independent sample t-tests on the Paragraph FR and FR+rec delay trials were conducted to assess memory performance. Examination of the mean

[11] Given the medium effect size, it is possible that a larger sample size may have produced a significant result.

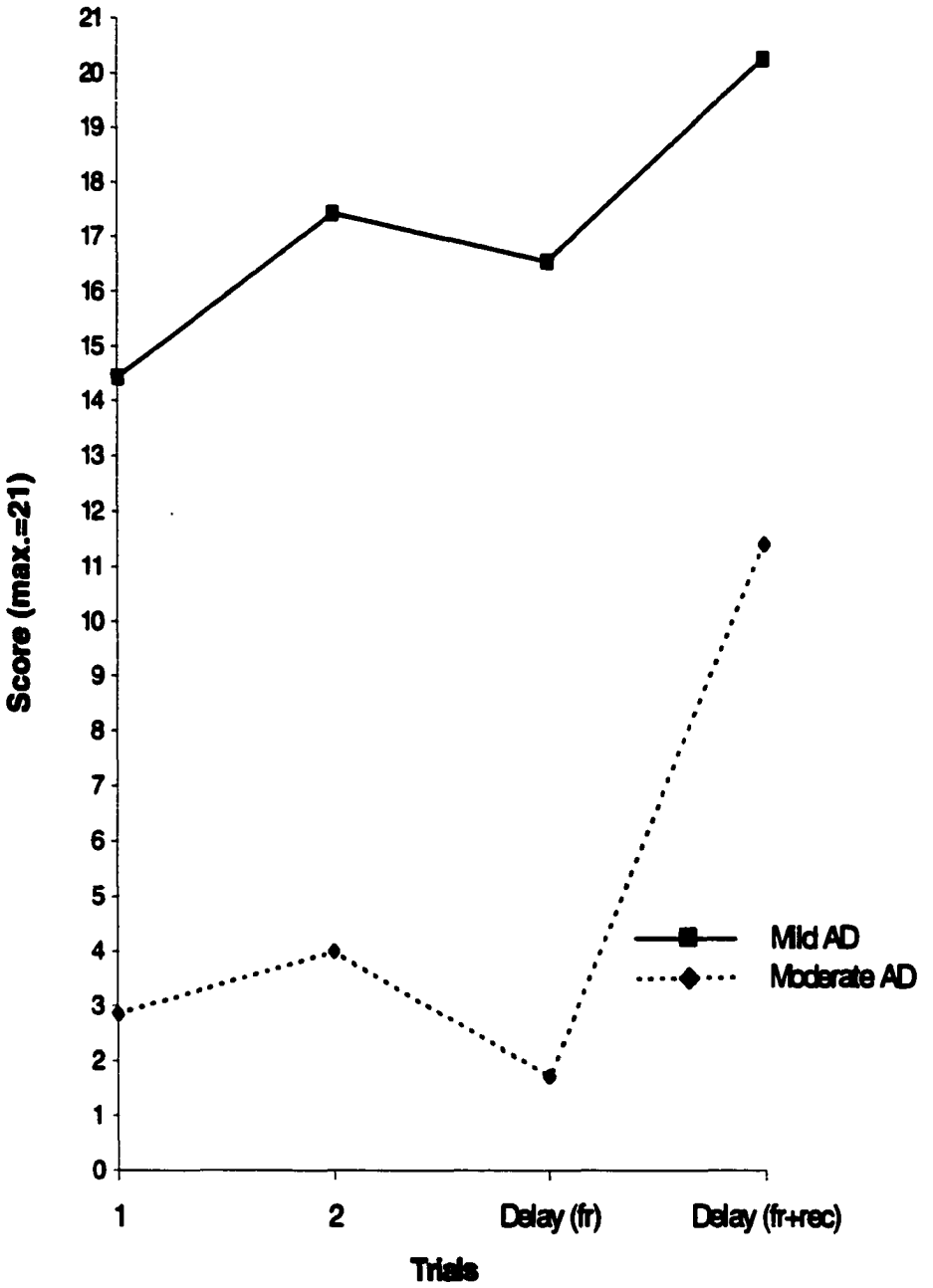


Figure 6. Mean performance on G-LAMB Paragraph Trials: Mild (n=7) and Moderate (n=7) AD groups.

differences between the Mild AD group (M = 16.6, SD = 1.72) and the Moderate AD group (M = 1.7, SD = 2.93) on free recall revealed that the Mild group achieved a significantly higher recall score than the Moderate group, t(12) = 11.58, p = .000, partial eta-sq = .918. Inspection of the FR + rec trials also revealed a statistically significant difference between the Mild (M = 20.3, SD = 0.76) and Moderate (M = 11.4, SD = 5.53) AD groups, t(12) = 4.20, p = .001, partial eta-sq = .595.

Rate of forgetting was examined using both difference scores and savings scores. The difference score method uncovered no significant differences between the Mild (M = 0.9, SD = 1.68) and Moderate (M = 2.3, SD = 2.43) AD groups, t(12) = 1.28, n.s., partial eta-sq = .120[12]. Savings scores provide a different view with the Mild AD group (M = 95.9%, SD = 10.5%) retaining significantly more of the learned information than the Moderate AD group (M = 34.3%, SD = 54.2%), t(11) = 2.96, p = .013, partial eta-sq = .444[13].

As predicted in the study hypotheses, the Mild AD group performed at a consistently and significantly higher level than the Moderate AD group on the learning and memory components of the Paragraph subtest. The only exception was the rate of forgetting when examined by the difference score method where there was no statistically significant difference between the Mild and Moderate AD group performance.

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[12] Given the medium effect size, it is possible that a larger sample size may have produced a statistically significant result.

[13] One moderate AD participant was excluded from the savings score analysis as this individual had a score of zero on both the final acquisition and delay trials of the Paragraph; thus, df = 11.

Relationship of G-LAMB Paragraph Performance to Other Variables

The strength of the relationships between age, education, and MMSE score and performance on the G-LAMB Paragraph by individuals with AD was examined using Pearson product moment correlations. These results are shown in Table 4.

Table 4

Correlation of Age, MMSE Score and Education to G-LAMB Paragraph Performance for Total AD Group (n = 14)

Trial	Age	MMSE	Education
1	-.66**	.86**	.48
2	-.69**	.87**	.41
FR	-.65*	.89**	.40
FR + rec	-.63*	.67**	.14

Note. MMSE = Mini-Mental State Examination; FR = free recall delay trial; rec = recognition delay trial.
* $p < .05$. ** $p < .01$.

Correlations between age and Paragraph trial scores were all significant and ranged from -.63 to -.69 (all $p < .05$). Thus, as age increased, Paragraph trial scores tended to decrease. Likewise, the correlations between the Paragraph trial scores and MMSE scores were all significant and ranged from .67 to .89 (all $p < .01$). Therefore, the higher the MMSE score, the higher the Paragraph learning and memory performance. Finally, the correlations between education level and performance on the Paragraph trials ranged from .14 to .48

but were not statistically significant.

Pearson product moment correlations were also calculated to assess the strength of the relationship between the G-LAMB Paragraph and other verbal tests administered to the Total AD group in the study (see Table 5).

Table 5

Correlation of G-LAMB Paragraph With Other Verbal Tests in Total AD Group (n = 14)

Para Trials	WL 1	WL 5	WL (FR)	WL (rec)	BNT	FAS	Animals
1	.81**	.85**	.92**	.72**	.82**	.55*	.79**
2	.74**	.89**	.91**	.79**	.81**	.42	.87**
FR	.76**	.88**	.96**	.89**	.81**	.47	.74**
FR+rec	.66**	.75**	.82**	.86**	.73**	.34	.65*

Note. Para = G-LAMB Paragraph; WL = Word List B, 1 = Trial 1, 5 = Trial 5 (last acquisition trial), FR = free recall delay trial, rec = recognition delay trial; BNT = Boston Naming Test.
* $p < .05$. ** $p < .01$.

Correlations between the G-LAMB Paragraph trials and the LAMB Word List B trials were all significant and ranged from .66 to .96 (all $p < .05$). The relationships between the Paragraph trials and the empirical version of the Boston Naming Test were also significant and ranged from .73 to .82 (all $p < .01$). Similarly, correlations between the Paragraph trials and semantic verbal fluency (Animals) were significant and ranged from .65 to .87 (all $p < .05$). The relationship between phonemic verbal fluency (FAS) and the G-LAMB

Paragraph, however, was significant only when comparing Trial 1 of the Paragraph to FAS , r = .55, p = .041. Correlations between FAS and the other G-LAMB Paragraph trials ranged from .34 to .47 but were not statistically significant.

As predicted in study hypotheses, performance of the AD sample on the G-LAMB Paragraph subtest was significantly correlated with their performance on other verbal tests. The only exception was the relationship between Paragraph performance and performance on the phonemic component (FAS) of the Verbal Fluency Test in which there was no significant correlation.

2) G-LAMB Figure (Visuospatial)

Trial by trial performance by the Mild and Moderate AD groups on the G-LAMB Figure is presented in Figure 7. With this visual display of the data in mind, further analyses were conducted to investigate visuospatial construction, learning, memory, rates of forgetting and the relationship between the performance of AD participants on the Figure subtest and their performance on other visuospatial tests.

Visuospatial constructional abilities were examined in order to identify any deficits and to report the mean level of performance for each AD group. Results of an independent sample t-test indicate no statistically significant difference between the copy trial scores of the Mild AD group (M = 24.2, SD = 1.13) and the Moderate AD group (M= 22.3, SD = 4.35), t(12) = 1.26, n.s., partial eta-sq =.117[14]. Given the maximum possible score of 26, both groups performed at a

[14] Given the medium effect size, it is possible that a larger sample size may have produced a statistically significant result.

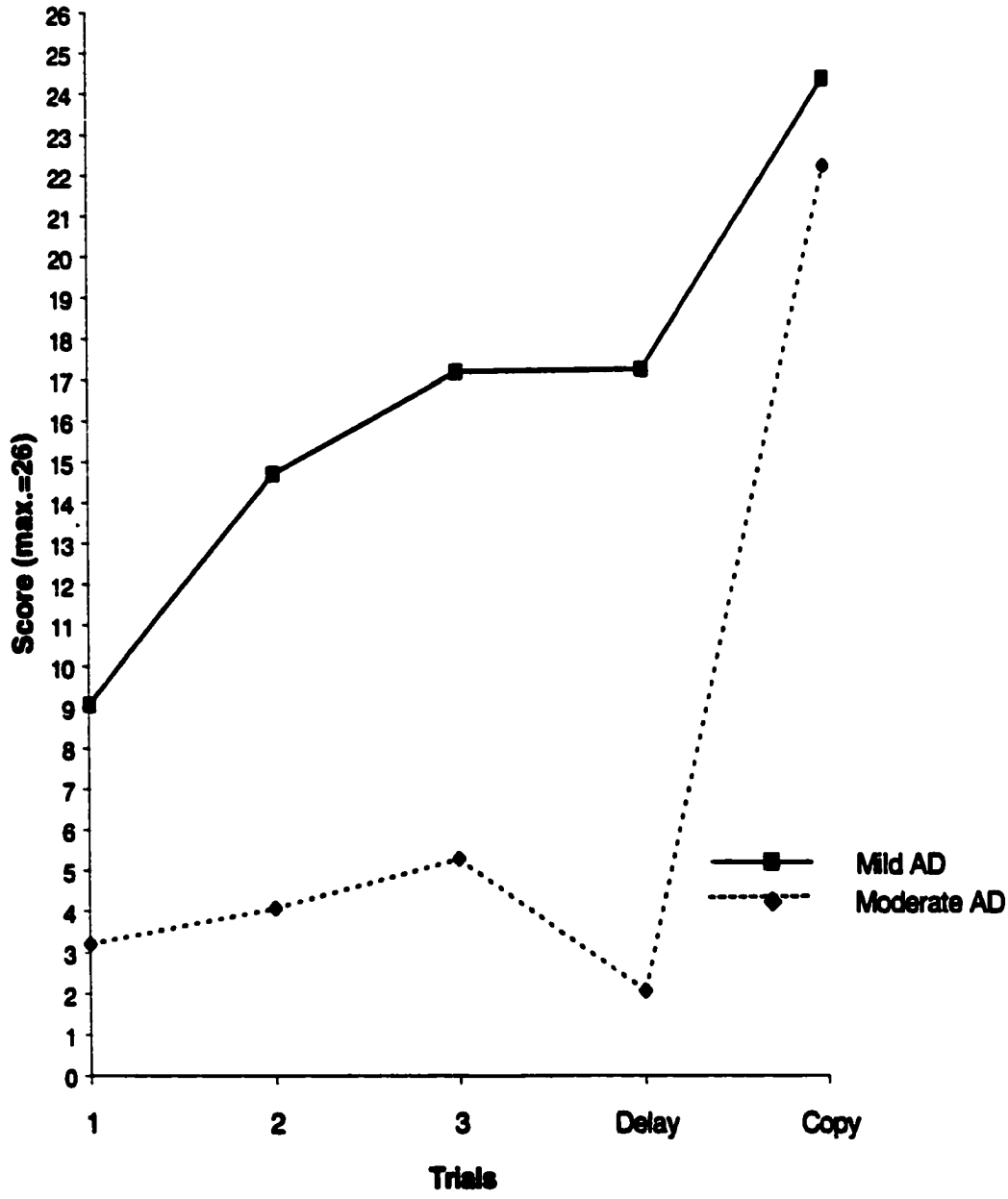

Figure 7. Mean performance on G-LAMB Figure Trials: Mild (n=7) and Moderate (n=7) AD groups.

high enough level that visuospatial constructional deficits should not confound the results of learning and memory analyses that follow.

To investigate learning, a 2 x 3 Group (Mild vs Moderate AD) x Trials repeated measures ANOVA was conducted. The Group x Trials interaction was significant, $F(2,24) = 14.23$, $p = .000$, partial eta-sq = .542; thus, a significant effect on one factor (e.g., Group) is conditional upon the other factor (e.g., trials). Posthocs were conducted to determine the precise nature of the interaction. Using a Bonferroni correction (Tabachnick & Fidell, 1996) to control for the Type 1 error rate (alpha = .0125), four paired sample t-tests were performed to investigate the rate of learning occurring from one trial to another for each group. Findings indicate that the only statistically significant increase in the amount learned was by the Mild AD group between Trial 1 ($\underline{M} = 9.1$, $\underline{SD} = 6.25$) and Trial 2 ($\underline{M} = 14.7$, $\underline{SD} = 4.93$), $t(6) = 4.65$, $p = .004$[15]. P-values for all other comparisons were greater than .0125 (see Table 6 for complete posthoc results). A significant between-subjects main effect was found for Group, $F(1,12) = 16.87$, $p = .001$, partial eta-sq = .584 and a significant within-subjects effect was found for Trials, $F(2,24) = 36.07$, $p = .000$, partial eta-sq = .750. Neither main effect contradicts the interaction findings; thus, both main effects are interpretable. Therefore, ignoring group status, some learning does occur from one trial to the next but the scores obtained by the Mild AD group are consistently higher (see Table 7 for Mild and Moderate AD group trial means).

Memory performance on the G-LAMB Figure was examined using an

[15] Effect sizes for the posthoc paired-sample t-tests are not provided as there is no widely accepted measure recognized at this time (Zumbo, personal communication, June 1998).

Table 6

Posthoc Paired t-tests for G-LAMB Figure Learning Trials

	Mild AD (n = 7)			Moderate AD (n = 7)		
Trial	t-value	df	p-value	t-value	df	p-value
1 to 2	4.65	6	.004	3.03	6	.023
2 to 3	2.84	6	.029	1.83	6	.117

Note. Significant p-value is < .0125 due to Bonferroni correction for Type 1 error rate.

Table 7

Means and Standard Deviations for G-LAMB Figure Learning Trials

	Mild AD (n = 7)		Moderate AD (n = 7)	
Trials	Mean	Std Deviation	Mean	Std Deviation
1	9.1	6.25	3.2	3.30
2	14.7	4.93	4.1	3.87
3	17.2	4.94	5.3	3.00

independent samples t-test to compare the 10-minute delay trial scores for each group. Results indicate that the mean memory performance of the Mild AD group (M = 17.3, SD = 5.41) was significantly higher than for the Moderate AD group (M = 2.1, SD = 2.61), $t(12) = 6.71$, $p = .000$, partial eta-sq = .789.

Both the difference score and the savings score methods were used to assess rates of forgetting between the final learning trial and the 10-minute delay. The independent sample t-test of difference scores for the Mild AD group (M = -0.1, SD = 1.81) and the Moderate AD group (M = 3.1, SD = 2.88) was statistically significant, $t(12) = 2.50$, $p = .028$, partial eta-sq = .342, suggesting that rate of forgetting on the G-LAMB Figure increases with the severity of the disease. A similar result is indicated by the savings score technique. The Mild AD group (M = 99.7%, SD = 12.2%) retained a larger percentage of information learned than did the Moderate AD group (M = 32.9%, SD = 43.4%), $t(12) = 3.93$, $p = .002$, partial eta-sq = .562.

Relationship of G-LAMB Figure Performance to Other Variables

Pearson product moment correlations were used to examine the strength of the relationships between age, education and MMSE score and performance on the G-LAMB Figure in the Total AD group. Correlations between age and Figure trial scores were all significant, ranging from -.69 to -.84 ($p < .01$) except for the copy trial which was not statistically significant, $r = -.29$. Thus, for learning and memory trials, the greater the age the lower the score; however, for the copy trial (assessing visuospatial constructional abilities), age was not related to level of performance. A similar pattern was found when comparing the Figure trial scores to MMSE scores. All correlations were significant, ranging from .69 to .88 (all $p < .01$) except for the copy trial which was not significant, $r = .25$. Examination of the relationship between education level and Figure trial success revealed mixed results. Correlations were statistically significant for Trial 3

(r = .59, p = .028) and for the copy trial (r = .71, p = .005). The remaining Figure trials correlated with years of education but were not statistically significant. Education correlated .53 (p = .053) with performance on the delay trial which, although not statistically significant, did show a trend and suggests that a larger sample size might have produced a significant result (see Table 8 for complete results).

Table 8

Correlation of Age, MMSE Score, and Education to G-LAMB Figure Performance for Total AD Group (n = 14)

Trial	Age	MMSE	Education
1	-.77**	.69**	.48
2	-.77**	.84**	.48
3	-.84**	.88**	.59*
Delay	-.69**	.88**	.53
Copy	-.29	.25	.71**

Note. MMSE = Mini-Mental State Examination.
* p < .05. ** p < .01.

In order to evaluate the strength of the relationship between the G-LAMB Simple Figure and other visuospatial tests given to the Total AD group during the course of the study, Pearson product moment correlations were computed (see Table 9). Correlations between the G-LAMB Figure learning and memory trials and the LAMB Simple Figure learning and memory trials were all significant and ranged from .66 to .85 (all p < .05). The relationship between the G-LAMB

Figure and LAMB Simple Figures copy trials was not statistically significant, $r = .39$, $p = .164$.

Table 9

Correlation of G-LAMB Figure With Other Visuospatial Tests for Total AD Group (n = 14)

G-LAMB Figure	LSF 1	LSF 3	LSF (delay)	LSF (copy)	Clock (cm 1)	Clock (cm 2)	Clock (copy 1)	Clock (copy 2)
1	.69**	.73**	.80**	.06	.29	-.02	.35	-.47
3	.66*	.73**	.85**	-.15	.53	-.26	.12	-.36
delay	.66*	.66*	.84**	-.09	.52	-.30	.16	-.36
copy	-.03	.27	.20	.39	.61*	-.64*	.10	-.63*

Note. LSF = LAMB Simple Figure: 1 = Trial 1; 3 = Trial 3 (last aquisition trial); cm 1 = command, scale 1; cm 2 = command, scale 2; copy 1 = copy, scale 1; copy 2 = copy, scale 2.
*$p < .05$. **$p < .01$.

Correlations between the G-LAMB Figure learning and memory trials and freehand drawing of a clock (command condition) ranged from .29 to .53 and were not statistically significant (all $p > .05$) when Scale 1 (quantitative score) was used to score performance. It should be noted, however, that Figure Trial 3 and the delay trial produced trends ($p < .06$) that with a larger sample size, might have resulted in significant findings. When Scale 2 (qualitative error score[16]) was used, none of the correlations with the Figure learning and memory trials was statistically significant ($r = -.02$ to $-.30$, all $p > .05$). However, correlations

[16] The greater the number of errors made, the higher the score.

between the Figure copy trial and the Clock Test command condition using both Scale 1 ($r = .61$, $p < .05$) and Scale 2 ($r = -.64$, $p < .05$) were statistically significant. Thus, if a participant produces a high quality freehand clock drawing, the same individual will tend to also perform well on the G-LAMB Figure copy trial.

Correlations between G-LAMB Figure learning and memory trials and performance when copying the picture of a clock ranged from .12 to .35 and were not statistically significant when Scale 1 (quantitative score) was used to score performance. There were also no statistically significant correlations when Scale 2 (qualitative error score) was used ($r = -.36$ to $-.47$, all $p > .05$). The correlation between the Clock Test copy condition and the G-LAMB Figure copy trial was not significant when Scale 1 was used to evaluate performance ($r = .10$, $p > .05$) but was statistically significant when Scale 2 was used ($r = -.63$, $p < .05$).

Consistent with the study hypotheses, the performance by AD participants on the learning and memory components of the G-LAMB Figure was significantly correlated with learning and memory performance on the LAMB Simple Figures. However, there was no significant correlation between copy trials as was expected. Correlations between the G-LAMB Figure and the Clock Test generally did not support the prediction of a significant relationship between similar tests. The only statistically significant finding that was predicted was the relationship between the Clock Test copy trial (scored using Scale 2) and the G-LAMB copy trial.

Relationships Between G-LAMB Paragraph and Figure Subtests

Examination of the relationships between the learning and memory components of the two G-LAMB subtests reveal correlations that are all statistically significant and range from .61 to .91 (all $p < .05$). However, none of the correlations (ranging from .10 to .26, all $p > .05$).between the Paragraph trials (assessing learning and memory) and the Figure copy trial (assessing visuospatial constructional abilities) are significant. Complete results can be found in Table 10.

Table 10

Correlation Between G-LAMB Paragraph and Figure Subtests For Total AD Group (n = 14)

	Paragraph			
Figure	1	2	FR	FR + rec
1	.71**	.61*	.66**	.62*
2	.86**	.85**	.88**	.80**
3	.87**	.87**	.89**	.76**
delay	.90**	.90**	.91**	.72**
copy	.23	.23	.22	.10

Note. FR = free recall delay trial; rec = recognition delay trial.
* $p < .05$. ** $p < .01$.

Thus, with few exceptions, the research hypotheses were met. A discussion of the practical implications of these findings follows.

CHAPTER FIVE

Discussion

The main objective of this study was to determine the usefulness of the G-LAMB for monitoring learning and memory performance in individuals already diagnosed with AD and for differentiating among different levels of severity of AD. Overall, the results obtained appear to confirm the G-LAMB's utility for those with Mild to Moderate level AD.

Historically, learning and memory test scores obtained by persons with AD have been so low that it was difficult to either distinguish one level of AD from another or to track changes in performance over time. Such shortcomings pose serious difficulties when it comes to prescribing and evaluating treatment regimes. These days, with the incidence of AD increasing year by year and new pharmacological and other treatments on the horizon, developing a instrument which can differentiate levels of AD and allow for a high enough score to avoid floor effects has become critical. For example, physicians are now prescribing Aricept, a new pharmacological treatment designed to deal with symptoms associated with early AD such as memory loss and difficulties with learning. An objective measure is needed in order to determine whether an individual is an appropriate candidate for the drug (i.e., should be at a mild stage of the disease) and to evaluate the impact of the treatment (Feldman, 1998). The G-LAMB appears to be such an instrument with regard to the assessment and monitoring of verbal and visuospatial learning and memory in people already diagnosed with AD.

As predicted in the study hypotheses, the normative sample performed at a consistently higher level on both the G-LAMB Paragraph and Figure than participants with AD. More specifically, the normative sample showed significantly better performance than individuals with AD in learning, memory, rate of forgetting and visuospatial construction. Although these findings may seem self-evident, when a new test (such as the G-LAMB) is being evaluated with a clinical sample for the first time, it is necessary to confirm the expected relationship between the clinical sample and the normative data. In addition, consistent with the research hypotheses, test scores were high enough in the Mild AD group to allow for monitoring changes in performance over time. The G-LAMB is a tracking, rather than a diagnostic, test battery. Therefore, high scores by the Mild AD group are very desirable (even if they are not distinguishable from normative performance) because they allow for longer periods of monitoring than would be afforded by lower scores.

G-LAMB Paragraph Performance

Analysis of the Total AD sample revealed a differentiation between the scores of the Mild and Moderate AD groups on both G-LAMB subtests. The G-LAMB Paragraph appears to provide some needed and previously less accessible information about those with Mild and Moderate levels of AD. First, there is a clear differentiation in the performance level of the Mild and Moderate AD groups for both learning and memory test components. If one looks at the performance of individuals in these two groups only, there is virtually no overlap of scores between the two groups (see Figure 8). This is, in part, due to the

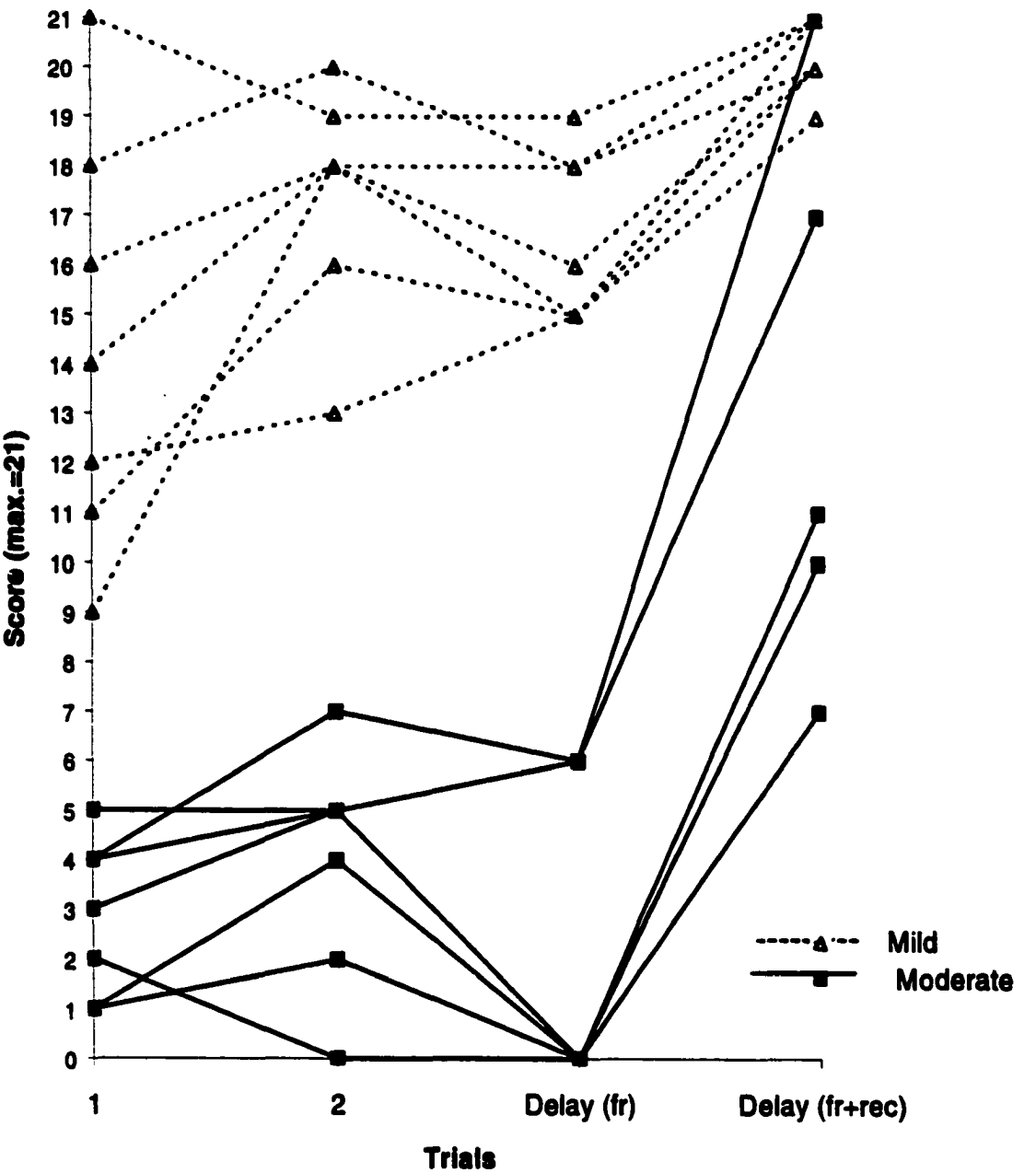

Figure 8. Individual performance on G-LAMB Paragraph Trials for AD groups: Mild (n=7), Moderate (n=7).

avoidance of floor effects in the Mild AD group. For example, with Mild AD scores ranging from 13 to 20 (out of a possible 21) following the last acquisition trial, there is ample room to monitor changes in learning performance over time. Ability to track changes beyond the Moderate AD level is limited by the (low) level of their acquisition test scores (ranging from 0 to 7). Some moderate individuals could be tracked for limited periods of time but most have scored too low to allow for any effective future monitoring. Even with this limitation in the Moderate group, scores on the G-LAMB Paragraph differentiate the Mild from the Moderate group and provide valuable information about the current level of learning and memory performance in both groups.

Although the Mild AD participants produced higher memory scores than the Moderate group on both the FR and FR+rec trials, it is interesting to note the relatively high level of performance of the Moderate AD group in the FR+rec condition. Mild AD scores ranged from 19 to 21 whereas the scores of those with Moderate level AD ranged from 7 to 21. Normative performance for FR+rec ranges from 17 to 21, strikingly similar to the range of Mild AD scores. Clearly, the opportunity to choose the correct answer from amongst other answers is a considerably easier task than searching for the answer in memory with no cue whatsoever. Even though the Moderate AD group performance is significantly lower than Mild Group performance on the FR+rec trial, the relatively higher scores in both AD groups suggests that, consistent with the literature, recognition memory remains relatively more intact in the earlier stages of AD than does free recall memory.

G-LAMB Figure Performance

The G-LAMB Figure is an improvement over many previously available tests (such as the Rey-Osterrieth Complex Figure Test) in terms of providing differentiation between performance of Mild and Moderate AD groups and avoiding floor effects in the Mild group. However, the G-LAMB Figure appears somewhat less successful at both of these tasks than the G-LAMB Paragraph. For example, when examining individual performance for each group (see Figure 9), there is not as clear a differention between groups in the sense that the performance of the two groups is not as distinct and there is some overlap between the groups. Specifically, the learning scores for the Mild AD group range from 3 to 22 on Trial 1 and 11.5 to 26 on Trial 3 whereas the Moderate AD group scores range from 0 to 10 on Trial 1 and 1 to 10 on Trial 3. There is one Moderate AD individual who crosses over into Mild "territory". But even removing this Moderate participant from the picture (whose performance could potentially be explained by a high premorbid level of visuospatial ability) does not alter the fact that the clear group distinction found in the Paragraph trials is not found in the Figure trials. The other limitation of the Figure findings is that although floor effects are avoided, the overall learning and memory performance level is lower than was anticipated. Consider an individual with Mild AD who scores 10 out of a possible 26 on the Figure memory trial. Although performance could be monitored until it decreased to zero, it would be for a more limited time period than would be possible with a score of 18 out of 26.

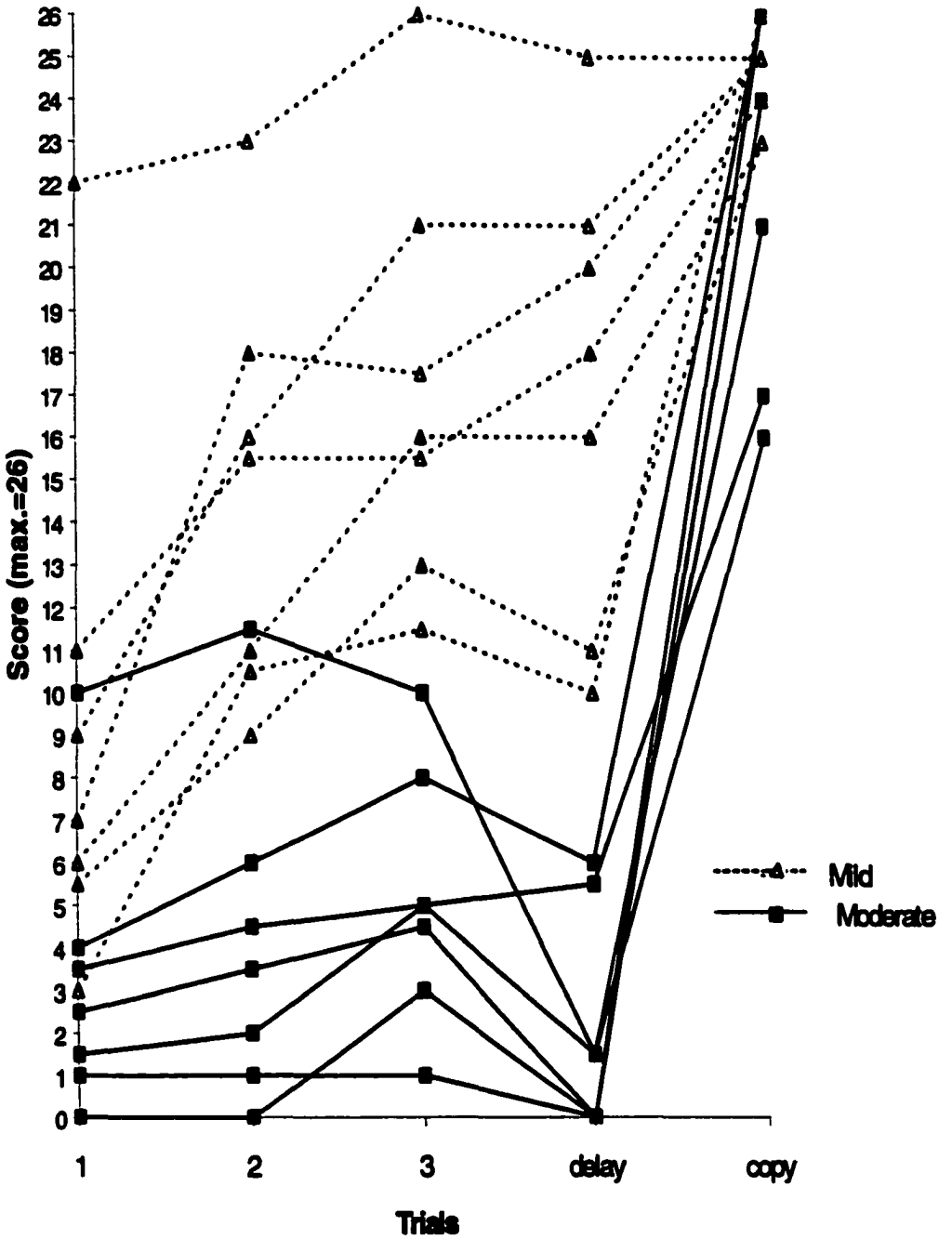

Figure 9. Individual performance on G-LAMB Figure Trials for AD groups: Mild (n=7), Moderate (n=7).

In this context, it is interesting to note that the only statistically significant increase in the amount learned from one Figure trial to another was by the Mild AD group from Trial 1 to Trial 2. This means that the learning curve for the Moderate AD group was essentially flat whereas for the Mild group, the curve leveled off after the second learning trial. In other words, participants are not fully utilizing the three learning trials available to them. They have stopped learning. Thus, in order to increase Figure performance levels enough to clearly differentiate the Mild and Moderate AD groups and allow for tracking changes over a substantial period of time, adding extra learning trials will not help. An easier form of the Figure may be needed.

Putting all this information together, it appears that the G-LAMB Figure, although a step in the right direction, may still be too difficult for optimum use with an Alzheimer population. It would seem that development of a less difficult revised version of the Figure might be the next logical step in order to reach the high level of utility achieved with the Paragraph subtest.

It is interesting to note that the visuospatial constructional performance of the Mild and Moderate AD groups on the Figure copy trials did not differ. This finding does not support study hypotheses but is consistent with the literature in the sense that memory deficits and not difficulties in constructional abilities are usually the among the first signs of AD. What the current findings do appear to suggest is that constructional abilities can remain relatively intact even into the moderate stages of Alzheimer's Disease.

Conclusions Regarding Use of the G-LAMB in an Alzheimer Population

The experience of administering the G-LAMB coupled with the study findings provide strong support for its use among individuals with Mild to Moderate AD. At first glance, restricting test use to mild and moderate disease levels may seem to be a weakness in the applicability of the G-LAMB. However, the inability to test more severely impaired individuals is consistent with the literature. Memory may deteriorate to the point at which the person cannot remember the instructions long enough to initiate or complete a task. This is not just a matter of sensitivity of learning and memory tests. In addition, once individuals reach a moderate-severe level of AD, other symptoms become more prominent (and these require more attention) and may negatively affect the assessment process (e.g., language deficits, distractability and lack of motivation).

The most immediately apparent improvement over other memory tests is the simplicity and brevity of the G-LAMB. These features tackle two basic problems encountered when testing individuals with AD: participant frustration and floor effects. Because the G-LAMB is a relatively less difficult test, performance reaches a higher level than on most traditional tests. As a result, the frustration that often accompanies poor performance has been alleviated and scores achieved are high enough to allow for tracking changes over time. This is important because treatment regimes merely become "a shot in the dark" when the impact of the treatment cannot be measured due to a lack of sensitivity in our tests to identify performance changes in cognitively impaired groups.

Another advantage of the G-LAMB is that it includes two subtests that allow assessment of both verbal and visuospatial learning and memory. This addresses a recently acknowledged need in the literature for tests that can examine specific memory systems (Mohr, Feldman & Gauthier, 1995). An example of the importance of having these two independent measures can be seen by examining the performance of a study participant with Moderate/Severe AD who is still living independently in the community. While her scores on the Paragraph were actually higher than the scores of all the Moderate participants, her performance on the Figure was essentially zero. Having this information in hand, the woman and her family could be advised that moving her to a smaller house or to an apartment (which might seem logical given the AD diagnosis) would probably be an error as her ability to learn and remember the layout of a new place is severely diminished. This particular woman noted during testing that she still likes to go on long walks around the neighbourhood. Test results would suggest that she should stick with her current route rather than introducing new ones because getting lost is a real possibility. At the same time, focusing on this woman's unusually well-preserved verbal skills would increase her ability to function and sustain her self-esteem.

The G-LAMB also provides the clinician with information about a person's abilities in both learning and memory. For example, when completing the Figure subtest, one study participant scored 10 out of 26 on the last learning trial but dropped to 1.5 out of 26 after the 10 minute delay. Such performance suggests that the individual is still able to acquire some new visuospatial information but

cannot retain it for very long. Therefore, it will not be helpful to walk her from her room in the care facility to the dining room as a reminder of how to get to supper two hours later. The information will be lost long before it is time to eat. On the other hand, another study participant scored 9 out of a possible 21 on the first learning trial of the Paragraph, increased his score to 18 at the second trial and scored 15 at the free recall delay. With a relatively good capacity for learning and retaining verbal information, it should be helpful to give this man verbal reminders about how to get to the dining room or to wash his hands before leaving the bathroom. However, someone whose delay score is very low would not remember such reminders and might be better served by recently designed, computer-controlled "smart" rooms that provide step by step verbal instructions to the user (e.g., a "smart" bathroom would tell the user to wash their hands and turn out the light before leaving the room).

Another helpful distinction provided by the G-LAMB is the examination of an individual's performance on a free recall memory task (i.e., no assistance or cues are given in recovering the memory) and recognition memory (i.e., the item simply has to be recognized and so considerable support is provided). Having this information allows the clinician to assess whether providing maximum support for remembering will allow the person to, in fact, remember. For example, one study participant scored zero out of 21 when trying to free recall information about the Paragraph after a 10-minute delay but scored 10 on the free recall plus recognition trial. Clearly, not all of the information is "forgotten". Instead, this individual, despite "bottoming out" on the FR trial, still has some

ability to remember if assistance is provided. If asked to describe her weekend with her family, she might not be able to recall any activities. However, if other family members started to describe events, she may very well be able to add new information.

Finally, another strength of the G-LAMB is the 10-minute delay interval (many tests have 20-40 minute delays) between the last learning trial and the recall trial. In addition to contributing to the brevity of the test, this delay interval also reflects the fact that, as the disease progresses, persons with AD are known to have a more rapid rate of forgetting than is the case for many other dementias. That is, most newly-acquired information is lost from memory within the first 10 minutes following acquisition. Thus, the shorter delay interval in the G-LAMB provides the clinician with a better means of delineating how early in the disease process an individual is showing this rapid forgetting as well as assisting the clinician in distinguishing individuals with AD from other types of dementia.

Other Findings of Interest

The current research reveals seemingly inconsistent findings regarding rates of forgetting. When difference scores, which look at the difference between the score at the last learning trial and the score on the FR delay trial, were employed, Mild and Moderate AD groups forgot the same (raw) amount of information. However, when savings scores were employed, the *percentage* of information retained from the last acquisition to the delay was significantly higher in the Mild group. That is, relative to the amount they had learned, the Mild AD

group forgot less. To clarify the potential source of this apparent difference, consider the following example. If an individual with a moderate level of AD scores 5 on the last acquisition trial and remembers one item at recall, they have the same difference score as an individual with a mild level of AD who scores 15 on the last acquisition trial and recalls 11 items at delay. Both have forgotten four items. Yet, in terms of percent of information retained, the moderate individual has retained only 20% of the information learned whereas the mild individual has retained 73%. Consistent with the literature, results of analyses on rates of forgetting appear to be impacted by the method of evaluation used when there are large differences between groups in the amount of information learned. This problem has yet to be resolved in the literature. As a result, most researchers employ more than one method when analyzing rate of forgetting data.

In terms of relationships between the Paragraph and the other verbal tests administered in this study, statistically significant positive correlations were found in all instances (as predicted) except between the Paragraph and the phonemic component of the Verbal Fluency Task (i.e., FAS). Here, the correlations were positive (ranging from .34 to .47) but were not statistically significant. However, there may be a certain logic to these lower correlations. First of all, Paragraph and Verbal Fluency share a verbal component but the former is a learning and memory task whereas the latter is a language test. Second, the Paragraph provides a meaningful context for organizing the information (i.e., a story line about a brother and sister going to the circus)

whereas the FAS (unlike the meaningful organizational category of Animals seen in semantic fluency), provides only a broad guideline ("Tell me as many words as you can think of that begin with the letter "F").

Finally, the relationships between the G-LAMB Figure and other visuospatial tests in the study were varied. As predicted, a significant, positive relationship was found between the G-LAMB Figure and the LAMB Simple Figures on learning and memory trials. Unexpectedly, this was not the case between the G-LAMB Figure and LAMB Simple Figures copy trials. With the tasks being similar, this difference is difficult to explain. However, it may be a statistical artifact whereby the restricted range of scores has depressed the level of the correlation. Two other potential explanations involve differences in test administration and differences between the figures themselves. First, the G-LAMB Figure administration allows for a 30 second exposure to the Figure at each learning trial whereas the LAMB exposure time is only 15 seconds. Thus, there may be a different level of familiarity with the figure by the time the copy trial is undertaken. A second possible explanation for the lack of a statistically significant correlation between the copy trials is that the G-LAMB Figure is one discrete unit whereas the LAMB Simple Figures are four distinct figures presented in a specific sequence. This difference may have an impact on copy performance. For example, those with AD could find copying four figures in a specified order more challenging than copying one figure (albeit with more detail).

The lack of statistically significant correlations between the G-LAMB

Figure learning and memory trials and the Clock Test command condition (i.e., freehand drawing of a clock) is less surprising because the tasks are somewhat different (i.e., the Clock Test does not have traditional learning or recall components). Whether scoring was done using Scale 1 (quantitative score) or Scale 2 (qualitative error score), there was a significant relationship between the Figure copy trial and the Clock Test command condition. However, although the Figure copy trial and the Clock Test copy trial performance were significantly correlated when the qualitative error score was calculated (as expected), there was no significant relationship when the quantitative score was used. This unexpected finding may be due to differences in the degree of familiarity with the object being copied (i.e., the G-LAMB Figure is new information whereas the face of a clock is not) or differences in test administration (as noted previously).

Limitations of the Current Study

Perhaps the most significant limitation to the current study is the small sample size. Despite efforts to maximize participation, the final group of fourteen participants was below the anticipated participation level. In this regard, two main factors need to be taken into account. First, it must be remembered that this is the first Alzheimer research in Northern B.C.; therefore, this was a new experience for potential participants and their families as well as for local medical facilities and agencies. Second, not having an Alzheimer Centre as would be the case in a major urban centre meant that participants had to be reached largely on an individual basis. Lack of an Alzheimer Centre also meant that there were no consistent local criteria for AD diagnosis. Thus, in addition to the G-LAMB, it

was necessary to conduct other neuropsychological tests in order to ensure that participants met the NINCDS-ADRDA diagnostic criteria for probable AD. Including these diagnostic tests greatly increased the length of the testing procedure and may explain why some participants were unwilling or unable to complete the entire process.

Conducting the additional neuropsychological tests also exposed a serious weakness in currently available norms. Specifically, for many tests, norms are simply unavailable for individuals over the age of 75 years or for those who have less than 8 years of education. This is a serious shortcoming when attempting to determine whether or not an individual shows a deficit in certain skills. Without appropriate age- and education-related norms, particularly for those who are older and less educated, it is possible that some people are being misidentified (i.e., inappropriately labeled "impaired" or vice versa). When assessing the standing of a 92-year-old on a memory test, it can be difficult to estimate whether the person shows a deficit when the closest norm available is for a 75-year-old and you are left to guess the impact of increased age on that skill. The problem is compounded if the 92-year-old has two years of education and is being compared to norms for someone with 9 years of schooling. It would seem that development of norms for older and less educated adults is critical to future diagnostic evaluation of cognitive deficits.

Future Directions

In general, the Geriatric Learning and Memory Battery appears to be a useful tool for assessing learning and memory performance in those with

Alzheimer's Disease. First, the scores of individuals with Mild AD are high enough to allow one to monitor changes in learning and memory at least into the moderate stage of the disease. Second, it was possible to differentiate the performance levels of those with Mild and Moderate AD, particularly on the Paragraph subtest. However, three immediate tasks remain. First, it would seem that development of a less difficult version of the Figure would be helpful in order to effect the same high performance level and clear group differentiation found with the Paragraph subtest. Second, in order to use the G-LAMB as a tracking test, it will be necessary to develop two or three sets of parallel materials for use in retest sessions so that practice effects due to the repeated exposure of an individual to the same test materials does not contaminate results. Finally, having established the utility of the G-LAMB for an AD population, further research is needed to evaluate its utility in other clinical populations such as those with vascular dementia and brain injuries.

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Appendix A

Participant's Name: _____

INFORMED CONSENT FORM

The purpose of an informed consent is to ensure that you understand the purpose of the study and the nature of your involvement or the involvement of your family member.

Present Study: A Study of Verbal and Visual Memory

Purpose. The purpose of this study is to examine memory performance for visual and verbal information.

Task Requirements. The participant will be given several opportunities to learn and remember a short paragraph and a geometric design as well as doing a number of other memory-related tasks.

Duration. The testing takes about one and a half hours but this can be divided into two shorter sessions if needed.

Anonymity/Confidentiality. The data collected in this study will be kept confidential and made available only to the researchers associated with this project.

Right to Withdraw. Participants have the right to refuse to answer any specific question or participate in any specific task. Participants also have the right to withdraw consent and terminate participation at any time without compromising their right to receive service.

Dissemination of Research Findings. After the research is completed (before the end of 1998), a one page summary of the overall results of the study will be available to participants and their families upon request. Individual test results for any study participant will not be made available.

Research Personnel. If you have any questions, please contact Dawn Hemingway (960-5694) or Dr. Anita Hubley (960-6506) at the University of Northern British Columbia.

I have read the above description of "A Study of Verbal and Visual Memory" and understand the conditions of my participation (or the participation of my family member). My signature indicates that I agree to participate in this study (or to have my family member participate in the study).

Participant or Family Member:

_____	_____	_____
(Print Name)	*(Signature)*	*(Date)*

Consent Obtained by:

_____

(Print Name)

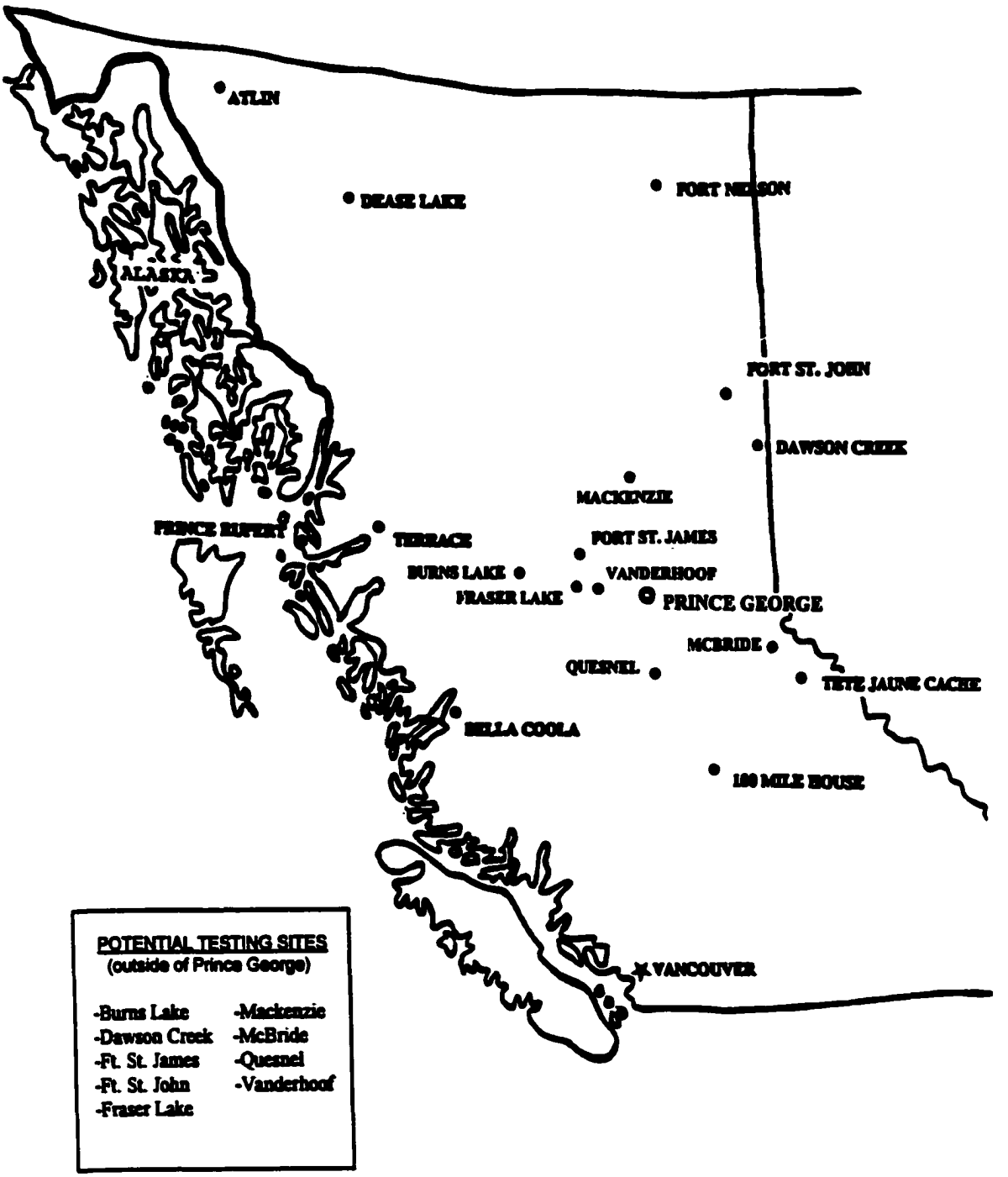
Participant's Physician:

_____

(Print Name)

Appendix B

Map of British Columbia Showing Location of Potential Testing Sites



Appendix C

FAMILY CONSENT TO RELEASE PHONE NUMBER FOR POTENTIAL RESEARCH PURPOSES

Currently, two researchers from the University of Northern British Columbia are studying the usefulness of a new test of memory for people with Alzheimer's Disease (AD). The study, which is funded by the Alzheimer's Society of B.C., is the first of its kind to be conducted in northern B.C. The researchers are looking for people who could participate in the study any time between December 1 and March 31, 1998. In order to help make this study a success, we (PGRCCS) are calling family members of potential participants in order to obtain permission to provide the researchers with your phone number. In this way, you will be able to speak directly to the researchers and, on that basis, decide if you would like your loved one to participate.

Purpose. The purpose of the study is to examine the usefulness of a new test of verbal and visual memory for people with Alzheimer's Disease.

Benefits. There are no immediate benefits to study participants. However, in the long run, it is expected that being able to determine the strengths, weaknesses and relative rate of decline in an individual's verbal and visual memory will assist caregivers, both in the community and in care facilities, to design their interventions more effectively by placing more emphasis on the person's strengths and less on their weaknesses. As a result, a better quality of life could be provided to persons with cognitive deficits.

Task Requirements. This study examines memory performance for different types of information. The participant will be given several opportunities to learn and remember a short paragraph and a geometric design as well as doing a number of other memory-related tasks.

Duration. The testing takes about one and a half hours but this can be divided into 2 shorter sessions if needed and can be conducted at the care facility or at the day centre.

Anonymity/Confidentiality. Any data collected in this study will be kept confidential and made available only to the researchers associated with this project.

Right to Withdraw. Participants have the right to refuse to answer any specific question or participate in any specific task. Participants also have the right to withdraw consent and terminate participation at any time without compromising their right to receive service.

Dissemination of Research Findings. After the research is completed (before the end of 1998), a one page summary of the overall results of the study will be available to participants and their families upon request. Individual test results for any study participant will not be made available.

Research Personnel. If you have any questions, please contact the researchers: Dawn Hemingway at 960-5694 or Dr. Anita Hubley at 960-6506.

I understand that giving my consent means that my phone number will be given to the study researchers so that they can contact me directly. I also understand that providing my phone number does not mean that I have agreed to have a family member participate in the study but rather that I would like to get more information and speak directly to the researchers involved.

(Name of Family Member)	(Date Consent Given)
(Name of Resident/Client)	(Facility or Program)
(PGRCCS Staff Member who obtained consent)	(Signature of PGRCCS Staff Member)

Appendix D

Letter to Physicians Regarding Alzheimer Memory Study

Alzheimer Research in Northern B.C.

December 1997

Dear Physicians:

We are writing to let you know about a research project, studying the usefulness of a new post-diagnosis memory test for people with Alzheimer's Disease (AD), that we are currently conducting. The study, which recently received some funding from the Alzheimer's Society of B.C., is the first of its kind to be conducted in northern B.C.

The main objective of the study is to determine if a recently developed test, the Geriatric Learning and Memory Battery (G-LAMB), will be more appropriate than traditional memory tests for assessing verbal and visual memory in individuals with mild to moderate stage Alzheimer's Disease. Traditional memory tests are often too difficult and those with AD may perform so poorly that it is difficult to assess strengths and weaknesses or to track memory changes over time.

We expect that the new test will make it possible to better determine the strengths, weaknesses and relative rate of decline in the verbal and visual memory of an individual already diagnosed with AD. Such information can assist physicians and other caregivers, both in the community and in care facilities, by placing more emphasis on the person's strengths and less on their weaknesses. We believe that a better understanding of an individual's memory strengths and weaknesses can help reduce stress and increase coping abilities for both caregivers and persons with AD.

We would appreciate any input or suggestions regarding potential participants in the Prince George area. A poster is attached for display in your waiting room area. If you require further information, please feel free to call us at the numbers listed below.

Sincerely,

Dr. Anita Hubley
Assistant Professor, Psychology
University of Northern B.C.
(960-6506)

Dawn Hemingway
Master's Student, Psychology
University of Northern B.C.
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Appendix E

Poster Advertising Alzheimer Memory Study

UNBC University of Northern British Columbia

ALZHEIMER MEMORY STUDY

Have you been recently diagnosed with Alzheimer disease? Do you know anyone who has Alzheimer disease? Dr. Anita Hubley and Dawn Hemingway are conducting a study on learning and memory changes in persons with Alzheimer disease in Prince George and other northern communities. This is the first time that Alzheimer research has been conducted in northern B.C.!

We are looking for as many people as possible with mild to moderate stage Alzheimer disease to take part in this important study. Each person will be given a number of different memory tasks lasting approximately 1 ½ hours. If desired, this time can be divided into two shorter sessions. Testing can take place at the university or in the participant's home (either in the community or care facility).

If you would like more information about this study (or know anyone who might want to take part), please call and leave a message for Dawn Hemingway at 960-5694 (Memory and Aging Laboratory). Thank you!

ALZHEIMER

MEMORY

STUDY

PARTICIPANTS

NEEDED

Call

960-5694