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AN EVALUATION OF THE EQUIVALENCE OF TWO WORD LEARNING TESTS WITH
MEMORY-INTACT AND MEMORY-IMPAIRED ELDERLY ADULTS

by

Laurie Morrison

B.A. (Hons.) Carleton University, 1989.

A Thesis
Submitted to the Faculty of Graduate Studies
through the Department of Psychology
in Partial Fulfillment of the
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of Master of Arts at
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The undersigned recommend to the
Faculty of Graduate Studies and Research
Acceptance of the thesis:

**“An Evaluation of the Equivalence of Two Word Learning Tests With
Memory-Intact and Memory-Impaired Elderly Adults”**

submitted by

Laurie Morrison

in Partial fulfillment of the requirements for

the degree of Master of Arts

Chair

Thesis Supervisor

Carleton University
July, 1998

ABSTRACT

The primary purpose of this study was to compare the acquisition and retention of a word list when two different learning procedures were employed. Twenty memory-intact (mean age = 65 years) and twenty memory-impaired (mean age = 71 years) older adults voluntarily participated in this investigation. Buschke's selective reminding procedure (also known as the partial list procedure) of presenting only those words not recalled on the previous learning trial was compared to the more traditional procedure (known as the total list procedure) wherein the entire word list is administered on each trial. As expected, memory-intact older adults performed better than their memory-impaired cohorts on both conditions. However, the type of procedure employed did not differentially affect acquisition or the amount of information retained following a twenty minute delay interval. The results of this study suggest that, contrary to Buschke's contentions, the selective reminding procedure did not produce significant advantages or greater practical utility over the traditional procedure, particularly within a memory-impaired sample. Several possibilities were proposed to explain such findings.

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An Evaluation of the Equivalence of Two Word Learning Tests with Memory-Intact and Memory-Impaired Older Adults

Introduction

The primary purpose of the current study is to determine whether two different methodological approaches used to assess verbal learning and memory (traditional list learning versus a selective reminding procedure) produce equivalent results in a sample of cognitively intact older individuals and in a group of memory-impaired elderly adults. Within the context of a comprehensive cognitive evaluation, the clinical assessment of memory and learning traditionally has been achieved, in part, by means of word list learning paradigms. These procedures typically involve the presentation of an entire list of words on each learning trial. As will be detailed later, there are several disadvantages associated with the traditional list learning approach, such as the confounding of practice and memory effects. In an effort to circumvent these difficulties, Buschke (1973) described an alternative strategy which he termed "selective reminding." In brief, rather than repeating the entire word list on every learning trial, only those words not recalled on the preceding trial are presented. While this procedure has been touted as a superior method to the traditional approach, this claim has not been substantiated in a memory-impaired sample. Thus, the main purpose of this study will be to compare Buschke's unique selective reminding procedure and the traditional list learning approach in a sample of both cognitively intact and memory-impaired older adults.

With the rapid expansion of the elderly population, dementia is reaching almost epidemic proportions in modern society. By far, the most common cause of dementia in the elderly is Alzheimer disease (AD), a neurodegenerative condition which results in a relentless erosion of intellect, memory, and personality. It is projected that, by the year 2030, almost a quarter of a million Canadians will be afflicted with this devastating disease (Gautrin, Forda, Tetreault, & Gavreau, 1990).

Memory impairment is typically the initial and most prominent symptom of dementia. Over the last century or so, experimental psychologists have categorized memory into several separate components or processes. They have long distinguished between a primary (or "short term") memory store of very limited capacity and a secondary (or "long term") memory store of much greater capacity. Within secondary memory, a major biological dichotomy distinguishes declarative and nondeclarative memory. Declarative memory includes memory for facts and events in which the memory content can be consciously described or declared through verbalization and/or visualization, or more generally, information and knowledge of the world. It is believed to be situated in the cerebral cortex and depends on the integrity of the medial temporal lobe system (i.e., hippocampal and related structures) (Squire & Zola-Morgan, 1991).

Nondeclarative memory refers to a heterogeneous set of distinct learning and memory abilities that change performance without access to the experiences that caused the change. In nondeclarative memory, experience alters behaviour unconsciously, without providing any memory context. Nondeclarative (also known as "procedural memory") is believed to be independent of the medial temporal lobe. Types of nondeclarative memory include skills (motor, perceptual, cognitive), dispositions (operant and classical conditioning), and nonassociative memory (i.e. habituation and sensitization).

Other memory dichotomies discussed in the literature include: anterograde and retrograde amnesia, recent and remote memory, as well as short-term memory and long-term memory. These different memory dichotomies are not mutually exclusive, and some memory terms and types overlap considerably (i.e., recent and short term memory). Given the obvious ambiguity which surrounds these various dichotomies, and in order to avoid confusion, Waugh and Norman (1965) have suggested the use of the terms "primary" and "secondary" memory. Indeed, Waugh and Norman developed the first modern behavioural model of memory and their concept of primary memory has served as a departure point for most modern theories.

Primary Memory

In Waugh and Norman's dualistic theory, primary memory is a short-term storage system that is conceptualized as being independent of secondary memory, a longer-term storage system. Primary memory serves the purpose of acquiring and briefly

retaining new information (Waugh & Norman, 1965). Information from the senses is briefly held in primary memory, then is displaced by new items and is permanently lost. However, rehearsal of items enables various coding processes to occur, which store the items in secondary or "long-term" memory (which is a relatively permanent store with unlimited capacity). A characteristic feature of primary memory is the limited amount of material (maximum capacity thought to be 7 ± 2 items) that can be remembered for short periods of time. Another feature is the rapid rate of forgetting which occurs over short intervals during which the individual is distracted by a subsidiary task.

Several procedures have been devised to measure the storage capacity of primary memory, also known as "immediate memory span." One approach has used the free recall procedure in which a person is presented with a series of items and instructed to recall as many of them as possible, in any order, immediately following the last presented item. When probability of recall is plotted against the serial position of the item in the list, normal individuals typically demonstrate a U-shaped curve in which the first few items and the last few items of the list are recalled better than those presented in the middle. Glanzer and Cunitz (1966) suggested that recall of the last few items, known as the recency effect, reflects temporary short-term memory or the number of items stored in primary memory. Items from the end of the series are retained in short term memory at the time of recall and are recalled first before being lost (i.e., they are not rehearsed and transferred to the long-term

store). Words recalled from the beginning of the list, called the primacy effect, are presumed to reflect material which has passed into secondary or long-term storage (via rehearsal and other active encoding processes) before the short-term store became too overloaded with incoming information. Thus, the primacy effect is a product of the amount of rehearsal which items receive while in primary memory or the short term store. Since the amount of rehearsal an item receives decreases progressively from the first item in the list, the initial few items (those receiving the greatest amount of rehearsal) are transferred to the long-term store (Atkinson & Shiffrin, 1971). Mid-list items receive the least rehearsal, are least likely to be transferred to long-term memory, and thus have the lowest recall probability.

Secondary Memory

According to Waugh and Norman, secondary or "long-term memory" is viewed as a relatively permanent repository of newly learned information with a theoretically unlimited capacity. With rehearsal and various active encoding strategies, information held in primary memory enters into secondary memory. In reviewing the effects of dementia upon primary and secondary memory, Wilson, Bacon, Fox, and Kaszniak (1983) found a moderate decrease in the primary memory component of free recall, contrasting with a more substantial decrease in the secondary memory component. These investigators further showed that the size of the demented patients' primary memory deficit correlated with the impairment in secondary memory. By contrast, Martin, Brouwers, Cox, and Fedio (1985) did not

find a differential impairment in either primacy or recency, as the slope of the serial position curve was the same for both normal and demented individuals. Instead, these investigators found a moderate decrease in both the primary and secondary memory components of AD patients, such that the latter group recalled less at all serial positions.

While it was commonly assumed that a single memory state existed in long-term memory, Tulving (1983) distinguished two forms of LTM, episodic and semantic memory, as a means of orienting research and theoretical development. Episodic memory refers to memories that require temporal and spatial contextual cues for retrieval (Tulving, 1983). Episodic memory is defined as an autobiographical record of specific events in an individual's experience, encoded in terms of a particular temporal-spatial context. These memories are elicited by questions of the “Where?”, “When?”, and “Who?” type that specify content. Patients with AD generally display a severe and progressive difficulty in learning and retaining new episodic information (i.e., an anterograde amnesia). This impairment in episodic memory is easily measured by a variety of standardized memory tests; for example the Buschke selective reminding test (Buschke, 1973; Buschke & Fuld, 1974; Masur et al., 1989; Masur, Fuld, Blau, Crystal, & Aronson, 1990) and the California Verbal Learning Test (Delis, Kramer, Kaplan, & Ober, 1987). As previously stated, this memory deficit can also be conceptualized as a failure to transfer information from primary (i.e., short term) memory to secondary (i.e., long term)

memory. Episodic memory is involved in the traditional tests of secondary memory, such as the learning of word lists and paired-associates, as these measures require recall of events associated with a particular temporal and/or spatial context.

Semantic memory, in contrast to episodic memory, may be thought of as a thesaurus of organized knowledge regarding words, concepts, and their associations, and the rules for manipulating these symbols and abstract ideas. Semantic memory involves relatively context-free information and is concerned with the knowledge necessary for the use of language and in particular, with the storage of and access to the meaning of words. Semantic memory refers to overlearned information that is part of one's general fund of knowledge and is no longer dependent upon temporal and spatial contextual cues for retrieval. This can be tested by asking about common geographical information, historical facts, vocabulary and the like. Tests of semantic memory include the Wechsler Adult Intelligence Scale -Revised (WAIS-R) Information and Vocabulary subtests, and word fluency tests.

Waugh and Norman's model of memory has been criticized for not adequately accounting for the apparent complexity of short term memory. Atkinson and Shiffrin (1968) thus proposed a dual concept of memory, similar to that of Waugh and Norman, which delineated more subsystems. In their model, memory has three stores: 1) the sensory register, 2) the short-term store, and 3) the long-term store. According to these Atkinson and Shiffrin, a stimulus is immediately registered within the appropriate sensory dimension and is either lost or passed on for further processing.

Atkinson and Shiffrin made an important distinction between the concepts of memory and memory stores; they use the term *memory* to refer to the data being retained, while *store* refers to the structural component that contains the information. Thus, in their system, information can be admitted to long-term store shortly after it has been presented, while other information can be held for several minutes in short-term store and never enter long-term store.

The short-term store was regarded as the working system, in which entering information decays and disappears rapidly. Information contained within the long-term store was envisioned as relatively permanent, even though it might be inaccessible because of the interference of incoming information. The function of the long-term store was to monitor stimuli in the sensory register (controlling those stimuli that enter the short-term store) and to provide storage space for information from the short-term store. Central to the Atkinson-Shiffrin theory of memory is the concept of subjective control over information flow in and out of short-term store. According to their theory, information briefly held in the sensory register is scanned by the individual and selected information is then introduced into the short-term store. The activation of specific control processes (which the individual may call into play at their discretion) depends upon the nature of the task and the immediate instructions. In this model, incoming stimuli pass from receptors to the sensory register (with a capacity of only several hundred milliseconds). If not rehearsed, information that has been transmitted to the short-term store will decay and be lost

in approximately 30 seconds. With rehearsal, control processes can maintain information in the short-term store for longer periods of time. Some information in the short-term store is then transferred to the long-term store, which is the permanent repository of knowledge. Thus while the earlier model of Waugh and Norman provided the gross anatomy of memory, the later model of Atkinson and Shiffrin contributed the concept of a human memory system that keeps track of incoming information and exercises some control over its limited information-processing capacity.

Soon after Atkinson and Shiffrin proposed their concept of memory, Craik and Lockhart (1972) introduced their level-of-processing model of memory. In summary, they proposed that incoming stimuli are subjected to a series of analyses starting with shallow sensory analysis and proceeding to deeper, more complex, abstract, and semantic analyses. Whether a stimulus is processed at a shallow or deep stage depends upon the nature of the stimulus and the time available for processing. An item processed at a deep level is less likely to be forgotten than one processed at a shallow level.

Information-processing models of memory stress the sequence of stages or hierarchical levels through which information is moved and processed. Craik and Lockhart's alternative viewpoint argued that memory traces are formed as a by-product of perceptual processing. Thus, the durability of memory is conceptualized as a function of the depth of processing, with depth defined in terms of the degree

of “meaningfulness” extracted from the material. Information that is not given full attention and is analysed only to a shallow level is soon forgotten; information that is deeply processed (i.e., attended to, fully analysed, and enriched by associations or images) is longer-lasting. In such depth-of-processing paradigms, study participants are presented with a list of words. Prior to the presentation of each word, the individual is asked a question about the word. Shallow encodings may be achieved by asking questions about the physical structure of the word (e.g., Is the word printed in capital letters?). Intermediate levels of encoding may be accomplished by asking questions about the phonemic characteristics of the word (e.g., Does the word rhyme with TRAIN?). Lastly, deeper levels are induced by asking questions requiring semantic analysis of the word (e.g., “Is the word an animal name?”). In general, deeper levels of analysis are associated with more durable memory traces and superior performance on subsequent memory tests for the words. In a study using the depth-of-processing paradigm in AD, Martin, Brouwers, Cox & Fedio (1985) attempted to assess whether AD patients would benefit from semantic encoding. Patients were presented with word lists and tested under free recall and three cued conditions. The patients were cued with either a rhyme, a word indicating where the object could be found, or a pantomime movement. The authors found no difference between recall under free encoding versus recall under the semantic encoding conditions.

While these early theorists proposed a dualistic approach to the conceptualization of memory, Tulving more recently offered an alternative hypothesis about memory systems which challenged the traditional models. In his paradigm, memory consists of a number of systems, each of which serves a different purpose and operates with different principles (Tulving, 1985). The combination of systems and principles makes up what is termed memory. While his theory maintains that there are five major memory systems, these may be grouped together into the above mentioned dichotomy of declarative (which includes the systems which Tulving termed “episodic”, “semantic”, and “short term memory”) and nondeclarative (which encompasses “procedural memory” and “perceptual representation”) memory. Although each system serves particular functions which the other systems cannot serve, the interaction of several systems is necessary for the performance of tasks.

Working within the framework of Waugh and Norman’s original conceptualization of memory, Buschke (1973) proposed an innovative and unique method which permits the simultaneous analysis of several elements of memory. While his procedure clearly did not represent a theoretical advance, Buschke’s approach provided a significant methodological advantage in that it facilitated the differentiation among various memory sub-components. The use of traditional list learning procedures does not allow the simultaneous examination of initial storage, retention, and retrieval from long term memory. In contrast, as will be detailed

later, Buschke's selective reminding procedure permits the decomposition of memory into such familiar information processing-based constructs as short-term recall, long-term storage, and long-term retrieval. It was Buschke's contention that such simultaneous analysis would allow a more adequate assessment of learning and memory.

Traditional List Learning

The evaluation of memory constitutes an integral part of the examination of cognitive functioning. In turn, word list learning is one of the most commonly used paradigms in the study of memory and in particular, verbal learning. Among the most frequently employed traditional list learning measures are the Rey Auditory Verbal Learning Test (Lezak, 1983; Rey, 1964) and the California Verbal Learning Test (Delis et al., 1986). In the typical "total list presentation" method used in these procedures, an individual is presented with a list of words and asked to recall as many as possible. Twelve to 20 items are commonly presented, one at a time. The acquisition process is assessed by repeatedly presenting the same list (the number of trials usually varying from 5 to 20, with 4-6 being the most common) in its entirety. Examinees are instructed to recall as many of the words as possible, without regard to the order in which the words were presented. In many free recall studies, a delayed recall component is also included to assess retention.

The performance of normal elderly individuals on the traditional list learning task has been well documented. Not surprisingly, results consistently indicate that

performance declines steadily with age, particularly between the ages of forty and eighty years (Bolla-Wilson & Bleecker, 1986; Query & Megran, 1983), and that the normal elderly have flatter learning curves. Serial position curves have also been employed to study the effects of aging on memory. The majority of studies comparing the recency effect of healthy younger and older adults have concluded that there is essentially no difference between these two populations in short term memory functioning (Craik, 1977; Craik & Jennings, 1992). Those few which obtained differences found them to be minimal (Craik, 1977; Kausler, 1982). The major effect of age has been on the long term memory component. The nature of the differences can be categorized as follows: 1) rehearsal deficits of the elderly, both in speed and quality (Salthouse, 1980; Schmitt, Murphy, & Saunders, 1981); 2) retrieval deficits where information about stimulus items does reach the long term store but the individual has difficulty in searching or retrieving from this store (Perlmutter, 1979; Smith, 1980); and 3) encoding deficits where items are not efficiently encoded by elderly adults at the time of learning, resulting in defective or inefficient long term storage (Kausler, 1982; Waugh & Barr, 1982).

The traditional list learning approach has also been used to compare the performance of normal elderly adults with those diagnosed with memory disorders. As might be expected, the majority of these investigations have shown that the overall performance of the demented patients was lower than that of the normal elderly individuals (Delis et al., 1991; Harnes & Dowson, 1982; Martin et al.,

1985). Serial position curves have also been used to compare the performance of the normal elderly and those with memory disorders. Most experiments have found the overall performance curve to be lower for dementia patients than for normal elderly individuals (Harris & Dowson, 1982; Martin et al., 1985; Miller, 1971). Several other studies have demonstrated that demented patients do not show the typical bimodal serial position curve. Indeed, a few studies have indicated that the curve for demented persons is more unimodal, lacking a pronounced primacy effect while the recency component remained essentially normal (Brooks & Baddeley, 1976; Kasniak et al., 1986; Martin et al., 1985). In some instances, however, patients with Alzheimer disease (AD) adopt a strategy of repeating the initial words on a list over and over again. This inevitably results in remembering the initial few words held in working memory (primacy effect) at the expense of the final words on the list (reduced recency effect). On the other hand, several studies have revealed that AD patients are consistently impaired on all measures of short-term memory, regardless of serial location. For example, Miller (1971) reported that demented patients had poorer recall across all serial word positions as compared to control participants. The impaired recall of words at the end of the list is believed to reflect the abnormally rapid loss from primary memory, whereas a disproportional recency effect and a reduced or absent primacy effect suggests a failure to transfer information from short term memory into long term memory. The lack of

consistency among the cited studies may be attributable to differences in levels of dementia severity. This hypothesis was confirmed by Harris and Dowson (1982) who concluded that the level of dementia significantly influenced which part of the serial curve was modified. These authors found that mild-to-moderate dementia suppressed the primacy effect while more severe dementia suppressed both primacy and recency.

Selective Reminding Procedure

Despite the widespread use of the total list presentation procedure, few studies have challenged its methodology and fewer still have proposed an alternative approach. One alternative strategy, purported to be superior to the traditional method, is selective reminding (also known as "partial list presentation"). This procedure was first introduced by Herman Buschke (1973), a physician specializing in the detection and analysis of memory disorders. "In essence, selective reminding simply involves the selective presentation on each recall trial of only those items which were not recalled on the immediately preceding trial" (Buschke, 1973, p. 543). On each trial, however, the individual must still attempt to recall the entire list, including the selectively-reminded words, as well as the items recalled on the prior recall trial.

In his original article, Buschke (1973) discussed three major disadvantages to the traditional total list presentation procedure. Firstly, in the total list presentation method, unlearned words are intermixed with those previously learned and recalled,

making them more difficult to focus on and acquire. Secondly, by conventional free recall, there is no way to determine exactly when an item has been learned.

Buschke suggested the criterion for learning is the retrieval of a word without its presentation on the immediately preceding trial. According to Buschke, such a determination was not possible with the traditional list learning procedure since all items are presented on every trial. Thus, learning is more clearly demonstrable in selective reminding than in conventional list learning. Lastly, the traditional method does not permit understanding of how item presentation results in initial encoding, facilitation of retrieval, or list organization.

The selective reminding approach appears to offer several advantages over the traditional method. Since only the unlearned words are presented on every trial, less administration time is required. This feature is particularly attractive in the assessment of elderly and/or memory-disordered individuals, where brevity of testing is an important factor (i.e., to minimize the potential detrimental effects of boredom and diminished attentional abilities). Secondly, the selective reminding procedure provides a distinctive form of feedback: Buschke believed that partial presentation maximized learning by indicating to the individual which items were posing the greatest difficulty (i.e., those which were not recalled on trial n and which were therefore presented on trial $n + 1$). This, in turn, would prevent over-learning of the more easily recalled list items and allow the learner to selectively rehearse those more difficult items. Thirdly, the selective reminding procedure does

not interfere with subjective encoding strategies which the individual may spontaneously use to organize the list during learning and retrieval. The partial list procedure might thus promote greater reliance on subjective organization since it does not present the same serial order on each trial. Partial presentation also provides the maximal opportunity to demonstrate which items had been learned and during which part of the learning sequence an item had been transferred to long term storage. This is demonstrated by the spontaneous retrieval of the item following the first study trial on which it had not been presented. Finally, the selective reminding presentation allows for a more adequate assessment of impaired memory and learning by simultaneously analysing initial storage, retention, and retrieval from long term memory.

In his original publication, Buschke (1973) employed a list of 20 words from a single semantic category (animals) and 12 learning trials. Since that time, the number of stimulus items used in different experiments has varied from 8 to 2, while the number of acquisition trials has ranged from 4 to 15. Although some studies have used pictures or line drawings as stimuli (Buschke, 1984; Grober & Buschke, 1987; Tuokko & Crockett, 1988), lists of both unrelated and same-category words are most often employed. In the most commonly used version (Hannay & Levin, 1985), participants are instructed to listen to a list of 12 words and then repeat as many as can be remembered. On each subsequent trial, the subject is reminded only of the words that were not recalled on the previous trials.

The test is discontinued after 12 trials or after the subject recalls all 12 words on two consecutive trials.

No theoretical or rational basis has been presented for a selection of 12 as the requisite number of trials to administer. The issue of test length was addressed by Kraemer, Peabody, Tinklenberg, and Yesavage (1983), who used a mathematical model to determine the optimal number of learning trials. From the results of their modelling, they concluded that "it is not possible to present a strong case for using more than 10 trials in a clinical setting, and 5 trials may be satisfactory for most purposes." (Kraemer et al., 1983, p. 373). Smith, Goode, LaMarche, and Boll (1995) also assessed the clinical utility of fewer trials of the selective reminding test as compared with a 12-trial administration, using two clinical populations. One sample consisted of 100 end-stage cardiac patients undergoing evaluation for heart transplantation. The other group was made up of 100 patients being evaluated after traumatic brain injury. Scores were derived for trials 2 through 12. Analyses conducted among these scores revealed correlations exceeding .90 between 6 and 12 trials and correlations exceeding .95 between 8 and 12 trials. The findings support the hypothesis that fewer trials of the selective reminding test provide information highly consistent with that provided by 12 trials. Similar correlations were found with both patient groups. Comparable correlations were also found for patients with mild, moderate, and severe head injury. These findings suggest that fewer trials of the selective reminding test would be adequate for diverse clinical populations and for patients with varying degrees of impairment.

Dependent Measures

The selective reminding procedure was intended to provide a variety of estimates of both storage and retrieval. In order to clearly understand the partial presentation procedure, it is necessary to explain how retrieval from short and long term memory stores is defined. Retrieval from short term memory is defined as the recall of items immediately following their presentation. Retrieval from the long term store is defined as the retrieval of an item without its presentation on the preceding study trial. For instance, a word recalled once from the short term store and spontaneously retrieved on the next trial without an additional presentation is said to have been retrieved from the long term store. Following initial retrieval without presentation, an item is seen as having entered long term storage on the trial during which it was last presented, even though it may not be spontaneously recalled for two or more subsequent trials (Buschke, 1973, Buschke & Fuld, 1974). Buschke postulated that the spontaneous retrieval of a stimulus word, without its prior presentation, was necessary to demonstrate storage and retention in long term store and to differentiate short term from long term retrieval during list learning. This is not possible using the traditional total list presentation approach due to the confounding effects of presenting all items on each and every acquisition trial (Buschke, 1974; Fuld & Buschke, 1976).

The total number of list items retrieved from long term memory is subdivided into two components, consistent long term retrieval and random long term retrieval. This differentiates between those items consistently recalled and those words randomly recalled across trials. A list item is consistently recalled when, after its initial spontaneous retrieval, it is retrieved on all subsequent test trials. Random long term retrieval is retrieval of an item which has previously entered and is assumed to be in long term storage but is inconsistently recalled across trials. Consistent recall is thus a measure of organized list learning while random retrieval represents item learning (Buschke, 1974; Buschke & Fuld, 1976). By using Buschke's partial presentation procedure, an estimation of short and long term storage can thus be obtained, as can an estimate of total long term retrieval, which is divided into consistent (list learning) and random (item learning) retrieval. It is also possible to determine when an item had initially entered into long term storage and to provide a measure of retrieval from this store. In summary, Buschke's procedure permits recording of the following dependent measures:

- 1) **Short Term Storage:** an item recalled immediately following its presentation is defined as having been retrieved from this store.
- 2) **Long Term Storage:** a word spontaneously recalled on two consecutive trials (without a reminder) is assumed to have entered this store on the first of the two

trials. Note that a word which has entered long term storage may, nevertheless, be missed on one of the subsequent trials.

3) **Long Term Retrieval:** an item recalled on any trial which had been listed as being in long term storage. Thus, once an item meets the criteria for long term storage, all subsequent recalls of that item are assumed to be retrieval from long term store.

4) **Short Term Retrieval:** a word recalled with reminding is said to have been retrieved from short term memory. Thus, short term retrieval represents the number of words recalled from short term storage.

5) **Consistent Long Term Retrieval:** a word subsequently recalled consistently from Long Term Storage without reminding is assumed to have been in Consistent Long Term Retrieval from the first point of continuous recall.

6) **Random Long Term Retrieval:** words that were in Long Term Storage, but were inconsistently recalled (i.e., a word is not recalled on trial 3 after having been consistently retrieved on trials 1 and 2).

7) **Total Recall:** is the total number of words recalled, summed across all trials.

8) **Delayed Free Recall:** the number of words recalled, without cuing, after a twenty minute period of delay.

9) **Delayed Cued Recall:** the number of words recalled after the provision of a semantic cue.

10) **Recognition:** the number of words recalled on a multiple choice recognition procedure.

The number of **Intrusions** (extralist words) given on each trial is also recorded.

Although part of the appeal of the selective reminding test has been its attempt to discriminate among components of memory, the scores derived have been found to be highly correlated (Keniston, 1982, cited in Kraemer et al., 1983; Paniak, Shore, & Rourke 1989). In light of this high degree of association amongst scores, at least one researcher has attempted to determine which scores are the most useful to report in analysis of memory performance. Paniak et al. (1989) found that both consistent long-term retrieval and the ratio of consistent long-term retrieval to long-term retrieval had predictive utility in the head-injury population.

Selective Reminding in the Evaluation of Clinical/Neurological Disorders

The selective reminding test has been used to examine memory performance associated with a wide variety of neurological disorders. For instance, this procedure has been used in the evaluation of dementia syndromes such as Alzheimer disease and multi-infarct dementia (Grober & Buschke, 1987; Loring, Meador, Mahurin, & Lergen, 1986; Masur, Fuld, Blau, Thal, Levin, & Aronson, 1989; Tuokko & Crockett, 1989), Huntington's disease (Caine, Ebert, & Weingartner, 1977; Paulsen, 1995), and Korsakoff's syndrome (Buschke & Fuld,

1974). Memory impairments associated with head injury (Cardenas, McLean, Farrell-Robertson, Baker, Brook, & Haselkorn, 1994; Paniak et al. 1989); temporal lobe lesions (Martin, Loring, Meador, & Lee, 1988; Westerveld, Sass, Sass & Henry, 1994); depression (Hart, Kwentus, Hamer, & Taylor, 1987), and asymptomatic sero-positive HIV infection (Goethe et al. 1989) have also been examined using the selective reminding test. In addition to its clinical utility in the assessment of memory disorders, the test has been employed in pharmacological studies which evaluated possible memory-enhancing effects of experimental drugs (Cardenas et al., 1994; Levy et al., 1994; Peters & Levin, 1977) as well as in studies which assessed the adverse effects of commonly prescribed psychotropic medications (Braconnier, DeVitt, Cole & Spera, 1982; Deptula et al., 1990; Pomara, Deptula, Medel, Block, & Greenblatt, 1989).

Paniak and colleagues (1989) examined selective reminding and memory performance in 21 severe closed head injured patients. The patients were tested within 6 months of regaining consciousness and then again after at least one year. Results indicated that head injured patients performed significantly worse at both testings than did hospitalized controls matched for age, education, and sex. The findings demonstrated a preponderance of less efficient random long term recall relative to consistent long term recall in the performance of the head-injured individuals. In other words, the head-injured group displayed significantly greater unorganized and random recall than did control individuals.

Cardenas et al. (1994) examined the effects of physostigmine (a cholinergic agonist) on memory loss after traumatic brain injury (TBI), as compared to placebo or scopolamine (a cholinergic antagonist). Each of the 36 individuals received each active drug and the placebo. Several neuropsychological measures, including the selective reminding test, were completed at baseline, after each drug phase, and at a one month follow-up. Results demonstrated an improvement in memory scores in 44% of individuals while taking oral physostigmine (compared to placebo or scopolamine). The most sensitive measure was long-term storage.

Depression has also been found to exert an effect on performance in the selective reminding paradigm. Hart and colleagues (1987) found that depressed individuals, while performing at a higher level than an Alzheimer group, were impaired relative to normal controls. Although total recall was only mildly impaired and recognition was equivalent to normal controls, depressed persons recalled proportionally fewer unreminded items and were less likely to recall high-imagery as compared to low-imagery items. The authors stated that this performance pattern was consistent with "psychobiological mechanisms" used to explain the cognitive deficits in a depressive disorder wherein memory loss has been "attributed to changes in central motivational state mediated by catecholaminergic systems" (Hart et al., 1987; p. 114). As such, recalling unreminded list items and employing high-imagery words for more elaborate encoding may presumably require greater cognitive effort than recalling recently presented words.

The Selective Reminding Test in the Study of Alzheimer Disease

Several studies have assessed the validity of the selective reminding procedure in the examination of patients with Alzheimer Disease (Larrabee, Lengen, & Levin, 1985; Levin, Grossman, Rose, & Teasdale, 1979; Peters & Levin, 1977). In general, results of the investigations involving Alzheimer patients indicate that recall is impaired relative to age-matched healthy controls, particularly on the first 4 trials. In one study, for instance, normal elderly controls recalled four times as many list items on the first two trials than did those with Alzheimer disease (Weingartner et al., 1981). Using the selective reminding procedure, Ober and colleagues (1985) have also reported a greater Long Term Recall deficit among Alzheimer patients compared to normal controls. In addition, Ober et al. (1985) confirmed the inconsistent retrieval pattern characteristically seen among Alzheimer patients. That is, individuals with Alzheimer disease are as likely to recall words not retrieved on the previous trial as they are to remember previously recalled items. In other words, they display a relatively greater proportion of random than consistent long term recall. In another investigation, Grober and Buschke (1987) demonstrated that Alzheimer patients may completely fail to retrieve some items, suggesting the dysfunction of at least two memory components. Firstly, the fact that some list items were never recalled (therefore not encoded into Long Term Storage) indicated an encoding deficit. Secondly, the Alzheimer patients' inconsistent recall across trials suggested a deficit in the

retrieval process. Alzheimer patients generally do not take advantage of stimulus attributes that are ordinarily used in the encoding of events. Therefore, this process and subsequent recall is not facilitated by the repetition of unrecalled list items (Weingartner et al., 1981). The authors hypothesized that this encoding deficit was due to impairment in Alzheimer patients' ability to access semantic memory, thereby decreasing their ability to associate events with one another and with existing structures in semantic memory.

Paulsen and colleagues (1995) compared the discriminative utility of problem-solving and memory tasks in patients with Alzheimer's and Huntington's disease and in age-, education-, and gender-matched control participants. A total of 80 individuals participated in the study: 20 patients with Alzheimer disease, 20 elderly normal individuals, 20 patients with Huntington's disease, and 20 demographically matched middle-aged normal controls. Memory was measured with a 10-item, 6 trial version of the Buschke selective reminding test. Results revealed that the Alzheimer and Huntington patients did not perform as well as their age-matched normal controls on the Total Recall and Long Term Memory measures. Alzheimer patients retrieved fewer items from long-term memory than did Huntington's patients. The patient groups did not differ significantly in Total Recall. There were no significant differences between the elderly normal control and middle-aged normal control groups on any of the selective reminding test measures. Results confirmed that while the test had great utility in differentiating

between normal controls and Alzheimer patients (i.e., it provided 96% classification accuracy between age-matched controls and patients with mild to moderate dementia), the test was less robust in differentiating between the dementia groups. Indeed, results indicated that while the Long Term Storage measure of the selective reminding test produced the best discrimination between Alzheimer and Huntington patients, it provided only modest sensitivity and specificity for differential diagnosis of these groups.

Levy and colleagues (1994) also used the selective reminding test to assess the safety and efficacy of transdermal physostigmine in 12 patients with Alzheimer disease. Repeated testing (using alternate forms) was carried out before the beginning of treatment, on the last day of treatment (day 9), and on the 4th day of subsequent placebo treatment. Results indicated that the performance of 6 of the 12 patients improved. These patients also reported improved vigilance and concentration, which was corroborated by their close relatives as well as by the rating physician. There were no differences between these six patients and the others in Mini-Mental Status Exam baseline scores, age, or sex.

Masur et al. (1990) assessed the ability of the selective reminding test to predict the development of dementia through the detection of memory impairment in non-demented individuals. The results of their study suggested that Buschke's procedure was a promising behavioural marker for the detection of memory impairment associated with dementia at a point well before an individual may

come to clinical attention. The test was administered to 385 non-demented volunteers (mean age = 80.4 years) enrolled in a longitudinal study of the risk factors in the development of dementia. Of these, 36 individuals ultimately became demented. Selective reminding scores obtained from 1 to 2 years *prior* to the diagnosis of dementia were compared with a set of previously established cutoff scores (i.e., 2 standard deviations below the mean score) derived from a cognitively normal elderly sample. The results showed that total recall and delayed recall measures of the selective reminding test were the measures best able to predict dementia. These measures demonstrated sensitivities of 47% and 44%, respectively, and specificities of 86% and 88%, respectively. The positive predictive values were 37% and 40%, respectively, or better than two-and-a-half times the base rate (calculations were based on an estimated prevalence rate of 15% for the development of dementia in an aging population).

Normative Data for the Selective Reminding Test

Despite the clinical application of the selective reminding test, limited normative data are available. In an attempt to establish norms, Ruff, Quayhagen, and Light (1988) examined the total and consistent long-term retrieval of 392 individuals. Twelve unrelated words and 12 learning trials were used, followed by a one hour delay recall test. Subjects were stratified according to age into 5 groups (16-24, 25-39, 40-54, and 55-70 years), gender, and level of education. Results indicated that only a slight decrement in performance (attributable to age

and education) was noted on both of the dependent measures. Recall remained quite consistent up to age 54, with a moderate drop in the 55 to 70 year range. The greatest difference was found for gender, with females out-performing males at all age levels on both total and consistent long term recall. According to the authors, performance on the selective reminding procedure may have been influenced more by the use of organizational strategies than by verbal intelligence or attention. When grouped into "finishers" and "non-finishers", those successfully completing the task (defined as two consecutive 100% recall trials) were more likely than "non-finishers" to employ strategies such as organizing recall output by primacy or recency items or grouping the items into more associational categories. As such, successful performance on the selective reminding procedure may be a function of how successfully individuals can organize the recall of the unreminded items, regardless of age. Unfortunately, it is difficult to determine if successful completion and enhanced performance on the selective reminding procedure is attributable to more efficient organization of unreminded items as output organization is not compared across both the partial and total list procedures.

A second normative study (Banks, Dickson, & Plasay, 1987) examined the performance of sixty healthy adults aged 65-75 across 12 acquisition trials with the identical word list used by Ruff et al. (1988). Study participants were stratified according to age (5 year intervals), gender, and education. They were

tested on short and long term retrieval, long term storage, consistent long term retrieval, and total recall (summed across trials). No significant differences in recall were found for level of education or age, the latter likely due to the extremely restricted range. The only significant differences in recall were once again related to gender, with females outperforming males on all dependent variables except retrieval from long term storage. Larrabee et al. (1988) also analyzed the performance of 271 individuals, ages 18-91 on Form 1 of the Verbal Selective Reminding Test. Their results were partially consistent with those reported by Ruff et al. (1988) and demonstrated that performance was significantly predicted by age and gender.

Comparisons with other tests

Although the selective reminding procedure has gained popularity in the field of clinical neuropsychology, Buschke's criticisms of traditional list learning have seldomly been subjected to empirical investigation. Furthermore, his claims regarding the advantages and practical utility of the partial presentation over the traditional procedure have not been clearly substantiated, particularly within a memory impaired population.

MacLeod (1985) has provided one of the very few studies which directly compares selective reminding with the traditional total list presentation procedure. Undergraduate students were presented with a list of 20 words in either a total or partial list format. In both conditions, study and test trials alternated until the

individual correctly recalled all 20 words on a single test trial. Three weeks after acquisition, an unannounced delayed retention trial was completed. Results indicated that the two procedures were "almost identical" in terms of both acquisition and later retention performance. In virtually all aspects -- trials to criterion, rate of acquisition, error patterns (number of intrusions or perseverations), subjective list organization, and delayed retention accuracy -- the two list-learning procedures were highly similar. The only observed difference between the two procedures was that the participants in the selective reminding condition were presented with far fewer items across trials than those in the standard condition. Given that the selective reminding procedure has the advantage of being faster to administer than the traditional method (because fewer items need to be presented on each study trial), and that there were "no apparent drawbacks" to using this paradigm, MacLeod concluded that selective reminding is a more efficient method of acquisition than the standard procedure.

While MacLeod's study suggested that the two procedures were essentially equivalent (except in administration time), his results were obtained in a sample of undergraduate students and were perhaps not applicable to the elderly. In an effort to extend MacLeod's results to an older group of individuals, Tupling (1991) compared selective reminding with the traditional approach in a sample of younger and older adults. Sixty-four participants were divided into four groups according to age and procedure used (total vs. partial list presentation) and received a 15-

word learning task, a subset of the Learning and Memory Battery (Tombaugh & Schmidt, 1992). Results corroborated MacLeod's earlier findings and documented that although older adults consistently recalled less information during acquisition and retention than did younger individuals, the partial and total list paradigms produced equivalent rates of learning. Furthermore, a trial-by-trial analysis of the dependent measures in the partial condition (including total recall, short term retrieval, long term storage, consistent long term retrieval), indicated that on all measures (except random long term retrieval) older individuals performed at a significantly lower level than did their younger counterparts. Nevertheless, trial-by-trial comparison showed that older individuals did not appear to benefit more from the repeated presentation of all words on each acquisition trial than did the younger group. These results indicated that older persons did not focus on and differentially rehearse selectively reminded items, a possible advantage which was hypothesized to enhance learning relative to the traditional method. Results also suggested that retrieval processes at delay were not affected differentially by the procedure employed. Total list presentation did not promote greater consolidation of the list nor a higher level of retention than partial presentation. Conversely, specific information provided by selective reminding as to which items were the most difficult to recall did not help to structure encoding and subsequent retrieval of the list. On the basis of his results, Tupling stated that "the equivalence of these procedures allows for a more confident comparison of results obtained by the

differing administration methods regardless of age of the participant." (Tupling, 1991, p.46). In view of the fact that selective reminding produced an equivalent level of learning relative to the traditional method (without the necessity of repeating the entire list on each learning trial), Tupling concluded that it may be a more efficient technique in terms of its shorter administration time.

EXPERIMENT

Rationale for the present study

Whereas MacLeod (1985) compared the two paradigms in two groups of undergraduate students, and Tupling (1991) examined younger and older adults, no published research has compared these procedures in a sample of healthy memory-intact and memory-impaired older individuals. Buschke's proposed theoretical advantages of the selective reminding procedure have been uncritically accepted, particularly with respect to a memory-impaired population. For instance, Buschke has postulated that his selective reminding procedure provides distinctive feedback to the individuals as the words that pose the greatest difficulty (i.e., are not spontaneously recalled) are highlighted on each learning trial. However, the selective reminding test is a recall task that requires effortful and unstructured retrieval of to-be-learned information. As such, this information varies on each trial depending upon what is selectively reminded. That is, in

addition to verbal learning, the task involves set shifting on each trial because the selectively reminded items vary from trial to trial. Such variability in the presentation of list items may be confusing for elderly individuals, particularly those experiencing memory impairment. It may be, therefore, that poor performance on the selective reminding test in an Alzheimer sample could be reflective of frontal lobe impairment (suggesting difficulties in such executive tasks as set shifting), as well as temporal lobe dysfunction.

Buschke also hypothesized that the selective reminding procedure would not interfere with an individual's subjective encoding strategies used to organize the list during learning and retrieval (i.e., tactics which allow an individual to take advantage of stimulus attributes thereby permitting the association of list items with each other). While younger and cognitively intact older individuals may use such effective strategies to enhance recall, it is possible that older and memory impaired subjects would not spontaneously employ such organizational tactics or use them as effectively. Furthermore, given that the selective reminding procedure does not present previously recalled items, response organization might be less consistent, thereby resulting in a greater amount of variability and fluctuation across trials, particularly within a memory-disordered sample. It is also possible that the selective reminding procedure would result in poorer performance among memory-impaired individuals in that, by its very nature, the task prevents the development of sequential strategies. As such, given the

constantly changing presentation order of the word list, a participant would not benefit from the predictable and consistent presentation of items in the same order. From a practical viewpoint, even the somewhat confusing nature of the selective reminding procedure's instructions (see below) may prove to be detrimental for memory-impaired elderly individuals.

Thus, while Buschke argued that the selective reminding procedure was of greater utility in the investigation of memory, there has been little empirical evidence to validate his claims, particularly within a memory-impaired sample. Several fundamental questions remain. Does the selective reminding procedure facilitate or enhance the acquisition of a word list in a memory disordered population? Does it permit greater subsequent retention relative to the traditional total list presentation procedure? Do the two paradigm affect memory performance differentially during list learning? Does the selective reminding procedure offer distinct advantages over traditional list learning?

Therefore, in an attempt to extend the previous findings of MacLeod (1985) and Tupling (1991), the purpose of the current investigation is to determine the equivalency of the two verbal learning paradigms - the traditional model (total list presentation) versus an alternative approach (Buschke's selective reminding procedure - partial list presentation) in a sample of healthy elderly and cognitively demented older community dwelling adults. This research will contribute to a better understanding of impaired verbal learning and memory in the demented

elderly population. If the current study can determine that one of the procedures evaluated is more efficient in the assessment of verbal learning in this population, the practical utility for future analyses of memory disorders will be significant. Maximizing the learning ability of these individuals will have great potential in the planning, development and implementation of rehabilitation and remediation programmes in the future. The results of the present study may also be of theoretical importance in evaluating the effects of aging and memory impairment. For example, some researches have reported that the amount of cognitive resources or "mental energy" an individual can allocate to a cognitive task diminishes with age (Salthouse, 1988). It is therefore reasonable to assume that healthy elderly adults and those with impaired memory will react differently to the two paradigms.

METHOD

Participants

Forty volunteers were involved in this study. Twenty healthy elderly (mean age = 64.8 years, s.d. = 5.8, range = 57-76) and 20 memory-disordered (mean age = 71.0 years, s.d. = 5.9, range = 62 - 83) individuals were recruited from the Ottawa area. Participation was voluntary and all individuals (and, in the case of memory-impaired patients, the personal legally responsible) signed an informed consent form (see Appendix A). Patient files of the Ottawa General Hospital Memory Disorder Clinic (MDC) were reviewed to obtain twenty patients who were given a provisional diagnosis of mild or moderate Alzheimer disease according to NINCDS-ADRDA (National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer Disease and Related Disorders Association) criteria for the clinical diagnosis of Alzheimer's Disease (see Appendix B) (McKhann et al., 1984). In order to receive a diagnosis of "probable Alzheimer disease" according to these criteria, a patient must have deficits (defined as performance below the 5th percentile for the patient's age and attained level of education) in two or more areas of cognition, one of which must be memory.

In the course of their evaluation in the MDC, participants received a physical and neurological examination by a neurologist and a neuroradiological examination (including a CT scan). In addition, each individual underwent a

series of standard laboratory procedures (e.g. complete blood counts, blood chemistries) designed to rule out various toxic or metabolic disturbances. None of the patients were taking anxiolytic or antidepressant medications. Further exclusion criteria included disturbed consciousness, a concurrent neurological disorder, a history of systemic disease, psychiatric disorder, or alcohol abuse.

Upon their regularly scheduled follow-up visit to the MDC, the patients were informed of the present study by the examining psychologist/psychometrist and invited to participate. Once their initial agreement to participate was secured, the investigator contacted the patient and their primary caregiver to provide further information (see Participant Information Sheet - Appendix C) and to schedule an evaluation. In the recruitment of healthy elderly adults, the relatives/spouses of the MDC patients were approached. These individuals were then interviewed regarding medical history and health status. This group was matched to the memory disorder patients for age, gender, and years of education. Residents of extended care nursing homes or hospital facilities were included. No advertisements or other methods of recruitment were used.

Procedure

Participants were divided evenly into four groups according to a 2 (cognitive status: memory-intact vs. memory-impaired) X 2 (procedure: total vs. partial list presentation) design yielding the four following groups: Memory-Intact/Total List, Memory-Intact/Partial List, Memory-Impaired/Total List, and Memory-

Impaired/Partial List. Volunteers received a 15 word learning task, a subtest of the Learning and Memory Battery (LAMB) (Tombaugh & Schmidt, 1992). The word list consisted of 15 unrelated words, each of which was a single example of a particular category (see Table 1).

Participants were tested for both acquisition and retention. Prior to the administration of the word list, volunteers were presented with a typewritten (enlarged print) list of category names, corresponding to each of the list words (i.e., the category "fruit" for the list word "banana"). This category list was provided in an attempt to maximize the use of possible encoding strategies for retrieval during free recall of the list. The category names were read aloud by the examiner. The category list was then removed and the volunteers were given five study trials of the 15 words, each of which was followed by a test trial. The participant's responses were recorded in the order in which they were recalled. All individuals received a delayed retention trial 20 minutes after acquisition in which they were asked to recall as many of the previously learned words as possible (providing a free recall score). Following free recall, the category words were provided as semantic cues for any unrecalled items (producing a cued recall score).

Word List Exemplars and Categories^a

Words	Categories
Pistol	Weapon
Dentist	Profession
Potato	Vegetable
Foot	Part of Body
Elephant	Animal
Dish	Kitchenware
Coat	Clothing
Trumpet	Musical Instrument
Floor	Part of Building
Banana	Fruit
Month	Unit of Time
Truck	Vehicle
Bed	Furniture
Yellow	Colour
Brother	Family Relative

^a From Tombaugh & Schmidt (1990)

Finally a multiple choice recognition procedure was used for any words not retrieved through free and cued recall. During the retention interval the Hierarchic Dementia Scale and an experimental visual recognition task were administered to all participants.

Total List Presentation

In the Total List Presentation procedure, all participants were initially given the following instructions:

"This is a test to see how well you remember words. I am going to read you a list of fifteen words. After I am finished I want you to tell me all of the words you can remember. The order you remember them does not matter. For example, if I said "trout", "spruce" and "waltz", you could say "waltz", "spruce", "trout", or "spruce", "waltz", and "trout". Each of the words in the list represents a different type of word grouping or category. "Waltz" represents a type of dance, "trout" comes from the fish category, and "spruce" is a type of tree. Each of the fifteen words I will read comes from one of the categories on this list".

Individuals were then presented with a printed list of the fifteen categories which were simultaneously read aloud by the examiner. Immediately following this, these instructions were given:

"You will be given five times to learn the fifteen words. After I am finished reading the list I want you to tell me as many of the words as you can remember from the list, including the words you gave me on the preceding trial. Each time I will read the entire list."

The list items were read aloud by the examiner at a rate of 2 seconds per word. Immediately following each presentation of the entire list, volunteers were asked to "tell me all of the words you can remember."

Partial List Presentation

The initial instructions for this procedure were identical to those of the total list presentation, with the exception that following the presentation and reading of the category list, participants were told that:

You will be given five times to learn the fifteen words. The first time I will read all fifteen words. This is the only time I will read the complete list. The rest of the time I will say only the words you omitted or said wrong. Then I'll ask you to tell me all the words on the entire list, including the ones you said on the previous trial".

As in the Total list procedure, after the presentation of all words on the first trial, participants were asked to "tell me all of the words you can remember". However, if recall was less than fifteen words (100%), then the following instructions were repeated:

"I am going to read only the words you missed or were wrong. When I am through, I want you to tell me all of the words you can remember, including those you previously recalled correctly".

The study was undertaken in order to test the following hypotheses:

Hypothesis I: Cognitively intact older adults will achieve superior learning at acquisition and greater recall at delayed testing than memory-impaired older adults, regardless of the learning procedure used (i.e., total list presentation or selective reminding approach).

Hypothesis II: Results will support Buschke's contentions and will thus demonstrate that the selective reminding procedure produces improved learning rates in the normal elderly population (relative to the total list presentation procedure).

Hypothesis III: Results will support Buschke's assumption that "learning by selective reminding is clearly superior to learning by conventional free recall." As such, those memory-impaired older individuals assessed using the selective reminding procedure will show superior rates of acquisition and retention compared to those tested using the traditional approach.

RESULTS

Demographic Variables

Means for the variables of age, years of education, as well as Mini-Mental State Examination (MMSE), Ottawa General Hospital Mental Status Examination (OGH), and Mattis Dementia Rating Scale (DRS) scores are shown in Table 2.

The memory-impaired individuals in the study were older ($M = 71.0$, $SD = 5.9$) than the memory intact participants ($M = 64.8$, $SD = 5.8$). This was confirmed by an analysis of variance (ANOVA) ($F(1,36) = 10.7$, $p < .01$). However, the age of those individuals in the partial list presentation group ($M = 68.9$, $SD = 7.0$) was not significantly different from those in the total list presentation group ($M = 66.9$, $SD = 6.0$) ($F(1,36) = 1.2$, $p > .05$). Analysis of the education variable showed that those participants receiving the partial list presentation (selective reminding) procedure obtained a significantly higher level of education than did those individuals in the total list presentation group ($F(1,36) = 9.12$, $p < .01$). Years of education did not, however, differ between the memory impaired or memory - intact participants ($F(1,36) = 2.73$, $p > .05$). As expected, the memory-impaired individuals obtained significantly lower scores than their memory-intact counterparts on the MMSE ($M = 23.3$, $SD = 2.1$ vs. $M = 29.4$, $SD = 0.8$), the OGH exam ($M = 29.9$, $SD = 2.9$ vs. $M = 38.5$, $SD = 1.3$), and the DRS

Descriptive Statistics for Demographic Variables

Demographic Variables						
Condition ^a	Gender M/F	Age	Education (years)	MMSE (/30)	OGH (/40)	DRS (/144)
IM/Total	3/7					
Mean		63.8	11.5	29.3	38.3	138.8
(S.D.)		(4.8)	(4.0)	(0.9)	(1.2)	(4.3)
Range		57-73	6-18	27-30	37-40	130-143
IM/Partial	4/6					
Mean		65.9	14.2	29.5	38.6	140.0
(S.D.)		(6.9)	(1.4)	(0.7)	(1.4)	(2.8)
Range		58-76	12-16	28-30	36-40	134-143
MI/Total	2/8					
Mean		70.0	10.1	23.1	29.4	122.2
(S.D.)		(5.7)	(2.2)	(2.0)	(3.1)	(6.4)
Range		62-82	8-14	20-26	25-35	107-129
MI/Partial	5/5					
Mean		72.0	12.7	23.5	30.4	120.7
(S.D.)		(6.2)	(2.8)	(2.2)	(2.8)	(6.3)
Range		65-83	8-18	19-26	26-34	110-132

^a IM/Total = Intact Memory/Total list; IM/Partial = Intact Memory/Partial list
 MI/Total = Memory-impaired/Total list; MI/Partial = Memory-impaired/ Partial list
 MMSE = Mini-Mental Status Examination score
 OGH = Ottawa General Hospital Mental Status Examination score
 DRS = Mattis Dementia Rating Scale score.

($\underline{M} = 121.5$, $\underline{SD} = 6.4$ vs. $\underline{M} = 139.4$, $\underline{SD} = 3.6$). An analysis of variance showed the group differences to be statistically significant at the .001 level (F values were 142.5, 139.0, and 120.4, respectively).

Acquisition

The trial-by-trial means of words recalled by participants in each of the four groups are illustrated in Figure 1 (see also Appendix D). As is evident, the performance of memory intact individuals was consistently and significantly higher than that of the memory-impaired participants (Status: $F(1,36) = 92.06$, $p < .001$). However, the type of procedure employed (i.e., partial or total list presentation) did not differentially affect acquisition (Procedure: $F(1,36) = .02$, $p > .05$). For both cognitive status groups, the number of words freely recalled increased across learning trials regardless of the procedure employed (Trials: $F(4,144) = 85.6$, $p < .001$). However, the memory - intact individuals acquired the words at a more rapid rate than did the impaired group and this difference progressively increased across learning trials (Status x Trials: ($F(4,144) = 7.59$, $p < .001$).

Figure 1: Trial by Trial Means of Free Recall During Acquisition and Delay by Participants in Each of Four Experimental Conditions

In order to determine “pre-treatment” equivalence of the groups on the dependent variable, a 2 x 2 ANOVA was performed on the number of words recalled by participants on the first trial only. Since all participants received identical treatment on this trial (i.e., all list items were presented), the level of recall on this trial should not differ between individuals within a specific cognitive status. On Trial 1, the mean number of words recalled by the memory-intact participants were 6.2 (for those receiving the partial list format) and 6.1 (for those receiving the total list procedure). The mean number of words recalled by the memory-impaired individuals on Trial 1 were 3.5 (for those in the partial list condition) and 2.6 (for those receiving the total list procedure). Although there was a main effect of status ($F(1,36) = 54.56, p < .001$), the effect of procedure ($F(1,36) = 1.42, p > .05$) and the status by procedure interaction ($F(1,36) = .90, p > .05$) did not approach significance. Thus, while memory - intact participants recalled more words on this trial than did their memory-impaired cohorts, the type of procedure did not have a differential affect upon the number of words recalled.

Because the difference in administration between the two procedures occurred for the first time on trial 2, this trial might be expected to be the most sensitive at detecting any differential effect of the procedure variable. Therefore, a 2 x 2 ANOVA was utilized to examine recall on trial 2 only. Consistent with the previous analyses, the effect of cognitive status was again significant in favour of the cognitively intact participants ($F(1,36) = 79.34, p < .001$). Neither the effect of

procedure ($F(1,36) = 0.19, p > .05$) nor the status $\times$ procedure interaction ($F(1,36) = 0.45, p > .05$) was statistically significant. Thus, while memory-intact individuals recalled a greater number of words on this trial than did those in the impaired group (7.9 vs. 3.9), the partial and total-list presentation procedures yielded similar levels of recall.

Of the 1475 individual words recalled during acquisition (collapsing over groups), only 99 (6.7%) were incorrect. Approximately two-thirds (61) of these were repetitions (perseverations) and the remaining were extralist intrusions. Most errors were on the first three test trials. Although the infrequency of errors prevented valid and reliable statistical analysis of them, there did not appear to be any differential error rate over the experimental conditions.

Retention

While the two procedures yielded similar results in both status groups during the learning trials, the question remained as to whether they might differentially affect the retention of word list items on a twenty minute delay trial. To address this question, several analyses were performed. In the first, the number of words recalled on the delay (free recall) trial served as the dependent variable. As can be seen in Figure 1, the memory - intact participants recalled significantly more words at delay than did the memory-impaired individuals (Status: $F(1,36) = 83.56, p < .001$). Neither the type of procedure employed ($F(1,36) = 0.02, p > .05$) nor the interaction between status and procedure ($F(1,36) = 0.39, p > .05$) were significant.

To examine "true" retention of the word list, delayed recall should be compared to recall at the end of acquisition (Trial 5) in order to determine the level of retention relative to the level achieved at acquisition. By using such a comparison, it is possible to determine if the two procedures produced different rates of forgetting. To accomplish this, a 2 (Status) x 2 (Procedure) x 2 (Trials) repeated measures ANOVA was utilized. The two levels of the repeated measures factor were the last learning trial and the delay free recall trial. If the type of procedure differentially affected the rate of forgetting, a significant procedure x trials interaction or an interaction between all three factors should occur. Consistent with the previous analyses, memory - intact individuals recalled a greater amount of information than did their memory - impaired cohorts (Status: $F(1,36) = 86.07$, $p < .001$). Although the amount of information available at delay decreased significantly from what had been acquired by the final learning trial (Trials: $F(1,36) = 190.88$, $p < .001$) for both cognitive status groups, the number of words recalled on these trials did not differ as a function of the procedure used (Procedure: $F(1,36) = .03$, $p > .05$). However, at delay, the memory-intact individuals retained more of what they had acquired by Trial 5 than did the memory-impaired individuals (Status x Trials, $F(1,36) = 7.45$, $p < .01$). None of the other interactions approached significance: Status x Procedure, $F(1,36) = .01$, $p > .05$; Procedure x Trials, $F(1,36) = .01$, $p > .05$; and Status x Procedure x Trials, $F(1,36) = 2.47$, $p > .05$. Thus, these analyses demonstrate that while all participants

recalled less information on the delay trial than on the final acquisition trial, the rate of forgetting was not differentially affected by type of procedure. Moreover, memory - impaired individuals recalled fewer words at delay than did memory - intact participants and they retained significantly less information relative to what they had acquired by the end of acquisition (trial 5) than did their cognitively intact counterparts.

Two other methods were used to further explore retention results. One method utilized "percent retained" scores. These were computed for each study participant by dividing the number of words recalled at delay by the number recalled on the fifth acquisition trial and multiplying by 100. The second measure was an "absolute difference score", computed by subtracting the number of words recalled on the delay trial from the number of words recalled on trial five. When the "percent retained" scores were submitted to a 2 x 2 ANOVA, a significant status effect occurred showing the higher performance of memory- intact participants (Status: $F(1,36) = 69.0, p < .001$). Indeed, while these individuals retained 69.8% of what they had acquired at Trial 5, the memory - impaired participants conserved only 13.9 % after a twenty-minute delay interval. No other F approached significance. The absolute difference scores were also submitted to the same analysis. The means of these scores for the cognitively intact and memory-impaired individuals were 3.3 and 5.0 respectively, indicating that the demented patients "lost" a greater number of items. This effect was statistically significant

(Status: $F(1,36) = 7.4, p < .01$). The procedure (Procedure: $F(1,36) = .07, p > .05$) and the Status x Procedure interaction ($F(1,39) = 2.4, p > .05$) were not significant. The cognitively intact participants thus retained more words relative to what they had initially acquired than did the memory - impaired individuals, regardless of the learning procedure employed.

Cued Recall and Recognition

Analysis of cued recall following free recall at retention showed that memory - intact individuals recalled a significantly greater number of list items through the presentation of cues than did memory - impaired participants (Status: $F(1,36) = 73.52, p < .001$). This occurred even though the individuals in the memory - impaired groups freely recalled significantly fewer words at retention than did cognitively intact participants, and were therefore cued for the recall of a greater number of words than were memory - intact individuals. The procedure used, however, did not affect the number of words recalled following cues (Procedure: $F(1,36) = .21, p > .05$). In addition, the number of words retrieved by cued recall did not differ between procedures for either of the two status groups (Status x Procedure: $F(1,36) = .03, p > .05$).

Upon examination of the number of words recalled by recognition, a main effect of status emerged (Status: $F(1,36) = 29.69, p < .001$), reflecting the fact that the memory - impaired group recognized fewer words than the memory - intact group (11.1 vs. 14.3). The procedure used, however, did not affect the number of

words recognized (Procedure: $F(1,36) = .07, p > .05$). Additionally, recognition did not differ between procedures for either of the two status groups (Status x Procedure: $F(1,36) = .37, p > .05$).

Partial List Measures

The trial-by-trial means and standard deviations of short term storage (STS), long term storage (LTS), short term retrieval (STR), long term retrieval (LTR), consistent long term retrieval (CLTR), and random long term retrieval (RLTR) are presented in Table 4. This was done for only those participants who received the partial list presentation as this condition is the only one from which these measures can be derived. Independent groups t-tests performed for each variable revealed significant differences ($p < .001$ level) between the memory- intact and memory - impaired participants. STS for the memory-intact participants was greater than that of the memory-impaired group, $t(18) = 6.52, p < .001$. Furthermore, on all measures of long term retrieval, the memory - impaired individuals performed at a significantly lower level than did their memory-intact counterparts.

Descriptive Statistics for Partial Procedure Measures by Cognitive Status Group
Summed across Acquisition Trials

	Memory-Intact		Memory-Impaired	
Measure	Mean	S.D.	Mean	S.D.
Short Term Storage**	44.9	8.8	24.2	4.7
Long Term Storage**	36.3	14.1	7.8	1.9
Short Term Retrieval*	11.3	6.3	17.5	5.1
Long Term Retrieval**	33.5	13.5	6.7	2.6
Consistent LTR**	22.8	13.0	2.4	1.9
Random LTR**	10.7	3.1	4.3	3.6

* significant to the .05 level

**significant to the .001 level

The obtained t values were as follows: LTS, ($t = 5.34$, $p < .001$); LTR, ($t = 5.45$, $p < .001$); CLTR, ($t = 4.61$, $p < .001$); and RLTR, ($t = 4.13$, $p < .001$). The memory-impaired individuals recalled significantly more list items via short term retrieval than did the memory-intact participants ($t = 2.39$, $p < .02$). It should be noted that a higher score on the STR by the memory-impaired group indicates a *failure* to place items into long-term memory which results in a much lower score on LTR. Thus, the higher STR score obtained by memory-disordered participants confirms their poorer performance. Most of the items recalled by the memory-intact participants were LTR items rather than words from STR. This suggests a greater proportion of recalled items were retrieved from long-term memory by the memory-intact group. In contrast, a significantly higher proportion of the memory-impaired groups' recall was STR rather than LTR which indicates that they were encoding only a small proportion of items into long-term memory. Consistent LTR items are the subset of LTR words which are retrieved from the time of their initial recall (without reminding) to the end of learning. While memory-intact individuals consistently retrieved a greater number of words from long-term storage, the memory-impaired participants showed almost no CLTR, indicating greater variability in the consistency with which they were able to recall the words. Indeed, this latter group displayed a larger proportion of random LTR (relative to CLTR) than did the memory-intact group, suggesting sporadic or intermittent recall and the consequent need for reminding.

In an effort to determine whether or not diminished CLTR was simply a characteristic feature of the recall of all demented individuals (and was not attributable to the different assessment procedures employed-- either total or partial list presentation), the consistency of recall of those individuals in the total list condition was also examined. For the purposes of this analysis, CLTR was defined as the consistent retrieval of a word from the time of its initial recall to the end of learning (with repeated presentation). RLTR, in contrast, was a measure of words inconsistently recalled across learning trials. As can be seen in Table 4, independent groups t-tests performed on each variable revealed a significant difference between the memory-intact and the memory-impaired individuals who received the total list presentation format. More specifically, the demented patients performed at a significantly lower level than did their cognitively-intact cohorts on a measure of CLTR ($t(18) = 5.30, p < .001$), indicating greater variability in the consistency of their retrieval. There was no significant difference in terms of RLTR ($t(18) = 1.74, p > .05$). When recall was examined specifically for the memory-intact participants in both partial and total list conditions (see Table 5), no significant differences emerged between the two procedures in terms of either CLTR ($t(18) = 1.62, p > .05$) or RLTR ($t(18) = 1.32, p > .05$). In contrast, when the recall of the memory-impaired patients was examined (see Table 6), it was evident that CLTR was greater amongst those individuals who had received the total list presentation format ($t(18) = 2.56, p < .05$). There was no

difference between procedures in terms of amount of RLTR displayed by demented patients ($t(18) = 0.38, p > .05$). Thus, while both the CLTR and RLTR of memory-impaired patients was inferior to that of the memory-intact participants (in both the total and partial list conditions), the CLTR of demented patients who received the partial list procedure was significantly lower than that of the memory-impaired patients in the total list condition.

Serial Position Curves

In order to examine recency and primacy effects and to determine group equivalence on recall of the list, the probability of recall by study participants of each list item was tabulated and plotted against its position in the list. The resultant serial position curves of Total and Partial groups and for memory-intact and memory-impaired volunteers are illustrated in Figures 2 and 3, respectively. Curves are shown plotted for the first learning trial only as this is the sole trial on which the two procedures were comparable (i.e., the entire list was read to all participants in the same order).

Consistent and Random Long Term Retrieval for Total list Procedure by Cognitive Status Group
Summed across Acquisition Trials

	Memory-Intact		Memory-Impaired	
Measure	Mean	S.D.	Mean	S.D.
Consistent LTR ^{**}	30.8	8.6	10.6	8.4
Random LTR ^{ns}	8.2	5.1	4.8	3.4

^{**}significant to the .001 level

^{ns} = non significant

Table 5

Consistent and Random Long Term Retrieval for both Partial and Total list Procedures for Memory-Intact Participants Summed across Acquisition Trials

Measure	Total List		Partial List	
	Mean	S.D.	Mean	S.D.
Consistent LTR ^{ns}	30.8	8.6	22.8	13.0
Random LTR ^{ns}	8.2	5.1	10.7	3.1

^{ns} = non significant

Consistent and Random Long Term Retrieval for both Partial and Total list Procedures for Memory-Impaired Participants Summed across Acquisition Trials

Measure	Total List		Partial List	
	Mean	S.D.	Mean	S.D.
Consistent LTR*	10.6	8.4	2.4	1.9
Random LTR ^{ns}	4.8	3.4	4.3	3.6

* significant to the .05 level

^{ns} = non significant

Given that all participants received the same procedure on the first trial, it is not surprising to note that the serial position curves of both groups (see Figure 2) were virtually identical, thereby demonstrating the overall equivalence of recall of participants in the two procedural conditions on this trial.

Upon comparison of the serial position curves of the two cognitive status groups (see Figure 3), it can be seen, as is typically the case, that primacy was greater for memory-intact participants than for memory-impaired individuals. In addition, the recall probability of terminal list items was also greater for the memory-intact group. However, in contrast to the normal “U-shaped” curve with both end of list and beginning of list long-term storage components present, the serial position curve of the memory-intact individuals reflects an unexpected mid-list peak. This may have been attributable to the somewhat more salient quality of the mid-list items in question (i.e., “trumpet”, “floor” and “banana” were the words in serial positions 8, 9, and 10, respectively). It is possible that these items were more easily focused upon and thus more readily acquired and retrieved by the memory-intact individuals. The curve of the participants with impaired memory reflects a much lower total number of words recalled and is almost unimodal. There is a reduced recency effect, reflecting a lowering of the short-term component (particularly of items 12 through 14), and only a small primacy effect, suggesting that few of the words at the beginning of the list reached long term storage.

Total

62

Partial

Figure 2: Serial Position Curves on Trial 1 for participants in the Total and Partial List Conditions

Memory Intact

63

Memory Impaired

Figure 3: Serial Position Curves for Memory-Intact and Memory-Impaired Individuals on Trial 1

These impressions were confirmed by statistical analysis. The 15 word positions in the list were combined into three groups. Thus each participant's scores, in terms of the total number of correctly recalled words on trial 1, was taken for word positions 1 to 5 combined, 6 to 10 combined, and 12 through 15. The scores were averaged over all participants in each group. A 3 x 2 factorial analysis was then carried out on this data. In addition to the significant difference between groups (Status: $F(1,38) = 54.1, p < .001$), there was a significant main effect for the serial position factor (Position: $F(2,38) = 6.89, p < .002$), but no significant Status x Serial position interaction ($F(2,38) = 1.77, p > .05$). These results confirm that differences exist between the two status groups in terms of the total number of words recalled and that the probability of recall of any word is dependent upon its position in the list.

Discussion

The results of this investigation suggest that acquisition and retention of a 15-item word list was similar for the two learning procedures (total and partial list presentation), a finding that was previously reported by MacLeod (1985) and Tupling (1991). The fact that this similarity occurred with memory-impaired as well as memory-intact older individuals extends the previous research to a memory-disordered group of participants. In view of the relative homogeneity in age of the memory-intact participants in the current investigation and those older individuals in the previous study, the replication of Tupling's findings with the memory-intact elderly group was anticipated. However, it was hypothesized that because of the impaired cognitive abilities in the memory-disordered group in the present study, acquisition and retention of the word list in this group might be differentially affected by the two procedures. This hypothesis was not substantiated. Although the cognitively intact older adults achieved superior learning at acquisition than memory-impaired older volunteers, the partial and total procedures produced equivalent acquisition effects within each cognitive status group. Thus, the present findings seriously questioned one possible advantage associated with the total list presentation procedure. That is, the memory-impaired individuals in this study did not appear to benefit more from the consistent and

repeated presentation of all words on each acquisition trial than did the intact group.

At the same time, it also appears that the memory-impaired patients did not benefit from the additional feedback provided by the partial list procedure, an advantage which had been posited by Buschke. Given the assumption that previously recalled items do not require as much effort to retrieve as those not yet recalled, it had been hypothesized that partial presentation would allow a dementing patient's limited resources to be diverted from rehearsing already-learned items and directed toward learning those not yet acquired. It had been suggested that partial presentation would highlight those more difficult to acquire words, thus facilitating learning relative to the traditional method. This hypothesis, however, was not substantiated as the results of the present study indicate that the memory-disordered patients did not "focus" on and differentially rehearse selectively reminded items. While selective reminding may have served to identify those words which had not been recalled for the cognitively-intact individuals (a process which had to be self-generated with the total list presentation procedure), the partial list presentation procedure may have, in fact, had a detrimental (though clinically significant) impact upon memory-disordered patients. Since information presented on each learning trial was different depending upon which items were selectively reminded, patients could not easily develop sequential strategies as they could when the information was presented in

the same order on each trial, which occurred in the total list presentation procedure. Observational data indicate that the variability in presentation appeared to cause undesirable confusion among the memory-disordered patients. After recalling selectively presented words, the patients would often stop, at which point it was necessary to remind them that they were also to recall unreminded words. Unfortunately the repetition of instructions may have been somewhat disruptive, interfering with the learning process, and further lengthening the time between word presentation and recall. While the results did not prove to be statistically significant, this may have contributed to the “forgetting” of previously recalled items and to the greater preponderance of random, unorganized recall in the memory-impaired group.

One of the proposed advantages of the selective reminding procedure was that this technique required less administration time. While it is true that fewer words were presented on each study trial in this condition (i.e., only those items not spontaneously recalled on the previous trial), clinical observation indicates that the apparent confusion created by this selective reminding actually resulted in a lengthier assessment (particularly with memory-impaired patients) as more time was required to clarify instructions. Thus one of the proposed advantages of the partial presentation was, in fact, a *disadvantage* when the procedure was utilized within a memory-disordered sample.

The previous findings (MacLeod, 1985; Tupling, 1991) of equivalence in the amount of information retained after a delay interval under the two procedures was supported by the present investigation. While the memory-intact participants recalled a greater number of words at delay than did their memory-impaired cohorts, the two procedures yielded similar levels of retention (i.e., the amount of information retained relative to what had been initially acquired did not differ as a function of the presentation method). That is, the rate of forgetting was not differentially affected by type of procedure used. While these results failed to yield a significant effect attributable to procedure, suggesting that retrieval processes at delay were not affected differently by the procedure employed, a significant effect associated with cognitive status was found. Results demonstrated that the memory- intact participants retained a greater number of list words relative to what they had acquired at the end of acquisition than did the memory-impaired patients, regardless of the learning procedure employed. Total list presentation did not promote greater consolidation of the list and result in a higher level of retention than in partial presentation for either of the cognitive status groups. Furthermore, in contrast to MacLeod's (1985) hypothesis, specific information provided by selective reminding as to which items were most difficult to recall did not appear to differentially enhance encoding and subsequent retrieval of the list in this study.

While the “percent retained” scores and the “absolute difference” scores yielded similar results in the present investigation (both analyses depicted superior retention of memory-intact volunteers), it is interesting to note that Tupling’s (1991) findings demonstrated a discrepancy when these scores were used to measure the rate of forgetting from acquisition to delay in a sample of older and younger memory-intact individuals. Analysis of the “absolute difference” scores indicated that the level of retention was similar for both younger and older individuals. However, when “percent retained” scores were submitted to the analysis, results indicated that younger participants retained a significantly higher percentage of what they had previously acquired than did older adults. Upon further examination, it appeared that this finding was attributable to an artifact arising from deriving these scores for two groups who had differing baseline levels of acquisition, which were significantly lower for the older group. In view of this, Tupling concluded that “absolute difference” scores, rather than “percent retained” scores were the best measure for examining the absolute rate of forgetting when one baseline level of learning is substantially lower than another. In the present study, both the absolute difference and percent retained scores showed the same effect. Thus, either the above-mentioned artifact was not present or it was not of sufficient magnitude to significantly bias the results.

The present trial-by-trial analyses replicate the findings of several earlier studies. For instance, Weingartner et al. (1981), as well as Ober and colleagues (1985), found an inconsistent recall pattern among demented patients. This was confirmed in the present study as the memory-impaired individuals were found to be as likely to remember words not recalled on a previous test trial as previously remembered items. More specifically, while consistent long-term retrieval improved over the course of learning for memory-intact participants, a disproportionate amount of essentially unorganized, random long term retrieval remained for memory-impaired patients. In an effort to examine whether or not impoverished consistent long-term retrieval was simply an artifact of the overall diminished level of recall of memory-impaired patients, consistency of retrieval was examined for both demented and cognitively intact individuals in both the total and partial list conditions. Results of the analyses indicate that while CLTR of memory-impaired patients was significantly inferior to that of memory-intact participants (under both procedures), the CLTR of demented patients who received the selective reminding technique was considerably lower than that of the memory-impaired patients in the total list condition. Thus, the diminished level of consistent recall of demented individuals appeared to be further attenuated when the selective reminding procedure was used to assess recall.

In addition to impoverished CLTR, the results of the present investigation indicated that demented patients displayed a disproportionately larger amount of

unorganized and random long term retrieval. Buschke postulated that random long term retrieval reflects learning which is inefficient and results in inconsistent recall because of an underlying failure to associate list items together or with material already in long-term storage. Given the nature of the selective reminding procedure, the constantly changing order of item presentation may serve to remove the inherent organizational structure of the word list. This, in turn, requires that individuals rely more on their own internal organizational processes to associate list items together. Thus, the selective reminding procedure demands greater reliance on subjective organization in order to encode the information.

Corroborating the earlier findings of Weingartner et al. (1981), the memory-impaired patients in this study did not appear to spontaneously use such encoding strategies and did not take advantage of stimulus attributes to associate list items with one another. Learning was therefore not facilitated by repetition of unrecalled list items in the partial list condition and the theoretical advantage proposed by Buschke appeared to impede learning (rather than enhance recall) for the memory-impaired group.

The present investigation also corroborated the findings of Ober et al. (1985) in that the memory-impaired patients in this study gave very few intrusions; in fact, the number of intrusions was not significantly greater for them than for the memory-intact controls. The intrusion rate was much lower than that reported for demented patients by Fuld and collaborators (Fuld, Katzman, Davies, & Terry,

1982). However, participants in the present study were not given any additional verbal tasks prior to, or during, the selective reminding procedure. Such tasks were employed in the Fuld study, which may have provided additional material for intrusions.

The memory-intact participants in the current investigation mastered list items more rapidly and recalled more items over trials than the memory-impaired group who displayed a more shallow learning curve, and appeared to focus most of their efforts on the recently presented words. After recalling these, the memory-disordered patients then had difficulty recalling any of the other list items. Thus, the memory-impaired group appeared to be relatively more dependent on short term memory processes (resulting in a more pronounced recency effect) and less dependent upon long term memory processes (reflected in a very small primacy effect) than the memory-intact individuals. The relatively greater recency effect shown by the memory-impaired individuals in this study may have been related to the fact that the mildly demented patients were allocating more of their limited processing capacities to the words just presented. They were thus less likely to engage in processing the previously recalled words in a manner that would enable encoding of the words into long-term memory. This strategy may not be intentional. As suggested by Ober et al. (1985), it may be a “default” approach to learning given the limitations in their attention and memory systems. It is also interesting to note that the memory-disordered individuals displayed superior

recall of several of the mid-list items in comparison to the intact group. Although these patients were recalling items that had not just been presented, this recall may not have been from long term memory. Rather, the responses may reflect perseverations within short term memory. While it has been proposed that the superior recall of certain mid-list items (known as the von Restorff effect) may have been related to their idiosyncratic meaningfulness, it may be that the memory-impaired individuals were merely demonstrating a short-term perseveration of the items (i.e., recycling these items in short-term memory and not attending to the other presented items).

In regard to the serial position curves produced by the different groups in this study, it is difficult to compare their patterns in terms of traditional findings. This is due to the fact that, unlike the present investigation, studies examining primacy and recency generally assess quite a large number of individuals and utilize a number of word lists (often equivalent forms with a high degree of internal homogeneity). The recall probabilities of list items in corresponding serial positions are then averaged across lists resulting in a “smooth” curve. Given the relatively small number of participants in the present study and the single presentation of one word list, the curves deviated somewhat from the “typical” pattern. In particular, as previously stated, some mid-list items were recalled with a probability much higher than is typically the case.

In spite of this shortcoming, the serial position curve findings of the present study replicate those of Miller (1971). Results confirm that the ability of patients with mild dementia in a free-recall situation is much inferior to that of age-matched normal controls, indicating diminished recall from both short and long term memory. The present findings suggest that this impaired performance was due to two factors: a more rapid loss of material from short term storage (as demonstrated by a relatively lower recency effect) and a significant difficulty in transfer of information between short term and long term storage (as evident from the very small primacy effect). The number of words consistently recalled from long term storage by memory-impaired older individuals in this study was significantly lower than that of the memory-intact participants. In contrast, the memory-impaired patients appeared to randomly recall a greater proportion of the list. According to Buschke (1973), a list item, one recalled without presentation on a given trial, is considered to have entered the long term store even though it may not be recalled for two or more subsequent trials. Presentation of the item on these trials is seen as a “reminder”. Given the results of the present investigation, it would appear that the necessity for “reminders” was greater for the memory-impaired patients, suggesting a deficit in retrieval from the long term store relative to their younger counterparts.

As stated above, despite the ways in which the performance of memory-impaired patients might have hypothetically differed on the two procedures, their

acquisition and retention were equivalent under both learning conditions.

MacLeod offered a theory to explain such a similar finding in his sample of younger adults. He suggested that in order to understand the absence of any difference, it was necessary to focus on what the study participants were attempting to do during acquisition. Given that the goal was to recall as many list words as possible on every trial, individuals “continually rehearsed the remembered words” and each study trial “represented an opportunity to add more words to the remembered set” (MacLeod, 1985, p. 239). Individuals must, in the traditional procedure, locate the yet to be remembered words in the entire list, while (presumably) ignoring already learned items. MacLeod proposed that the only difference between the two procedures was that selective reminding simply performed this location function for the participants. With this exception, all other processes were identical in the two procedures. Citing Murdock et al. (1974), MacLeod concluded that “the characteristics of list presentation seems to be surprisingly unimportant in affecting learning itself” (MacLeod, 1985, p. 239).

Given that the selective reminding procedure and the traditional method of serial learning were found to yield similar levels of acquisition and retention in his study of older individuals, Tupling (1991) speculated that MacLeod’s assumption may have also applied to an older sample. Tupling therefore concluded that younger and older adults utilize similar cognitive strategies in learning and remembering information in both procedures.

In the present investigation, the selective reminding procedure and the total list presentation method were found to yield similar levels of acquisition and retention in a sample of memory-disordered elderly adults. For these patients, the challenge of learning a 15-item word list was equally difficult under both presentation conditions. Thus, the noted equivalence between the two procedures may have less to do with the method employed and more to do with the exceptionally high demands of the task for these individual who, as a group, recalled fewer than half the number of words by the fifth learning trial than their memory-intact cohorts. Results of this study suggest that the memory-impaired patients were not able to take advantage of the purported benefits associated with the selective reminding technique. Without these advantages, the selective reminding procedure did not prove to be significantly different from the traditional method in terms of practical utility. Thus, to paraphrase MacLeod's conclusions, the characteristics of list presentation appear to be relatively unimportant in affecting learning, even the limited acquisition demonstrated by memory-impaired individuals in this study. The comparability of the two procedures provides no evidence to suggest that, as MacLeod had conjectured, the partial procedure may perform the function of locating for the individual previously unrecalled words. While it is possible that this may be the case, the equivalence of the two procedures in the present study indicates that this function, if it does occur, does not provide any additional benefit in the learning and retention of a word list over the total procedure. The results

from the two cognitive status groups indicate that the selective reminding procedure did not differentially benefit those older adults who have experienced a decline in cognitive abilities. Although it was not found to be significant under statistical analysis, on the basis of experimenter observation, it would appear that the memory-impaired patients had difficulty handling the complexity of the partial list-learning task. That is, they could not simultaneously process the just-presented words and the previously recalled items as could cognitively-intact individuals. This tendency to respond to fragments of a task, and not to the complete task, has been noted to occur in other patients groups (i.e., those with frontal lobe lesions) as well (Ober et al., 1985). The fact that the selective reminding test did not promote greater acquisition in a memory-impaired group may reflect the fact that these patients were unable to attend to both the previously recalled items and the recently presented words. The demands of this list-learning procedure may thus have proven to be too taxing for their impaired attention processes and the selective reminding technique therefore did not demonstrate differential benefit for the memory-impaired group.

Buschke (1974, 1984) and others (Hasher & Zacks, 1979) have stressed the role of attention and cognitive skills that are necessary to execute an efficient strategy in learning and memory. While deficits in these basic cognitive processes do not constitute memory impairment, such deficits may underlie apparent memory problems. These difficulties would be expected to affect consistent and

random long term retrieval differently by undermining the various attentional, set-taking, and mnemonic strategies that culminate in the organization of material in long-term memory. Adequately processed items would presumably be “chunked” or associated with one another, and would be more likely to be recalled together, thus enlarging the number of list items meeting the criteria for consistent long term retrieval (CLTR). Conversely, words joined by weaker associative bonds resulting from inadequate processing would be more susceptible to omission during recall; this would result in an increase in the number of words characterized by random long term retrieval and a complementary decrease in CLTR words. As previously noted, the present investigation confirmed these assumptions. While the amount of CLTR increased across learning trials for memory-intact volunteers, a disproportionate amount of unorganized random long term retrieval remained for the memory-impaired patients.

While the results of this investigation indicated that the selective reminding procedure and the traditional method of serial learning produced equivalent rates of acquisition and retention in memory-impaired patients, the experience of assessing the individuals in this study with Buschke’s procedure has led this examiner to conclude that the benefits associated with this selective reminding technique are far outweighed by several disadvantages. Firstly, in contrast to the findings of MacLeod’s study, the use of the selective reminding procedure with a demented sample does not result in reduced administration time. In fact, quite the

opposite was true as additional time was required to explain the requirements of this procedure to the memory-impaired individuals who appeared to find both the instructions and the nature of the selective reminding test rather confusing. In a related vein, the detailed scoring implicit in Buschke's procedure necessitated considerable time and effort. Given that this technique was shown to produce a level of learning and retention equivalent to that of the traditional method in a memory-disordered sample, the additional time required for its administration and scoring may be better used by clinicians and researchers in other endeavours. Finally, results of this investigation suggested that the selective reminding test promoted greater inconsistent retrieval in memory-impaired patients relative to that demonstrated by memory-intact individuals. This may have been due to the fact that the patients were not presented with a predictable and consistent serial list of items, thus preventing them from efficiently using sequential strategies to enhance their recall. Given these considerations, in comparison to the traditional total list presentation method, Buschke's selective reminding procedure does not appear to be a more efficient technique in the clinical and experimental assessment of verbal memory in memory-disordered individuals.

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APPENDIX A
CONSENT FORM

Formulaire de Consentement

Une Etude d'Equivalence de Deux Tests d'Apprentissage Chez des Adultes Souffrant de Démence et des Adultes en Santé

L.E. Morrison, B.A., T.N. Tombaugh, Ph.D.

Le but du projet de recherche auquel j'ai accepté de participer évalue l'utilité de deux tests d'apprentissage. Ma participation consistera à apprendre une liste de 15 mots et à subir une évaluation de fonctions de langage, d'attention, et de mémoire. L'évaluation sera d'une durée d'environ 60 à 90 minutes.

On m'a assuré(e) que l'information générée par cette étude sera confidentielle, tel que stipulé par les règlements de l'Hopital général d'Ottawa. Toute donnée sera indentifiée par un numéro de code et seuls les chercheurs qui m'ont contacté(e)s sauront quel numéro de code a été jumelé avec mon nom. La clé contenant la liste des jumelages de numéros de code et noms sera gardée dans un endroit sécurisé et ne pourra être accédée que par les chercheurs de l'étude.

Je suis conscient(e) du fait que l'évaluation pourrait me fatiguer. Dans l'éventualité où je deviendrais fatigué(e) ou inconfortable, je pourrai en avvertir l'examineur qui cessera l'évaluation.

Je n'aurai pas à payer pour cette évaluation et je ne serai pas non plus rénuméré(e) pour ma participation.

Je ne bénéficierai pas directement d'avoir participé à cette étude. Je sais cependant que les résultats de l'étude seront d'une utilité clinique et pratique. Par exemple, ils pourront servir à diagnostiquer les problèmes de mémoire associés avec diverses maladies tels que la maladie d'Alzheimer et les accidents cérébrovasculaires.

Ma participation est strictement volontaire et je peux, en tout temps, refuser de participer ou de terminer l'évaluation.

J'ai eu l'occasion de poser des questions concernant l'évaluation et les réponses qui m'ont été données sont adéquates.

Participant ou
personne responsable

Relation

Témoin _____

Date

CONSENT FORM

91

A Study of the Equivalence of Two Serial Learning Paradigms in
Healthy and Demented Elderly Adults

L.E. Morrison, B.A., T.N. Tombaugh, Ph.D.

I understand that I have been asked to participate in a research study which will evaluate the usefulness of two learning tests. I will be asked to learn a list of 15 words and will be given a standardized assessment of my language, attention and memory skills. This evaluation will take approximately 60-90 minutes of my time.

I understand that the information produced by this study will be subject to the confidentiality and privacy regulations of the OGH. All data collected will be stored in the investigator's research file and identified only by a code number. The code key connecting names to numbers will be kept in a separate secure location under lock and key. Access to all data collected will be limited to the study investigators.

I understand that I may be fatigued by this testing. I understand that if I am fatigued or experience any other discomfort, I must inform the investigator and the session will end.

I will not be charged for this assessment and there will be no payment of any remuneration.

I will not directly benefit from my participation in this study. I understand, however, that the results of these tests will have a wide range of clinical and practical usefulness. For example, they will assist in diagnosing memory problems associated with a number of different illnesses, including Alzheimer's disease and strokes.

I understand that my participation is voluntary and that I may refuse to participate or may withdraw and discontinue participation in the study at any time.

I have been given an opportunity to ask questions concerning the evaluation and the questions I have asked have been adequately answered.

Participant or person legally responsible

Relationship

Witness _____
signature

Date

APPENDIX B

NINCDS-ADRDA CRITERIA FOR DIAGNOSIS OF ALZHEIMER DISEASE

Criteria for Clinical Diagnosis of Alzheimer's Disease (National
Institute of Neurological and Communicative Disorders (NINCDS) and
Stroke and the Alzheimer's Disease and Related Disorders Association
(ADRDA) Criteria for Clinical Diagnosis of Alzheimer's Disease 93

I. The criteria for the clinical diagnosis of PROBABLE Alzheimer's disease include:

dementia established by clinical examination and documented by the Mini-Mental Test, Blessed Dementia Scale, or some similar examination, and confirmed by neuropsychological tests;

deficits in two or more areas of cognition;

progressive worsening of memory and other cognitive functions;

onset between ages 40 and 90, most often after age 65; and

absence of systemic disorders or other brain diseases that in and of themselves could account for the progressive deficits in memory and cognition.

II. The diagnosis of PROBABLE Alzheimer's disease is supported by:

progressive deterioration of specific cognitive functions such as language (aphasia), motor skills (apraxia), and perception (agnosia);

impaired activities of daily living and altered patterns of behavior;

family history of similar disorders, particularly if confirmed neuropathologically; and

laboratory results of:

normal lumbar puncture as evaluated by standard techniques,

normal pattern or nonspecific changes in EEG, such as increased slow-wave activity, and

evidence of cerebral atrophy on CT with progression documented by serial observation.

III. Other clinical features consistent with the diagnosis of PROBABLE Alzheimer's disease, after exclusion of causes of dementia other than Alzheimer's disease, include:

plateaus in the course of progression of the illness;

associated symptoms of depression, insomnia, incontinence, delusions, illusions, hallucinations, catastrophic verbal, emotional, or physical outbursts, sexual disorders, and weight loss;

other neurologic abnormalities in some patients, especially with more advanced disease and including motor signs such as increased muscle tone, myoclonus, or gait disorder;

seizures in advanced disease; and

CT normal for age.

IV. Features that make the diagnosis of PROBABLE Alzheimer's disease uncertain or unlikely include:

other neurologic abnormalities in some patients, especially with more advanced disease and including motor signs such as increased muscle tone, myoclonus, or gait disorder;

seizures in advanced disease; and

CT normal for age.

IV. Features that make the diagnosis of PROBABLE Alzheimer's disease uncertain or unlikely include:

sudden, apoplectic onset;

focal neurologic findings such as hemiparesis, sensory loss, visual field deficits, and incoordination early in the course of the illness; and

seizures or gait disturbances at the onset or very early in the course of illness.

V. Clinical diagnosis of POSSIBLE Alzheimer's disease:

may be made on the basis of the dementia syndrome, in the absence of either neurologic, psychiatric, or systemic disorders sufficient to cause dementia, and in the presence of variations in the onset, in the presentation, or in the clinical course;

may be made in the presence of a second systemic or brain disorder sufficient to produce dementia, which is not considered to be the cause of the dementia; and

should be used in research studies when a single gradually progressive severe cognitive deficit identified in the absence of other identifiable cause.

VI. Criteria for diagnosis of DEFINITE Alzheimer's disease are:

the clinical criteria for probable Alzheimer's disease and histopathologic evidence obtained from a biopsy or autopsy.

VII. Classification of Alzheimer's disease for research purposes should specify features that may differentiate subtypes of the disorder, such as:

familial occurrence;

onset before age of 65;

presence of trisomy-21; and

coexistence of other relevant conditions such as Parkinson's disease.

APPENDIX C
PARTICIPANT INFORMATION SHEET

Renseignements aux Participants

Les problèmes de mémoire constituent une des difficultés les plus fréquentes que les gens éprouvent en vieillissant. L'oubli, les troubles de concentration, l'attention pauvre, et les difficultés à se rappeler des noms ou des rendez-vous comptent parmi de tels problèmes.

L'évaluation de la capacité d'apprentissage fait partie intégrante de l'étude de la mémoire et de l'état cognitif. Je suis maintenant en voie d'évaluer l'utilité et le mérite de deux tests d'apprentissage. Ce projet va me permettre d'amasser des renseignements qui aideront à développer des stratégies et des techniques pour aider les gens à mieux apprendre et mieux se rappeler. Cette recherche fait partie d'une étude présentement en cours à l'Université Carleton et a été approuvée par le comité de déontologie de l'hôpital général d'Ottawa. Les tests employés dans notre étude vont être d'une utilité clinique et pratique. Par exemple, ils pourront servir à diagnostiquer les problèmes de mémoire associés avec diverses maladies tels que la maladie d'Alzheimer et les accidents cérébrovasculaires.

Je recherche des participant(e)s âgé(e)s de 60 à 85 ans. Si vous êtes intéressé(e) à participer, vous allez devoir apprendre une liste de mots. Vous subirez également un examen bref de vos fonctions de mémoire, d'attention, de cognition, et de langage. Si vous acceptez de participer, l'évaluation, qui prendra environ 1-1.5 heures, se déroulera à un moment qui vous conviendra. Vous trouverez ci-joint copie du formulaire de consentement que vous devrez signer si vous désirez participer à l'étude. Veuillez noter que votre participation est entièrement bénévole et que vous pouvez cesser de participer en tout temps. Aucun des tests n'implique l'usage de déception et nul test ne cause de douleur. Les résultats de l'étude seront gardés strictement confidentiels. Votre participation ne sera pas rémunérée.

J'espère sincèrement que cette étude va vous intéresser. Les connaissances acquises par l'entremise de telle recherche vont augmenter notre compréhension du bon fonctionnement ainsi que des troubles de la mémoire. Ce projet de recherche va également être utile dans la planification de programmes de réadaptation.

Votre participation est des plus précieuses et serait grandement appréciée.

Je vous remercie de votre considération.

Laurie Morrison, B.A.
Département de Psychologie
Hôpital général d'Ottawa

Participant Information Sheet

One of the most common difficulties experienced by people as they grow older is a problem with memory. This might include such things as forgetfulness, poor concentration, a shorter attention span, and difficulty remembering names of people or appointments.

The assessment of learning skills is an integral part of the evaluation of memory and mental status. In this respect, I am currently evaluating the usefulness and relative merits of two learning tests. A more long-term goal is to provide information that may assist in the development of strategies and techniques to help people improve their ability to learn and remember. This project is part of an ongoing, long-term study of learning and memory which has been endorsed by Carleton University and has been approved by the Ethics Committee of the Ottawa General Hospital. When completed, these tests will have a wide range of clinical and practical usefulness. For example, they will assist in diagnosing memory problems associated with a number of different illnesses, including Alzheimer disease and strokes.

At this time I am looking for volunteers between the ages of 55 and 85. If you are interested in helping, I will be asking you to learn and recall a list of words. You will also be given a brief assessment of your memory, attention, cognition and language skills. If you agree to participate in this study I will arrange to carry out this evaluation at your convenience. It will take approximately 1 - 1 1/2 hours of your time. For your information, I have included a copy of the consent form that I will ask you to sign if you agree to participate in this research. Please note that participation is strictly on a volunteer basis. You may withdraw from this study at any time if you wish to do so. There will be no pain or deception involved in any of the tests. Your identity will not be disclosed and the results of the research will be held in strictest confidence. There will be no payment of any remuneration.

I sincerely hope that you will find this study of interest. The knowledge gathered from this research will certainly help us to better understand how people learn and may provide practical utility for future analysis of memory disorders. This research will also be beneficial in planning for future rehabilitation and remediation programmes.

Your participation is therefore very valuable and would be very much appreciated.

Thank you for your time.

Laurie Morrison, B.A.
Department of Psychology
Ottawa General Hospital

APPENDIX D

TRIAL-BY-TRIAL MEANS OF FREE RECALL DURING ACQUISITION AND
RETENTION BY PARTICIPANTS IN EACH OF FOUR EXPERIMENTAL CONDITIONS

Trial by Trial Means of Free Recall During Acquisition and Retention by Participants in Each of Four Experimental Conditions

	<u>Memory-Intact</u>		<u>Memory-Impaired</u>	
	Partial list	Total list	Partial list	Total list
<u>Acquisition</u>				
Trial 1 - Mean (S.D.)	6.2 (1.2)	6.1 (1.4)	3.5 (1.1)	2.6 (1.4)
Trial 2 - Mean (S.D.)	7.9 (1.5)	8.0 (1.6)	4.2 (0.9)	3.7 (1.4)
Trial 3 - Mean (S.D.)	9.5 (2.2)	9.5 (1.9)	5.0 (1.3)	4.7 (1.5)
Trial 4 - Mean (S.D.)	9.9 (2.1)	10.7 (2.0)	5.3 (1.1.)	5.4 (1.8)
Trial 5 - Mean (S.D.)	11.4 (2.6)	12.0 (2.2)	6.2 (1.6)	5.4 (2.8)
Total Recall	44.9 (8.8)	46.3 (7.1)	24.2 (4.7)	22.2 (8.1)
Intrusions	1.2 (1.3)	0.5 (0.9)	1.0 (2.1)	1.1 (1.0)
<u>Retention</u>				
Free Recall	8.5 (3.5)	8.2 (2.4)	0.7 (0.6)	1.3 (2.2)
Cued Recall	12.1 (2.7)	12.7 (1.1)	5.5 (3.1)	5.4 (3.1)
Recognition	14.1 (1.1)	14.4 (0.8)	11.3 (2.2)	10.9 (2.5)

APPENDIX E
RAW DATA

	group	subject	status	procedur	age	educatn	handedns	lang	gender	mmse,sc	ogh,exam
1	TOTAL LIS	1.00	impaired m	total list pre	69.00	8.00	RIGHT	ENGLISH	FEMALE	23.00	27.00
2	PARTIAL LI	2.00	impaired m	partial list p	79.00	18.00	RIGHT	ENGLISH	FEMALE	24.00	30.00
3	PARTIAL LI	3.00	impaired m	partial list p	83.00	12.00	RIGHT	ENGLISH	FEMALE	24.00	32.00
4	PARTIAL LI	4.00	impaired m	partial list p	74.00	13.00	RIGHT	ENGLISH	MALE	22.00	28.00
5	TOTAL LIS	5.00	impaired m	total list pre	74.00	13.00	RIGHT	ENGLISH	FEMALE	20.00	25.00
6	TOTAL LIS	6.00	impaired m	total list pre	71.00	9.00	RIGHT	ENGLISH	FEMALE	22.00	29.00
7	TOTAL LIS	7.00	impaired m	total list pre	62.00	9.00	RIGHT	FRENCH	MALE	23.00	27.00
8	TOTAL LIS	8.00	impaired m	total list pre	74.00	10.00	RIGHT	ENGLISH	MALE	21.00	28.00
9	TOTAL LIS	9.00	impaired m	total list pre	82.00	10.00	RIGHT	ENGLISH	FEMALE	22.00	29.00
10	PARTIAL LI	10.00	impaired m	partial list p	76.00	12.00	RIGHT	ENGLISH	FEMALE	24.00	32.00
11	TOTAL LIS	11.00	impaired m	total list pre	65.00	8.00	RIGHT	ENGLISH	FEMALE	26.00	35.00
12	TOTAL LIS	12.00	impaired m	total list pre	65.00	8.00	RIGHT	ENGLISH	FEMALE	25.00	34.00
13	PARTIAL LI	13.00	impaired m	partial list p	71.00	10.00	RIGHT	ENGLISH	MALE	26.00	34.00
14	TOTAL LIS	14.00	impaired m	total list pre	69.00	12.00	RIGHT	ENGLISH	FEMALE	23.00	31.00
15	PARTIAL LI	15.00	impaired m	partial list p	65.00	8.00	RIGHT	ENGLISH	FEMALE	24.00	29.00
16	PARTIAL LI	16.00	impaired m	partial list p	72.00	16.00	RIGHT	ENGLISH	FEMALE	21.00	26.00
17	TOTAL LIS	17.00	impaired m	total list pre	69.00	14.00	LEFT	ENGLISH	FEMALE	26.00	29.00
18	PARTIAL LI	18.00	impaired m	partial list p	65.00	12.00	RIGHT	ENGLISH	MALE	25.00	34.00
19	PARTIAL LI	19.00	impaired m	partial list p	65.00	14.00	RIGHT	ENGLISH	MALE	26.00	32.00
20	PARTIAL LI	20.00	impaired m	partial list p	70.00	12.00	RIGHT	ENGLISH	MALE	19.00	27.00

	drs.tot	attn.drs	ip.drs	construt	concept	memory	total.re	trial,1	trial,2	trial,3	trial,4
1	122.00	35.00	35.00	6.00	31.00	15.00	26.00	4.00	4.00	6.00	6.00
2	132.00	36.00	37.00	6.00	32.00	21.00	25.00	4.00	4.00	6.00	4.00
3	124.00	35.00	31.00	6.00	37.00	15.00	19.00	4.00	4.00	4.00	4.00
4	124.00	36.00	33.00	6.00	30.00	19.00	25.00	3.00	4.00	5.00	6.00
5	107.00	35.00	21.00	6.00	31.00	14.00	9.00	.00	1.00	3.00	3.00
6	123.00	36.00	34.00	5.00	35.00	13.00	18.00	3.00	3.00	3.00	4.00
7	126.00	37.00	31.00	5.00	33.00	20.00	39.00	4.00	6.00	7.00	9.00
8	127.00	37.00	31.00	6.00	33.00	20.00	26.00	4.00	4.00	6.00	6.00
9	118.00	34.00	32.00	6.00	34.00	12.00	17.00	2.00	2.00	3.00	5.00
10	123.00	37.00	30.00	6.00	38.00	12.00	25.00	3.00	4.00	5.00	5.00
11	129.00	36.00	32.00	6.00	39.00	16.00	16.00	2.00	3.00	3.00	3.00
12	124.00	36.00	32.00	6.00	30.00	20.00	26.00	4.00	5.00	6.00	6.00
13	126.00	36.00	32.00	6.00	32.00	20.00	24.00	4.00	5.00	4.00	5.00
14	127.00	36.00	30.00	6.00	34.00	21.00	25.00	2.00	4.00	5.00	7.00
15	115.00	34.00	31.00	6.00	27.00	17.00	21.00	2.00	3.00	4.00	6.00
16	118.00	36.00	31.00	6.00	31.00	14.00	21.00	3.00	5.00	4.00	5.00
17	119.00	35.00	31.00	6.00	31.00	16.00	20.00	1.00	5.00	5.00	5.00
18	118.00	33.00	27.00	6.00	33.00	19.00	36.00	6.00	6.00	8.00	8.00
19	117.00	36.00	27.00	6.00	33.00	15.00	25.00	4.00	4.00	6.00	5.00
20	110.00	33.00	31.00	5.00	27.00	14.00	21.00	2.00	3.00	4.00	5.00

	trial.5	delay.fr	delay.cu	delayrec	absol.sc	percent	first3rd	mid3rd	last3rd	slr	lls
1	6.00	.00	5.00	9.00	6.00	.00	1.00	2.00	1.00	.	.
2	7.00	3.00	13.00	14.00	4.00	42.85	.00	.00	.00	23.00	2.00
3	3.00	.00	2.00	9.00	3.00	.00	1.00	.00	2.00	15.00	5.00
4	7.00	.00	6.00	15.00	7.00	.00	.00	1.00	3.00	20.00	5.00
5	2.00	.00	.00	5.00	2.00	.00	2.00	.00	2.00	.	.
6	5.00	.00	5.00	11.00	5.00	.00	2.00	.00	.00	.	.
7	13.00	6.00	12.00	15.00	7.00	46.15	.00	.00	2.00	.	.
8	6.00	3.00	8.00	12.00	3.00	50.00	2.00	1.00	1.00	.	.
9	5.00	.00	4.00	11.00	5.00	.00	.00	.00	2.00	.	.
10	8.00	.00	4.00	10.00	8.00	.00	.00	1.00	.00	21.00	4.00
11	5.00	.00	5.00	12.00	5.00	.00	1.00	1.00	2.00	.	.
12	5.00	4.00	6.00	12.00	1.00	80.00	1.00	1.00	2.00	.	.
13	6.00	.00	3.00	8.00	6.00	.00	.00	1.00	2.00	18.00	7.00
14	7.00	.00	6.00	11.00	7.00	.00	1.00	.00	2.00	.	.
15	6.00	2.00	6.00	11.00	4.00	33.33	3.00	.00	1.00	14.00	7.00
16	4.00	.00	4.00	10.00	4.00	.00	.00	.00	2.00	.	.
17	4.00	.00	3.00	11.00	4.00	.00	1.00	.00	2.00	11.00	15.00
18	8.00	2.00	8.00	12.00	6.00	25.00	3.00	2.00	1.00	9.00	31.00
19	6.00	.00	5.00	13.00	6.00	.00	2.00	.00	2.00	25.00	.00
20	7.00	.00	4.00	11.00	7.00	.00	.00	.00	2.00	19.00	2.00

	sts	llr	cltr	rltr	intrusio	persever	visrecog	vrtrial1	vrtrial2	vrtrial3	vr.delay
1	.	.	18.00	2.00	3.00	1.00	43.00	13.00	14.00	16.00	14.00
2	25.00	2.00	2.00	.00	.00	.00	39.00	11.00	13.00	15.00	14.00
3	19.00	4.00	.00	4.00	.00	.00	41.00	13.00	14.00	14.00	13.00
4	25.00	5.00	3.00	2.00	.00	1.00	43.00	14.00	14.00	15.00	16.00
5	.	.	.00	4.00	2.00	.00	31.00	9.00	12.00	10.00	11.00
6	.	.	7.00	9.00	.00	.00	40.00	13.00	13.00	14.00	14.00
7	.	.	24.00	5.00	2.00	.00	44.00	14.00	15.00	15.00	15.00
8	.	.	15.00	8.00	.00	.00	43.00	13.00	14.00	16.00	16.00
9	.	.	13.00	.00	.00	.00	42.00	13.00	14.00	15.00	15.00
10	25.00	4.00	.00	4.00	2.00	.00	41.00	13.00	14.00	14.00	13.00
11	.	.	.00	.00	2.00	2.00	43.00	13.00	15.00	15.00	15.00
12	.	.	15.00	5.00	.00	6.00	44.00	14.00	14.00	16.00	16.00
13	24.00	6.00	.00	6.00	.00	.00	44.00	14.00	16.00	14.00	15.00
14	.	.	14.00	5.00	.00	.00	43.00	13.00	14.00	16.00	16.00
15	21.00	7.00	3.00	4.00	.00	.00	47.00	15.00	16.00	16.00	15.00
16	.	.	3.00	9.00	.00	.00	44.00	13.00	15.00	16.00	16.00
17	21.00	10.00	.00	10.00	2.00	2.00	36.00	12.00	13.00	11.00	12.00
18	36.00	27.00	16.00	11.00	8.00	9.00	45.00	14.00	15.00	16.00	15.00
19	25.00	.00	.00	.00	.00	.00	48.00	16.00	16.00	16.00	16.00
20	21.00	2.00	.00	2.00	.00	1.00	44.00	13.00	15.00	16.00	15.00

	vr.match	hd.total	orient1	prefron2	ideomot3	looking4	idealio5	denom6	compreh7	regis8	gnosis9
1	16.00	173.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	8.00	9.00
2	16.00	182.00	10.00	10.00	9.00	10.00	10.00	10.00	10.00	8.00	10.00
3	16.00	172.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	4.00	10.00
4	16.00	179.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	8.00	10.00
5	16.00	162.00	10.00	10.00	9.00	8.00	6.00	10.00	8.00	8.00	8.00
6	16.00	164.00	10.00	10.00	10.00	10.00	10.00	8.00	10.00	6.00	9.00
7	16.00	193.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
8	16.00	190.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
9	16.00	179.00	10.00	10.00	10.00	10.00	8.00	10.00	10.00	10.00	8.00
10	16.00	178.00	10.00	10.00	10.00	10.00	9.00	10.00	10.00	6.00	8.00
11	16.00	178.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	8.00	8.00
12	16.00	171.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	8.00	9.00
13	16.00	182.00	10.00	10.00	10.00	10.00	6.00	10.00	10.00	10.00	9.00
14	16.00	188.00	10.00	10.00	10.00	10.00	9.00	10.00	10.00	10.00	10.00
15	16.00	176.00	10.00	10.00	10.00	10.00	9.00	9.00	10.00	10.00	9.00
16	16.00	179.00	10.00	10.00	10.00	10.00	6.00	10.00	10.00	10.00	8.00
17	16.00	180.00	10.00	10.00	8.00	10.00	8.00	10.00	10.00	8.00	9.00
18	16.00	187.00	10.00	10.00	10.00	10.00	7.00	10.00	10.00	10.00	10.00
19	16.00	187.00	10.00	10.00	9.00	10.00	9.00	10.00	10.00	10.00	9.00
20	16.00	171.00	10.00	10.00	10.00	10.00	7.00	8.00	10.00	10.00	9.00

	read10	orient11	constr12	concen13	calcul14	draw15	motor16	remotmem	write18	simil19	recenmem
1	10.00	8.00	10.00	8.00	9.00	9.00	10.00	10.00	10.00	6.00	.00
2	10.00	8.00	10.00	9.00	7.00	9.00	10.00	10.00	10.00	10.00	2.00
3	10.00	8.00	10.00	9.00	7.00	10.00	10.00	4.00	10.00	10.00	.00
4	10.00	6.00	10.00	7.00	7.00	10.00	10.00	6.00	10.00	10.00	6.00
5	8.00	10.00	10.00	5.00	8.00	10.00	10.00	4.00	10.00	10.00	.00
6	10.00	8.00	10.00	7.00	7.00	3.00	10.00	8.00	10.00	4.00	4.00
7	10.00	10.00	10.00	9.00	7.00	9.00	10.00	10.00	10.00	10.00	8.00
8	10.00	8.00	10.00	7.00	10.00	9.00	10.00	10.00	10.00	10.00	6.00
9	10.00	6.00	10.00	10.00	8.00	9.00	10.00	10.00	10.00	10.00	.00
10	10.00	8.00	10.00	10.00	8.00	9.00	10.00	10.00	10.00	10.00	.00
11	10.00	8.00	10.00	8.00	8.00	8.00	10.00	10.00	10.00	10.00	.00
12	10.00	8.00	10.00	8.00	9.00	7.00	10.00	6.00	10.00	6.00	.00
13	8.00	8.00	10.00	9.00	6.00	8.00	10.00	10.00	10.00	10.00	8.00
14	10.00	8.00	10.00	9.00	7.00	10.00	10.00	10.00	9.00	10.00	6.00
15	8.00	8.00	8.00	8.00	7.00	8.00	10.00	10.00	10.00	6.00	6.00
16	10.00	8.00	10.00	6.00	8.00	9.00	10.00	10.00	10.00	10.00	4.00
17	10.00	8.00	10.00	9.00	9.00	9.00	10.00	10.00	10.00	8.00	4.00
18	10.00	10.00	10.00	8.00	8.00	9.00	10.00	10.00	9.00	10.00	6.00
19	10.00	8.00	8.00	9.00	9.00	10.00	10.00	10.00	10.00	10.00	6.00
20	10.00	8.00	10.00	7.00	7.00	9.00	10.00	10.00	8.00	8.00	.00

	group	subject	status	procedur	age	educatn	handedns	lang	gender	mmse.sc	ogh.exam
21	TOTAL LIS	21.00	normal cont	total list pre	65.00	6.00	RIGHT	ENGLISH	FEMALE	29.00	37.00
22	TOTAL LIS	22.00	normal cont	total list pre	57.00	12.00	RIGHT	ENGLISH	FEMALE	29.00	39.00
23	PARTIAL LI	23.00	normal cont	partial list p	59.00	13.00	RIGHT	ENGLISH	FEMALE	30.00	40.00
24	TOTAL LIS	24.00	normal cont	total list pre	66.00	8.00	RIGHT	ENGLISH	FEMALE	27.00	37.00
25	PARTIAL LI	25.00	normal cont	partial list p	68.00	13.00	RIGHT	ENGLISH	FEMALE	29.00	39.00
26	TOTAL LIS	26.00	normal cont	total list pre	59.00	8.00	RIGHT	ENGLISH	FEMALE	30.00	38.00
27	PARTIAL LI	27.00	normal cont	partial list p	60.00	14.00	RIGHT	ENGLISH	MALE	30.00	39.00
28	TOTAL LIS	28.00	normal cont	total list pre	63.00	8.00	RIGHT	ENGLISH	MALE	29.00	37.00
29	PARTIAL LI	29.00	normal cont	partial list p	70.00	15.00	RIGHT	ENGLISH	MALE	30.00	40.00
30	TOTAL LIS	30.00	normal cont	total list pre	73.00	15.00	RIGHT	ENGLISH	MALE	30.00	40.00
31	PARTIAL LI	31.00	normal cont	partial list p	63.00	15.00	RIGHT	ENGLISH	FEMALE	30.00	39.00
32	PARTIAL LI	32.00	normal cont	partial list p	59.00	15.00	RIGHT	ENGLISH	FEMALE	30.00	40.00
33	TOTAL LIS	33.00	normal cont	total list pre	68.00	18.00	RIGHT	ENGLISH	FEMALE	29.00	38.00
34	PARTIAL LI	34.00	normal cont	partial list p	72.00	16.00	RIGHT	ENGLISH	MALE	29.00	36.00
35	TOTAL LIS	35.00	normal cont	total list pre	66.00	16.00	RIGHT	ENGLISH	FEMALE	30.00	38.00
36	PARTIAL LI	36.00	normal cont	partial list p	74.00	13.00	RIGHT	ENGLISH	FEMALE	29.00	38.00
37	TOTAL LIS	37.00	normal cont	total list pre	59.00	13.00	RIGHT	ENGLISH	FEMALE	30.00	39.00
38	PARTIAL LI	38.00	normal cont	partial list p	76.00	16.00	RIGHT	ENGLISH	MALE	28.00	37.00
39	PARTIAL LI	39.00	normal cont	partial list p	58.00	12.00	RIGHT	ENGLISH	FEMALE	30.00	38.00
40	TOTAL LIS	40.00	normal cont	total list pre	62.00	11.00	RIGHT	ENGLISH	MALE	30.00	40.00

	drs.tot	attn.drs	lp.drs	construt	concept	memory	total.re	trial.1	trial.2	trial.3	trial.4
21	140.00	37.00	37.00	6.00	36.00	24.00	50.00	8.00	11.00	10.00	10.00
22	143.00	37.00	37.00	6.00	38.00	25.00	54.00	6.00	8.00	12.00	14.00
23	141.00	37.00	37.00	6.00	37.00	24.00	50.00	7.00	8.00	10.00	12.00
24	130.00	36.00	37.00	6.00	32.00	19.00	39.00	6.00	7.00	8.00	9.00
25	140.00	36.00	35.00	6.00	38.00	25.00	41.00	5.00	8.00	9.00	9.00
26	133.00	37.00	35.00	6.00	31.00	24.00	51.00	7.00	8.00	11.00	12.00
27	143.00	37.00	37.00	6.00	38.00	25.00	37.00	7.00	6.00	7.00	8.00
28	142.00	37.00	37.00	6.00	38.00	24.00	43.00	6.00	7.00	9.00	10.00
29	143.00	36.00	37.00	6.00	39.00	25.00	59.00	7.00	10.00	13.00	14.00
30	141.00	37.00	37.00	6.00	38.00	23.00	48.00	8.00	8.00	8.00	10.00
31	140.00	36.00	37.00	6.00	38.00	23.00	45.00	6.00	8.00	10.00	10.00
32	142.00	37.00	37.00	6.00	37.00	25.00	58.00	8.00	11.00	13.00	11.00
33	140.00	37.00	37.00	6.00	36.00	24.00	30.00	4.00	5.00	6.00	7.00
34	138.00	37.00	36.00	5.00	36.00	24.00	30.00	4.00	7.00	6.00	6.00
35	143.00	37.00	37.00	6.00	39.00	24.00	48.00	7.00	10.00	9.00	10.00
36	138.00	37.00	36.00	6.00	37.00	22.00	42.00	5.00	7.00	8.00	10.00
37	139.00	37.00	37.00	6.00	35.00	24.00	50.00	4.00	8.00	12.00	12.00
38	134.00	35.00	37.00	6.00	36.00	20.00	43.00	7.00	7.00	9.00	10.00
39	141.00	37.00	37.00	6.00	37.00	24.00	44.00	6.00	7.00	10.00	9.00
40	137.00	36.00	36.00	6.00	34.00	25.00	50.00	5.00	8.00	10.00	13.00

	trial.5	delay.fr	delay.cu	delayrec	absol.sc	percent	first3rd	mid3rd	last3rd	str	lis
21	11.00	7.00	14.00	15.00	4.00	63.63	2.00	3.00	3.00	.	.
22	14.00	10.00	13.00	15.00	4.00	71.42	.00	4.00	2.00	.	.
23	13.00	14.00	15.00	15.00	-1.00	107.69	2.00	.00	4.00	1.00	55.00
24	9.00	5.00	11.00	13.00	4.00	44.44	.00	4.00	3.00	.	.
25	10.00	5.00	8.00	12.00	5.00	50.00	1.00	1.00	4.00	14.00	28.00
26	13.00	8.00	14.00	15.00	5.00	61.53	4.00	1.00	3.00	.	.
27	9.00	8.00	12.00	13.00	1.00	88.89	.00	3.00	1.00	6.00	37.00
28	11.00	6.00	12.00	14.00	5.00	54.54	2.00	2.00	3.00	.	.
29	15.00	9.00	15.00	15.00	6.00	60.00	1.00	1.00	2.00	6.00	55.00
30	14.00	10.00	14.00	15.00	4.00	71.42	1.00	1.00	3.00	.	.
31	11.00	9.00	14.00	15.00	2.00	81.81	4.00	1.00	2.00	20.00	26.00
32	15.00	14.00	14.00	15.00	1.00	93.33	2.00	.00	3.00	9.00	50.00
33	8.00	5.00	11.00	15.00	3.00	62.50	2.00	2.00	3.00	.	.
34	7.00	4.00	10.00	14.00	3.00	57.14	1.00	4.00	2.00	19.00	12.00
35	12.00	12.00	13.00	14.00	.00	100.00	1.00	2.00	3.00	.	.
36	12.00	7.00	11.00	13.00	5.00	58.33	2.00	3.00	3.00	18.00	24.00
37	14.00	11.00	13.00	13.00	3.00	78.57	1.00	1.00	2.00	.	.
38	10.00	5.00	8.00	14.00	5.00	50.00	.00	4.00	1.00	8.00	39.00
39	12.00	10.00	14.00	15.00	2.00	83.33	4.00	1.00	2.00	12.00	37.00
40	14.00	8.00	12.00	15.00	6.00	57.14	1.00	2.00	3.00	.	.

	sis	lir	cllr	rltr	intrusio	persever	visrecog	vrtrial1	vrtrial2	vrtrial3	vr.delay
21	.	.	27,00	11,00	3,00	.00	46,00	15,00	15,00	16,00	15,00
22	.	.	40,00	6,00	.00	1,00	45,00	14,00	15,00	16,00	14,00
23	50,00	49,00	31,00	18,00	.00	.00	46,00	14,00	16,00	16,00	16,00
24	.	.	22,00	7,00	.00	.00	45,00	13,00	16,00	16,00	14,00
25	41,00	27,00	17,00	10,00	.00	3,00	47,00	15,00	16,00	16,00	16,00
26	.	.	23,00	19,00	1,00	4,00	48,00	16,00	16,00	16,00	16,00
27	37,00	30,00	20,00	10,00	.00	5,00	46,00	15,00	15,00	16,00	15,00
28	.	.	36,00	2,00	.00	.00	47,00	16,00	15,00	16,00	16,00
29	59,00	54,00	47,00	7,00	2,00	5,00	45,00	15,00	15,00	15,00	15,00
30	.	.	36,00	5,00	.00	1,00	43,00	15,00	13,00	15,00	16,00
31	45,00	24,00	16,00	8,00	1,00	6,00	48,00	16,00	16,00	16,00	16,00
32	58,00	49,00	38,00	11,00	.00	.00	48,00	16,00	26,00	26,00	26,00
33	.	.	16,00	6,00	1,00	2,00	48,00	16,00	16,00	16,00	15,00
34	30,00	11,00	.00	11,00	1,00	.00	44,00	12,00	16,00	16,00	14,00
35	.	.	29,00	14,00	.00	4,00	47,00	16,00	15,00	16,00	16,00
36	42,00	24,00	16,00	8,00	3,00	.00	48,00	16,00	16,00	16,00	16,00
37	.	.	39,00	8,00	.00	.00	48,00	16,00	16,00	16,00	16,00
38	43,00	35,00	22,00	13,00	1,00	.00	48,00	16,00	16,00	16,00	16,00
39	44,00	32,00	21,00	11,00	4,00	5,00	48,00	16,00	16,00	16,00	16,00
40	.	.	40,00	4,00	.00	3,00	47,00	15,00	16,00	16,00	16,00

	vr.match	hd.total	orient1	prefron2	ideomol3	looking4	idealto5	denom6	compreh7	regist8	gnos9
21	16.00	199.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
22	16.00	195.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
23	16.00	198.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
24	16.00	197.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
25	16.00	190.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
26	16.00	197.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
27	16.00	200.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
28	16.00	198.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
29	16.00	198.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
30	16.00	198.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
31	16.00	198.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
32	26.00	200.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
33	16.00	191.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
34	16.00	194.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	8.00	10.00
35	16.00	198.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	8.00	10.00
36	16.00	189.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
37	16.00	188.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	8.00	10.00
38	16.00	196.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
39	16.00	198.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
40	16.00	195.00	10.00	10.00	10.00	10.00	9.00	10.00	10.00	10.00	9.00

	read10	orient11	constr12	concen13	calcul14	draw15	motor16	remolmem	wfile18	simil19	recenmem
21	10.00	10.00	10.00	10.00	10.00	9.00	10.00	10.00	10.00	10.00	10.00
22	10.00	10.00	10.00	7.00	10.00	10.00	10.00	10.00	10.00	10.00	8.00
23	10.00	10.00	10.00	10.00	8.00	10.00	10.00	10.00	10.00	10.00	10.00
24	10.00	10.00	10.00	9.00	10.00	8.00	10.00	10.00	10.00	10.00	10.00
25	10.00	10.00	10.00	9.00	4.00	9.00	10.00	10.00	10.00	10.00	8.00
26	10.00	10.00	10.00	10.00	10.00	9.00	10.00	10.00	10.00	10.00	8.00
27	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
28	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	8.00
29	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	8.00
30	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
31	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	8.00
32	10.00	10.00	10.00	10.00	8.00	10.00	10.00	10.00	10.00	10.00	10.00
33	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
34	10.00	10.00	10.00	9.00	6.00	10.00	10.00	10.00	10.00	10.00	8.00
35	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	6.00
36	10.00	8.00	10.00	9.00	7.00	9.00	10.00	10.00	10.00	10.00	10.00
37	10.00	10.00	10.00	5.00	6.00	9.00	10.00	10.00	10.00	10.00	8.00
38	10.00	10.00	10.00	9.00	9.00	10.00	10.00	10.00	10.00	10.00	8.00
39	10.00	10.00	10.00	10.00	10.00	9.00	10.00	10.00	10.00	10.00	10.00
40	10.00	10.00	10.00	10.00	10.00	9.00	10.00	10.00	10.00	10.00	8.00

IMAGE EVALUATION TEST TARGET (QA-3)

APPLIED IMAGE, Inc.
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989

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