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Brief Visuospatial Memory Test-Revised: Form Equivalency for Ages 80-89

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Abstract
Normative data has established that normal age-related declines are more pronounced on visual-graphic than verbal memory tests. The BVMT-R is a visual-graphic memory test clinically useful for the elderly because the relatively simple content minimizes low ceiling effects and it has six alternate forms that can be used in serial evaluations. However, subjectively, not all forms appear to be equal in complexity. The purpose of this study was to assess the equivalence of Forms 1 and 4 of the BVMT-R for individuals aged 80-89. Volunteer participants were 26 men and 64 women without significant history of, or current, medical / psychological problems or substance use. Subjects were divided into two age groups: 80-84 (n = 42) and 85-89 (n = 48). Subjects were administered Forms 1 and 4 one week apart in counterbalanced order. There were no significant differences between Forms 1 and 4 for BVMT-R Total and Delayed raw scores for the 80-84 age group Wilks’s = .952, F(2,40) = 1.01, p = .374. There were significant differences between Form 1 and 4 raw scores for ages 85-89 Wilks’s = .842, F(2,46) = 4.32, p = .019. BVMT-R Total raw scores were higher for Form 1 F, (1, 47) = 8.83, p = 0.005, and nearly significantly higher for Delayed raw scores F, (1, 47) = 3.94, p = 0.053. Individuals in their early 80’s obtain comparable scores on Forms 1 and 4 of the BVMT-R. For patients in their late 80’s, learning, and likely delayed recall, is easier for Form 1 than Form 4.
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BRIEF VISUOSpatial MEMORY TEST-REVISED:
FORM EQUIVALENCY FOR AGES 80-89

A DISSERTATION
SUBMITTED TO THE FACULTY
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>ii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>iii</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>REVIEW OF LITERATURE</td>
<td>3</td>
</tr>
<tr>
<td>Memory as a Cognitive Process</td>
<td>3</td>
</tr>
<tr>
<td>Normal Memory Function in Older Adults</td>
<td>5</td>
</tr>
<tr>
<td>Neurological Disease Affecting Memory in Elders</td>
<td>16</td>
</tr>
<tr>
<td>Neuropsychological Assessment of Memory</td>
<td>22</td>
</tr>
<tr>
<td>METHODOLOGY</td>
<td>28</td>
</tr>
<tr>
<td>RESULTS</td>
<td>31</td>
</tr>
<tr>
<td>DISCUSSION</td>
<td>33</td>
</tr>
<tr>
<td>APPENDICES</td>
<td></td>
</tr>
<tr>
<td>A. Neurological and Health Screening Questionnaire</td>
<td>37</td>
</tr>
<tr>
<td>B. Letter to Participants with Low MMSE Scores</td>
<td>39</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>40</td>
</tr>
</tbody>
</table>
Abstract

Normative data has established that normal age-related declines are more pronounced on visual-graphic than verbal memory tests. The BVMT-R is a visual-graphic memory test clinically useful for the elderly because the relatively simple content minimizes low ceiling effects and it has six alternate forms that can be used in serial evaluations. However, subjectively, not all forms appear to be equal in complexity. The purpose of this study was to assess the equivalence of Forms 1 and 4 of the BVMT-R for individuals aged 80-89. Volunteer participants were 26 men and 64 women without significant history of, or current, medical / psychological problems or substance use. Subjects were divided into two age groups: 80-84 (n = 42) and 85-89 (n = 48). Subjects were administered Forms 1 and 4 one week apart in counterbalanced order. There were no significant differences between Forms 1 and 4 for BVMT-R Total and Delayed raw scores for the 80-84 age group Wilks’s Λ = .952, F(2,40) = 1.01, p = .374. There were significant differences between Form 1 and 4 raw scores for ages 85-89 Wilks’s Λ = .842, F(2,46) = 4.32, p = .019. BVMT-R Total raw scores were higher for Form 1 F, (1, 47) = 8.83, p = 0.005, and nearly significantly higher for Delayed raw scores F, (1, 47) = 3.94, p = 0.053. Individuals in their early 80’s obtain comparable scores on Forms 1 and 4 of the BVMT-R. For patients in their late 80’s, learning, and likely delayed recall, is easier for Form 1 than Form 4.

Key Words: BVMT-R; Memory; Aging; Geriatrics; Assessment
**LIST OF TABLES**

Table 1 Age Groups 80-84 and 85-89 Means and SD for Descriptive Variables …….. 29
Table 2 BVMT-R Form Comparisons Within Age Groups 80-84 and 85-89…………… 32
Table 3 BVMT-R Form Comparisons Between Age Groups 80-84 and 85-89…………… 32
It is well established that as individuals age, memory abilities decline (Albert, Duffy, & Naeser, 1987; D. Howieson, Holm, Kaye, Oken, & J. Howieson, 1993; Lezak, Howieson, & Loring, 2004). Older adults may complain of forgetting names and places, losing items around the house, or having difficulties finding the right words. Memory problems are so commonplace and are enough of a concern that often, normal people are referred for a memory evaluation. In fact, memory declines are the most common concern for older adults who are referred for neuropsychological evaluations (Green, 2000). Memory declines beyond that associated with normal aging are characteristic of neurological pathology, Alzheimer’s Disease (AD) being a primary concern because of the increased risk with increasing age (DSM-IV-TR, 2000). Neuropsychological evaluations of memory are often the only way to distinguish normal memory declines associated with aging from abnormal memory decline, especially in the early stages of progressive dementia (Albert, Moss, Tanzi, & Jones, 2001). Reliable diagnosis is important in order to reassure patients with normal age associated memory decline and to identify patients with impaired memory who may need medical treatment.

Because of normal age-related memory decline, it is important that neuropsychologists use tests that are age appropriate and have norms that extend into the upper decades. Memory continues to change substantially after age 70, so much so that normal memory test performance is substantially different at ages 70, 75, 80, and 85.

Often when evaluating older adults it is important to perform serial assessments to monitor the patient’s course and clarify diagnosis. For many memory tests, alternate forms are not available, thus increasing the chances that practice effects may inflate and obscure meaningful clinical changes. Ideally, when conducting serial evaluations, equivalent alternate test forms would be used avoid practice effects. This is especially important for memory tests as
they appear to be highly susceptible to practice effects (Theisen, Rapport, Axelrod, & Brines, 1998). Unfortunately equivalent forms are not available for many commonly used memory tests.

In addition to appropriate norms and alternate forms, when choosing memory evaluations for the elderly it is also important to consider the complexity of the test. Norms for memory tests have established that normal age-related declines are more pronounced on visual-graphic memory tests that involve drawing than for verbal memory tests (Howieson et al., 1993; Koss, Haxaby, DeCarli, & Schapiro, 1991). As a result, many visual-graphic memory tests that are clinically useful for younger patients are not for patients past age 70. Because normal performance for this age group is low, there is a low ceiling making it difficult to distinguish clinically significant memory impairment from normal age-related decline. The Brief Visuospatial Memory Test-Revised (BVMT-R; Benedict, 1997) is a visual-graphic memory test that is useful for memory assessment in the elderly because the content is easier, it includes multiple presentations to assess learning, and has six alternate forms that can be used in serial evaluations to avoid practice effects. However, subjectively (in the opinion of this researcher), not all six forms appear to be equal in complexity. For example, some figures in Form 4 appear more complex and not easily verbally mediated, while figures on Form 1 appear to be more common shapes, and perhaps are more easily verbally mediated. Furthermore, norms for the BVMT-R only extend to age 79; therefore it is not certain if Forms 1 and 4 are equivalent for individuals in their 9th decade, where variations in complexity of a task can significantly affect performance. It is important to determine if the alternate forms are equivalent for patients in their 80s in order to know if memory change can be reliably detected when doing serial evaluations.
Review of Literature

To place the importance of memory assessment of the elderly in proper context it is important to consider various aspects of memory function, pathology, and evaluation. In the following pages, a cognitive model of memory will be presented, the normal cognitive aging process will be discussed, neurological diseases that affect memory will be reviewed, and the types of tests neuropsychologists use to assess memory will be outlined.

Memory as a Cognitive Process

Memory is complex and multidimensional. Traditionally, memory is conceptualized as two processes, short-term (attention and working memory) and long-term memory. Working memory is the brief, immediate memory for information that is currently being processed while long-term memory is information that is more permanently stored and retrieved for later use (Matlin, 2005). Additionally within both working and long-term memory the type of incoming stimuli that is being encoded is often considered (i.e., verbal vs. nonverbal).

**Working memory.** The information held in working memory is active and available, so an individual can use the information to complete a variety of cognitive activities. There have been many theories to explain working memory and a commonly referred to model is the multicomponent model originally created by Alan Baddeley (1986). Baddeley’s approach emphasizes that working memory is a multipart system that temporarily holds and manipulates information as cognitive tasks are being performed. According to Baddeley’s model, working memory consists of four components: the phonological loop, the visuospatial sketchpad, the episodic buffer, and the central executive.

The phonological loop is the portion of working memory responsible for storing a limited number of sounds for a short period of time. The phonological loop stores sounds that are
audible as well as inaudible, such as an inner voice. The visuospatial sketchpad stores visual and spatial information as well as information that has been visualized from verbal stimuli. While it is possible to use the phonological loop and the visuospatial sketchpad at the same time it is not possible to perform two visuospatial tasks or two phonological tasks simultaneously. The episodic buffer has the ability to temporarily store information from the phonological loop, the visual spatial sketchpad, and long-term memory. The episodic buffer is a relatively new concept in the working memory model and is thought to be the “workspace” that is accessed by conscious awareness. The episodic buffer also provides an interface between the other components of working and long term memory. The central executive does not store any information; rather, it integrates information from the phonological loop, the visuospatial sketchpad, and the episodic buffer. The central executive is responsible for filtering out irrelevant information. Although Baddeley’s (1986) original model of working memory has been upheld over three decades of research, the construct of working memory continues to evolve (Baddeley, 2003).

**Long-term memory.** Long-term memory is the capacity to store memories of experiences and information accumulated over a lifetime. For the sake of simplicity, long-term memory can be broken down further into four subsets; however, this does not indicate that these four specific categories are distinctly different forms of memory. The four categories of memory include procedural memory, perceptual representation systems, semantic memory, and episodic memory (Tulving, 2000). These four memory systems deal with different types of information and are mediated by different regions of the brain, and therefore are differentially vulnerable to aging. Procedural memory and perceptual representation systems are classified as implicit, meaning they require no effort to remember and occur unconsciously. Procedural memory
consists of an individual’s knowledge about how to do something. Perceptual representation systems encode and retain sensory information and are responsible for priming effects, in which exposure to a stimulus influences response to a subsequent stimulus. In contrast, episodic and semantic memories are classified as explicit, meaning they require conscious effort to remember. Specific events that have occurred during a person’s life form episodic memories. These memories allow a person to recall earlier episodes in his or her life. Semantic memories are organized knowledge about the world and other acquired factual information.

**Differential incoming stimuli.** Processes in both working and long-term memory can be further classified according to the modality in which the individual receives the information. Incoming verbal stimuli is often assessed through auditory modality whereas incoming spatial/graphic stimuli are typically assessed through visual modality. Therefore, when studying memory processes, researchers typically examine both auditory-verbal and visual-graphic modalities. The pattern of performance on auditory-verbal and visual-spatial/graphic memory tests can provide important diagnostic information when assessing the memory function of an older adult (Lezak et. al, 2004).

**Normal Memory Function in Older Adults**

Mild memory difficulties are commonplace among the elderly, sometimes making it difficult to diagnose memory deficits that may reflect neurological disease. However, understanding normal age-related changes in cognitive functioning aids in differentiating diseases such as Alzheimer’s from normal memory decline (Hyman & Gómez-Isla, 1998). Normal declines in memory begin at about age 50, and substantial declines are notable as individuals enter their mid-70s (Albert et al., 1987). Interestingly, the effects of age on memory are highly dependent upon the type of memory task (immediate vs. delayed), the type of memory
process assessed (encoding, storage, or retrieval), and the type of stimulus presented (verbal vs. nonverbal).

**Immediate memory.** There are typically two types of tasks associated with immediate memory: attention and working memory. Attention span tasks involve the ability to retain a recently experienced event for a brief period of time, such as repeating a string of digits. Working memory tasks require simultaneous maintenance and active manipulation of information. For example, an individual may be given a string of alternating numbers and letters and asked to arrange them in ascending order beginning with letters and then numbers. Aging seems to have a greater affect on working memory, a task that requires both maintenance and processing of information.

For example, Dobbs and Rule (1989) assessed five groups ranging in age from 30-99 years on auditory-verbal immediate memory tasks that varied in complexity. The researchers found that for easier tasks, there were only slight variations in performance among different ages and age did not predict performance. Conversely, for more complex tasks, the differences in performance were pronounced and age did predict performance.

Likewise Park et al. (2002) assessed 245 people ranging in age from 20-92 on a series of tasks involving visuospatial and verbal immediate memory. For the first task, the participants were asked to replicate patterns tapped out by the examiner on raised blocks, as well as repeat a span of digits. During the second task, participants were given reading and computation span tasks, while simultaneously answering a series of questions or math problems. After they were given the spans and answered questions, they were asked to recall the last word from each question or the last number from each math problem. The researchers found that there was a larger age decline for the second task, suggesting that normal age-related declines occur for tasks
that require both maintenance and processing but not on tasks that require only maintenance. Similarly, Rueter-Lorenz & Sylvester (2005) found few age-related differences in immediate memory for simple tasks that require rote maintenance abilities and for various forms of priming and recognition tasks. So, as task complexity increases, so does the performance differential between older and younger adults.

**Delayed memory.** As noted above, there are several subcategories of delayed or long-term memory: procedural memory, the perceptual representation systems, semantic memory, and episodic memory. Procedural memory and perceptual representation systems generally do not decline with age (Laver, 2009; Luo & Craik, 2008). Conversely, age-related declines are found for semantic and episodic memory. Consequently, these two forms of memory are most often researched and assessed in older adults. Episodic memory shows the greatest decline with age whereas semantic memory is generally spared with only slight decline (Bäckman & Farde, 2005; Luo & Craik, 2008; Old & Naveh-Benjamin, 2008).

For example, Spaniol, Madden, and Voss (2006) asked older and younger adults to judge the pleasantness of a series of words, half of which described living things. After viewing the lists the participants either completed an episodic test where they indicated whether a given word was from the study list or a very simple semantic test where they indicated if a given word described a living or nonliving thing. The researchers found that older adults performed less accurately than younger adults on the episodic task, but there was not a difference between the two groups for the semantic task. This study highlights that age-related declines are more common for episodic than semantic memory; however, it is important to consider that the semantic portion of this task was extremely easy. In fact, the semantic task was likely not sensitive to normal age-related declines at all but rather would have been sensitive only to severe
dementia. Additionally it is important to note that participants were not prompted to repeat or remember the words, which is typically how episodic memory is measured in neuropsychological assessments. It is possible that participants may have increased their performance if they were instructed to recall the words.

Although age-related declines are more prominent for episodic tasks, declines are not consistent on tasks within the domain of episodic memory. The most common subsets of episodic memory that show age-related declines are free recall, associative learning, source memory tasks, and prospective memory tasks (Luo & Craik, 2008).

During free recall tasks, individuals are asked to retrieve information that was formally presented without any cues or guidance. Associative learning is when participants must create and retrieve associative links between units that did not have prior relations; source memory tasks require individuals to remember the original source of information rather than the actual stimuli that were presented; and prospective memory is a common, everyday memory task that requires one to remember to perform an intended action at some appropriate point in the future.

A relevant study comparing episodic free recall and semantic memory was conducted by Rönnlund, Nyberg, Bäckman, and Ilsson, (2005). The researchers asked 1,000 participants ranging in age from 35 to 80, to complete a series of episodic and semantic memory tests on two occasions separated by five years. Episodic measures included: recall of self-performed and other-performed actions, recall of a list of words, and recall of statements. Semantic measures included: test of general knowledge, vocabulary, and word fluency. The researchers found that until the age of 55-60, episodic memory was fairly stable; after 60, a large decline was noted. Semantic memory performance increased between the ages of 35-55, and leveled off until the age of 65 when a slight decline was noted.
Gutchess and Park (2009) assessed episodic associative memory by showing related and unrelated complex pictures to young and old adults. Participants were 28 young adults and 32 elderly adults. The participants viewed a target picture with either a related or unrelated background. For example a cow might be shown in a pasture, or a cow might be shown in a Laundromat. The participants were told to try to remember the entire scene. After a 12 minute delay, the participants were presented with pictures either with the same or different background and were told to identify whether this was the exact picture they had seen previously. Older adults preformed worse on this task than younger adults, suggesting that their associative or binding abilities (putting pieces of memory together) decline with age. They were not as successful in remembering the association between the target picture and background.

Episodic source memory was examined by Simons, Dodson, Bell and Schacter (2004). Older and younger adults listened to a series of sentences read by four speakers (two male and two female) while simultaneously reading the sentence and viewing a photograph of the speaker. After presentation, the participants were shown more sentences and asked to distinguish between old and new sentences. Older adults performed equally as well as their younger counterparts on this task, but their performance was significantly worse when asked to identify the speaker of earlier presented sentences.

A relevant study by Einstein, McDaniel, Manzi, Cochran, and Baker (2000) examined age-related declines in episodic prospective memory. Older and younger adults were given paragraphs to read followed by reading comprehension questions and two trivia questions. The participants were told that each time they came across the word “technique” or “system” in the paragraphs they were to press the F1 key when they reached the trivia question phase of the trial. Additionally, participants were presented with audible digits and were to press a handheld
counter every time they heard two odd-digit numbers consecutively. The researchers found that younger participants had significantly higher levels of prospective memory than did older participants. This finding supports that prospective memory abilities decline with age. However, it is also important to consider the complexity of memory tasks and age-related decline. In this study, the participants completed multiple simultaneous cognitive tasks, which likely affected older adults’ ability to utilize prospective memory skills. It is possible that a simpler prospective memory task may have yielded different results.

Based on the research discussed above, it is evident that as adults age there is a decline in memory performance. Both immediate and delayed memory is affected, with complexity playing an important role in the ability to remember information. This decline is greatest for episodic memory, with only slight decline for semantic memory. In particular, episodic free recall, associative learning, source memory tasks, and prospective memory abilities show the greatest decline.

Both immediate and delayed memory are usually conceived as having three stages: encoding, storage, and retrieval; as a result, during memory evaluations, an individual’s ability to acquire, store, and retrieve information in memory for both verbal and nonverbal domains should be tested (Lezak et al., 2004). Encoding refers to the initial processing of information; storage is the maintenance of the encoded information; and retrieval refers to the process by which the stored information is used (Neath & Suprenat, 2005).

**Encoding.** There is strong evidence suggesting that as individuals age, encoding ability greatly declines as tasks become more difficult, and therefore more cognitive resources are required (Park, Smith, Morrell, Puglisi, & Dudley, 1990; Salthouse, Mitchell, Skovronek & Babcock, 1989; Smith, Park, Earles, Shaw & Whiting, 1998). For example, Park et al. (1990)
examined the effect of age on short-term memory abilities for unrelated and related pictures. The researchers reported large age differences between young and older adults when the task required more reliance on basic processing mechanisms (unrelated pictures) as compared to reliance on world knowledge (related pictures).

Another relevant study was conducted by Troyer, Häfliger, Cadieux, and Craik (2006). They compared age-related differences in incidental and intentional learning of names. Older and younger adults viewed surnames and were told they would need to remember only specified names. Before viewing each name, the participants were instructed on how they should encode the information; physical processing (stating the first letter of the name), phonemic processing (stating a word that rhymed with the name), semantic processing (defining or making an association with the name), or intentional learning (simply trying to remember the name for later). The researchers found that with both recall and recognition, younger adults did significantly better than older adults for intentionally learned names. Interestingly, there was no difference between the two groups on any of the other encoding conditions. Although the researchers found significant results, it is important to note that the sample size for this study was rather small (20 older adults, 20 younger adults). It would be useful to replicate this study with a larger sample. This research suggests that older adults are more susceptible to encoding difficulties, specifically for information learned intentionally.

**Storage.** Researchers have found that age-related declines in the storage process are variable and highly dependent upon the time between initial encoding of information and retrieval. For example, Park, Smith, Morrell, Puglisi, and Dudley (1990) assessed rates of forgetting visual information amongst older and younger adults. The participants studied a series of line drawings and took recognition tests after three minutes, 48 hours, one week, two weeks,
and four weeks. The researchers found that there was no age-related difference in forgetting rates after three minutes and 48 hours. However, after weekly intervals, older adults performed worse than their younger counterparts, suggesting that as individuals age they have larger forgetting rates, specifically after a 48 hour period. Although this study provides valuable information about memory storage for long periods, memory tests in a neuropsychological evaluation typically assess recall after 30 minutes. Age-related declines are found after 30 minutes and are generally not due to a storage issue, but rather encoding and retrieval (discussed below) inefficiencies.

**Retrieval.** There are several ways to assess an individual’s ability to retrieve information; for example, free-recall, cued-recall, and recognition tasks. These types of retrieval vary in difficulty, thus it is beneficial to examine retrieval ability in different ways to determine the degree to which individuals can recall information (Old & Naveh-Benjamin, 2008). In the experiment by Troyer and et al. (2006) mentioned above, older and younger adults were presented with surnames and asked to recall them by writing down all names they could remember and in a recognition task. The researchers found that there was a significant difference between age groups for the recall task, with the older adults performing worse. A significant difference was not found between groups for the recognition task. Similarly, McDown (as cited in Old & Naveh-Benjamin, 2008) found that older adults performed worse than their younger counterparts on cued recall, while there was no significant difference between age groups on recognition tasks. These studies suggest that as individuals age, their ability to retrieve information without cues declines, followed by a lesser decline in retrieval with cues, and performance on recognition tasks is generally persevered throughout the aging process (Craik & Jennings, 1992).
Although there is evidence of age-related declines for encoding, storage, and retrieval, by and large, most researchers have found that the greatest decline is found for encoding abilities. Haaland, Prince, and Laure (2003) used the standardization sample from the WMS-III (\(N = 1250\)), to determine whether encoding, retrieval, or storage of verbal and spatial information was most affected by normal aging. The researchers assumed that immediate recall reflected skills of encoding and retrieval, and delayed recall reflected storage and retrieval of the information that was initially encoded. They found that immediate memory significantly deteriorated with increasing age, more so than delayed memory. Consequently, delayed memory also deteriorated, but this finding was largely explained by the poorer immediate memory. The decrease in recall between the immediate and delayed varied minimally across the age range suggesting that there is a slight deterioration in the storage process, but the deterioration in encoding and retrieval is most influential. These findings suggest that initial encoding and retrieval, rather than storage and retrieval, is the greatest change that occurs in memory with normal aging.

Two major theories have been developed to explain age-related memory decrements as a result of decreased encoding and retrieval abilities (Anderson & Craik, 2000). The first theory, Reduced Attention Resources (Anderson & Craik), hypothesizes that the amount of attentional resources available is significantly reduced as individuals age. Consequently, demanding cognitive processes such as encoding and retrieval receive less attention with aging and therefore cognitive skills such as memory decline. Anderson (1999) demonstrated reduced attentional resources by comparing memory performance and reaction time between younger and older adults. The researcher found that older adults appeared to have less attentional resources which negatively impacted memory tasks that required formation of new associations and self-initiated retrieval. A second theory, Decrease Processing Speed (Salthouse, 1994) indicates that as
individuals age, there is a significant decrease in processing speed. Therefore, older adults do not have enough time to process information and fully encode leading to decreased memory performance. A relevant study by Weible and colleagues (2002) compared younger and older adult’s memory performance for a word list by presenting the list both quickly and at a slowed rate. The researchers found that at the faster presentation rate the younger adults performed significantly better than the older participants, while performance was similar between groups for the slower presentation rate. It was concluded that older adults could perform significantly better on memory tasks if they are given additional time to encode the information.

In addition to research on age-related memory changes for immediate and delayed memory as well as processes of memory such as encoding, storage, and retrieval, the type of stimulus, verbal or nonverbal, also has an impact on age-related memory functioning.

**Verbal vs. nonverbal stimuli.** Test performance declines much more for visual tests that involve drawing than for verbal tests (Howieson et al., 1993; Koss et al., 1991). For example, Howieson et al. (1993) compared the neuropsychological results of 34 individuals aged 84-100 and 17 individuals aged 65-74 and found that the largest difference between the two age groups was a sharp decline in visual perceptual abilities for the older group. Performance on verbal measures indicated these abilities are relatively spared during the aging process. Haaland and colleagues (2003), as noted above, found similar results when analyzing visual-spatial and verbal data from the standardization sample from the WMS-III ($N = 1250$). The researchers found that the deterioration for immediate recall was greater for visual-spatial information than for verbal information, suggesting that there is a steeper decline for visual-spatial than for verbal memory.

Age related changes in performance on visual memory tasks that involve drawing are evident in the age norms for the Visual Reproduction subtests of the Wechsler Memory Scale-
Third Edition (WMS-III; Wechsler, 1997). This test requires the examinee to draw figures that vary in complexity immediately after viewing the figures and after a 25-35 minute delay. The normative data for this test ranges from 17-89 years of age and highlights the decline in performance with advancing age. For example, at ages 65-70 a raw score between 31 and 36 is needed to achieve a fiftieth percentile score. As individuals enter into their 80s, the raw scores needed to achieve a fiftieth percentile score drop significantly: 28-33 for ages 80-84; 16-21 for ages 85-89. As individuals age, their visual-graphic memory skills decline and average performance is substantially lower.

It is not possible to be certain why age-related declines in memory occur. However, given that all memory processes depend on brain anatomy and physiology, age-related changes in memory are likely intimately linked to structural and functional age-related changes that occur in the brain. Brain imaging technology has made it possible to compare younger and older adult brains, and as a result several significant changes have been found in the elderly brain. Neuroimaging studies have shown structural changes as well as increases and decreases of cerebral activation in the aging brain.

There have been two significant findings regarding cerebral activation in older adults. The first is known as Hemispheric Asymmetry Reduction in Older Adults (HAROLD; Cabeza, 2002). This effect refers to an age-related increase in bilateral activation of prefrontal activity when performing episodic, semantic, and working memory tasks. This is in contrast to young adults, who typically show lateralized activation during such tasks. Cabeza (2002) hypothesized that this change in activation is a functional compensation strategy used by the brain. Dennis, Daselaar, and Cabeza identified a second significant cerebral activation change that occurs in older adults, a reduction in occipital activity coupled with an increase in prefrontal cortex
activity (Posterior-Anterior Shift in Aging; as cited in Hayes & Cabeza, 2008). Similarly, these researchers believe this shift in activation is a compensatory action that occurs to aid in cognitive functions such as memory.

In addition to cerebral activation changes, structural changes are also found in the aging brain. Overall reduction in cerebral volume is normal. With regard to memory, Raz and Rodrigue note that the medial temporal regions show shrinkage (as cited in Hayes & Cabeza, 2008). Raz and Rodrigue also found that in adults over age 50, reductions in volume of the hippocampus and enthorhinal cortex were present, with greater atrophy in the hippocampus.

A study by Iidaka et al. (2001) suggests that the decline in visual memory abilities may be due to decreased activation in the hippocampus. They compared neural activations of young and old healthy adults while they memorized related, unrelated, and abstract pictures for a subsequent recognition task. Through the use of functional magnetic reasoning imaging (fMRI) the researchers found that older adults showed lower levels of activation throughout the brain, with the main difference in the medial temporal areas where the hippocampus is located. Older adults also performed significantly lower on the memory task than the young adults. The age related decreases in hippocampal activity parallel the declines in memory performance and may possibly account for them.

Taken together, it appears that age-related changes in the hippocampus, frontal lobes, and temporal lobes play a significant role in age-related memory changes.

Researchers have shown that there is a normal age-related decline that occurs with memory ability (Lezak, Howieson, & Loring, 2004). This decline is most evident for complex information, episodic memories, and visual-graphic information (Park et al., 2002; Old & Naveh-Benjamin, 2008; Howieson et al., 1993). Additionally, researchers have found that memory
declines are often due to inefficiency of the encoding process, rather than the storage or retrieval stages (Anderson & Craik, 2000). There also is evidence that brain changes take place in older adults, resulting in altered cerebral activation as well as shrinkage of important memory structures such as the hippocampus (Anderson & Craik, 2000; Iidaka et al., 2001).

**Neurological Diseases Affecting Memory in Elders**

Since there is normal age related cognitive decline, it can be difficult to distinguish benign decrements in function from cognitive impairment associated with underlying neurological disease. However, understanding normal declines as well as changes that occur because of a neurological disease greatly aids in making appropriate diagnoses. Although some memory loss is commonplace with the elderly, there are instances when the severity and pattern of memory loss may be evidence of Mild Cognitive Impairment (MCI) and/or dementia, such as occurs in Alzheimer’s disease (AD), or other neuropsychological disorders (Hyman & Gomez, 1998).

Although there is some disagreement, Mild Cognitive Impairment (MCI) is often considered to be a transitional stage between healthy aging and dementia (Storandt, Grant, Miller & Morris, 2002). The concept of Mild Cognitive Impairment was developed to characterize older adults who were neither cognitively normal nor demented. MCI is characterized by cognitive complaints in the presence of generally preserved daily functioning (Morris & Cummings, 2005). Amnestic MCI, in which memory deficits dominate, is most commonly thought of as the prodromal stage of AD (Storandt et. al, 2002). In fact, Fischer and researchers (2007) conducted a longitudinal study (30 months) with patients diagnosed with MCI and found that conversion rates to AD were 48.7% for those with amnestic MCI and 26.8% for those with nonamnestic
MCI. Other researchers have found conversion rates of 31% (Mitchell & Shiri-Freshki, 2008) to 64% (Geslani, Tierney, Herrmann, Szaalai, 2005).

Dementia is a syndrome characterized by multiple cognitive deficits with memory often a prominent early symptom for some types (DSM-IV-TR, 2000). The prevalence of dementia increases substantially with age. For individuals ages 65-69 between 1.4% and 1.6% experience dementia, a figure that rises to 16% to 25% for those over 85 years of age (DSM-IV-TR, 2000).

The most common forms of dementia are slowly progressive, and eventually cause severe impairment in all aspects of memory and reasoning (Whalley, 2001). Dementing syndromes often are classified as either subcortical or cortical. These terms are associated with distinctive patterns of neuropsychological and neurobehavioral findings, which greatly aid clinicians in making diagnostic decisions (Green, 2000). For example, a subcortical dementia shows characteristics of mental slowing, forgetfulness, impaired ability to manipulate acquired knowledge, motor difficulties, personality changes, and depressed mood. Prototypical diseases of subcortical dementia include Progressive Supranuclear Palsy, Parkinson’s disease and Huntington’s disease (Albert, Feldman, & Willis, 1974). In comparison, cortical dementias have characteristics of impaired acquisition, recall, and recognition of information, as well as impairment in naming, word fluency, and visuospatial functioning (Green, 2000). The prototypical disease of cortical dementias is AD (Gómez-Isla et al., 1997).

Aarsland and colleagues (2003) compared individuals who had acquired dementia from Parkinson’s disease (PD; subcortical) and AD (cortical). Their subjects were 35 patients with PD and 29 with AD an average age of 74. They completed neuropsychological testing and significant differences were found among the memory, construction, and some executive function tasks. The researchers found that patients with AD had significantly lower scores on
both verbal and nonverbal memory tests, while those with PD were significantly more impaired on initiation, perseveration, and construction tasks. These findings support the notion that there are distinct neuropsychological patterns for cortical and subcortical dementias.

Understanding the distinctive cognitive deficits of subcortical and cortical dementias is crucial for accurate diagnosis and treatment. Two cortical dementias, Frontotemporal and AD, are two of the most common dementias (Muangpaisan, 2007). As such, understanding each disorder is necessary when working with the aging population.

**Frontotemporal dementia.** Frontotemporal dementia affects language, cognition, and behavior. Neary et al. (1998) established three subtypes of FTD: frontotemporal degeneration, progressive nonfluent aphasia, and semantic aphasia. They identified symptoms and neuropsychological findings for each subtype of FTD. Frontotemporal degeneration is marked by disordered social conduct, such as impairment in social regulation, emotional blunting, and loss of insight. Additional symptoms include: decline in personal hygiene and grooming, mental rigidity and inflexibility, distractibility, dietary changes, and perseverative and stereotyped behavior. Neuropsychological findings show significant impairment on frontal lobe tests. Disorder of expressive language is the dominant feature in progressive nonfluent aphasia and may include agrammatism, phonemic paraphasia, and anomia. Individuals with progressive nonfluent aphasia typically have difficulty comprehending sentences and following conversations while understanding word meaning is often preserved. During neuropsychological testing, patients typically show nonfluent aphasia. Semantic aphasia is marked by impaired understanding of word meaning. Individuals may have fluent yet empty spontaneous speech as well as an impaired ability to name words and comprehend. Neuropsychological findings
indicate that individuals with semantic aphasia show semantic loss and failure to comprehend, while syntax, spatial skills, and day to day memorizing abilities are preserved.

**Alzheimer’s disease.** AD is one of the most common causes of dementia. One of the earliest manifestations of AD is memory impairment. Specifically, individuals with AD have impairments in recall and recognition for both verbal and nonverbal information (Rueter-Lorenz & Sylvester, 2005). Additionally, impairment in acquisition of new information remains a hallmark feature throughout the course of AD (Albert, 1998). It is important to note that mild memory difficulties are commonplace among the elderly population and therefore thorough, professional assessments are needed to determine whether memory changes are a benign decrement in abilities or are in fact a result of a neurological disease.

Alzheimer’s disease is a degenerative disorder that occurs predominantly in older adults. While memory deficits are the most common symptom of AD, especially in the early phases, other characteristics include difficulty naming objects, solving visuospatial problems, and manipulating executive functions. Attention deficits are also common in people with AD (Knowlton, 2005). Three main phases have been identified for AD (Whalley, 2001). Initially individuals experience memory impairment, poor concentration, and slight difficulties in completing everyday tasks. Memory loss is not confined to one specific type of memory deficit as individuals with AD often exhibit problems with episodic memories followed by impairments in semantic knowledge as the disease progresses (Giffard et al., 2001; Grady, 2005; Knowlton, 2005; Weingartner, Grafman, Boutelle, Kaye & Martin, 1983). In the second stage, language is typically preserved but an individual may experience delusions or hallucinations, as well as some facial weakness and abnormal foot withdrawal response indicative of frontal lobe dysfunction. Memory ability continues to decline and individuals may not recognize family members. They
frequently have difficulty expressing oneself and need extra help with hygiene and household chores. Additionally, those in the second stage of AD often become restless and wander especially during the late afternoon or evening. They may get suspicious, angry and are easily upset or agitated. Finally, language becomes severely impaired and eventually is lost completely. Individuals in the last stage may not recognize themselves or their relatives and they typically become incontinent, are unable to perform daily tasks, and often are bedridden.

Definitive diagnosis of AD is confirmed by detection of characteristic lesions in the limbic system and supported cortical areas at death. However, medical advancements have contributed to the process of diagnosing AD prior to autopsy. Specifically, markers in cerebrospinal fluid (CSF) and neuroimaging have been examined to differentiate those with and without AD. For example, researchers have found that individuals with AD have decreased amyloid-β1-42 and increased p-tau levels in their CSF. In fact, Welge and colleagues (2009) were able to identify individuals with AD with 94% accuracy by reviewing both p-tau and amyloid-β1-42 levels. Although these findings certainly contribute to AD research, it is important to note that the specificity relating to false negatives (participants with AD that were not detected by CSF markers) is uncertain. Therefore, although CSF markers aid in diagnosing AD, these tests alone are not sufficient for diagnosis. With regard to neuroimaging, researchers have found that individuals with AD show more ventricular volume than non-demented counterparts (Vemuri et. al, 2010). Increased ventricular volume can be noted throughout the AD process due to the large proportion of cortical cells that become necrotic. In fact, at death, about 30% of the cortical cells in the brain of an AD patient are necrotic, and those that survive often show decreased functioning with reduced dendritic sprouting and synaptic formations (Whalley,
2001). As with CSF markers, neuroimaging supports diagnostic decisions of AD but is not solely sufficient for a diagnosis.

AD often affects areas of the temporal and parietal lobes. The temporal lobes perform many functions such as processing auditory input, providing visual and vestibular information, manipulating memory systems, and moderating temperament (Park & Gutchess, 2005). The parietal lobes contain the sensory cortex, language, and visual association areas (Park & Gutchess, 2005; Whalley, 2001). Although these areas of the brain are responsible for many different functions, memory, visuospatial impairment, and executive dysfunction are typically the most pronounced cognitive impairments in persons with AD (Park & Gutchess, 2005). Damage to these areas would cause a person with AD to have difficulty with easy memory tasks or drawing something as simple as a clock face (both tasks are sensitive tests for early AD; Whalley, 2001). Although more than memory loss is needed for a diagnosis of AD, memory impairment may be the only significant deficit at the very earliest stages of the disease. Neuropsychological evaluations of memory are paramount as they are often the only way to distinguish normal memory declines associated with aging from abnormal memory declines indicative of neurological disease (Albert et al., 2001).

Neurological diseases that affect memory in older adults such as AD and frontotemporal dementia are diseases with distinct cognitive profiles (Green, 2000). Therefore, neuropsychological assessment is useful for identifying and distinguishing between different disorders. Memory test performance, in particular, often is crucial in this regard (Albert et al., 2001). As such, neuropsychological assessment of memory will be considered below.
Neuropsychological Assessment of Memory

As noted above, declines in memory may be due to neurological diseases or the natural aging process. Performance on neuropsychological memory assessments provides essential information for accurate diagnostic decisions. Neuropsychological memory tests are almost exclusively based on episodic memory through the use of word lists, narratives, and reconstructing pictures (Spaan, Raaijmakers, & Jonker, 2003). There are some tests that assess semantic memory (some verbal subtests from the WAIS-III; Wechsler, 1997; and Boston Naming Test; Goodglass & Kaplan, 2000) but these are typically not interpreted as memory tests (Spaan, et al., 2003). Memory tests can be subdivided based on the type of stimuli to be memorized (verbal or nonverbal), the demands of replication of the material (free recall, cued recall, or recognition), and the length of time between the initial introduction to the stimulus and reproduction (immediate recall, delayed recall).

Memory tests are most often classified by the modality in which the example stimulus is presented (verbal or visual). However, it is important to note that some nonverbal memory tests may contain stimuli susceptible to verbal encoding. Both verbal and nonverbal tests can be further classified according to the degree of complexity and the difficulty that reproduction requires. For example, a simple nonverbal test, such as the BVMT-R, contains individual geometric shapes, whereas the Rey-Osterrieth Complex Figure Test (Osterrieth, 1944; translated by Corwin & Bylsma, 1993) contains several shapes that form a complex figure. The difficulty of reproduction required is based on whether stimuli are reproduced through free recall, cued recall, or recognition. Additionally, memory tests may require recall of information immediately after the initial presentation and/or after a 20-30 minute delay.
It is the pattern of performance among these different aspects of memory (modality, stimulus complexity, and difficulty of retrieval) that aid diagnostic decisions. Researchers have found that declines in certain memory abilities are better indicators of neurological disease, particularly for AD. For example, Elias et al. (2000) conducted a longitudinal study spanning 22 years with 1,043 non-demented participants aged 65-94 at baseline. Over the years, the researchers identified 106 participants who met criteria for probable AD, and found significant differences between their test results and those of their non-demented counterparts on tests of episodic and semantic memory, specifically for tests of learning, immediate recall, and retention for narratives. Similarly, Bäckman, Small, and Fratiglioni (2000) compared individuals who developed AD (N = 15) with those who were non-demented (N = 105) three and six years prior to a dementia diagnosis. Researchers found that those with probable AD performed significantly lower on tests of free recall and recognition of word lists than their non-demented counterparts. Grober, Lipton, Hall, and Crystal (2000) conducted a similar comparison with 264 initially non-demented elderly adults over the course of 10 years. They also found significant differences in scores between those who eventually met criteria for dementia and their non-demented counterparts on tests of free recall and recognition of word lists. The research in this area predominately examines neuropsychological tests of verbal memory and suggests that such tests are useful for predicting and diagnosing neurological diseases affecting memory (Ferma et al., 2006; Linn et al., 1995; Small, Herlitz, Fratiglioni, Almkvist, & Bäckman, 1997; Spaan et al., 2003).

As evidenced above, the research examining memory declines in older adults is primarily on verbal memory tests. This may be due to the fact that many visual tests are complex and therefore may not be sensitive enough to find significant differences between normal age-related
memory declines and those due to an underlying disease process. The normal age-related changes that occur make most visual memory tests insensitive to visual memory impairment in the elderly because of the low test score ceiling. In fact, Albert et al. (2001) compared the performance of those with dementia and those without on two visual-graphic memory tests. They did not find any significant differences between the groups’ performances, but this is likely because the visual memory tests used, Visual Reproduction & Rey-Osterrieth Complex Figure, are complex and have a low test score ceiling for older adults. Visual memory tests with easier content may be more effective in detecting visual memory impairment in the elderly. In contrast to Albert’s study, Zonderman and colleagues (1995) used a simpler visual test and found that individuals aged 55-95 with dementia scored significantly lower both before diagnosis of dementia and after on the visual memory test than their non-demented counterparts. The researchers used the Benton Visual Retention (BVR; Benton, 1974) test, which although simple, is limited because it assesses only immediate recall for geometric figures, with no evaluation of delayed recall or recognition. Together, these studies indicate that simpler visual-graphic memory tests are useful in distinguishing normal from pathological memory changes in the elderly.

Given the frequent benefit of conducting serial testing to diagnose neurological disorders in the elderly, equated alternate forms are necessary as practice effects are of particular concern (Thiesen et. al, 1998). If equated alternate forms are not available and serial testing is conducted, practice effects may inflate or obscure clinically significant changes in performance.

For example, Thiesen et al. (1998) examined practice effects over four administrations of three subtests from the Wechsler Memory Scale-Revised (WMS-R). Sixty-four participants completed assessments over two-week intervals. The researchers found that over the four
administrations, participants’ performance increased significantly. In fact, at the second administration participants who initially performed in the “average” range were classified as “superior.” Similarly, Youngjohn, Larrabee, and Crook (1992) compared the initial and re-test (21 days later) performance of 115 participants on several memory measures. The researchers found that the participants scored significantly better during the second examination, suggesting that practice effects had occurred.

Another relevant study by Benedict and Zgaljardic (1998) demonstrated that alternate forms can substantially decrease the effects of practice on both verbal and nonverbal memory tests. These researchers administered the Hopkins Verbal Learning Test-Revised (HVLT-R; Benedict, Scretlet, Groninger, & Brandt, 1998) and the BVMT-R (Benedict, 1997) to 30 volunteers aged 57-82, with a mean age of 63.3. Participants were placed into two groups, an alternate-form group, and a same-form group. The participants were tested every two weeks for four sessions. The researchers found significant improvement in performance for the same-form group for both verbal and visuospatial tests. No significant difference was found for the alternate-form group for the verbal test; however there was significant improvement for the alternate-form group for visuospatial memory. Although significant, this change in scores was much smaller than that found with the same-form group on the visuospatial test indicating that alternate forms are beneficial. The researchers suggest that this latter finding may be due to learning that occurs with the process of actually taking the test (looking at six figures, strategizing how to remember them, practicing drawing, etc.) rather than learning the specific figures. Additionally, the test-retest intervals were two weeks, which may not be realistic as most serial neuropsychological examinations are conducted every 6-12 months.
As noted above, equivalent parallel forms are useful when conducting memory assessments. With older adults, parallel forms are particularly useful because sequential testing is often necessary to identify the decline of neurodegenerative diseases. If a memory test with only one form is administered repetitively, neuropsychologists may underestimate the rate of deterioration in dementia because of practice effects. Unfortunately, although equated alternate forms significantly reduce the chance of practice effects, they are not available for many of the most common neuropsychological tests (Theisen et. al, 1998).

Together, these studies indicate that simpler visual-graphic memory tests with equated alternate forms are useful for identifying pathological memory changes as well as associated progression of memory decline in the elderly. The BVMT-R is a visual-graphic memory test that not only contains simple visual stimuli, assesses immediate, delayed, and recognition memory abilities, but also has six alternate forms (Benedict, 1997). During the test, patients view a display of six figures, arranged in a 2 X 3 matrix for 10 seconds. After 10 seconds, patients recall the figures by reconstructing (drawing) them from memory. The patients are provided two additional 10 second exposures, followed by recall to assess learning over successive trials. Individuals are asked to recall the figures again 25 minutes later without any further exposure to the stimuli. Scoring is based on the respondent’s accuracy and location of drawing the figures. Following the Delayed Recall trial, the respondent completes a yes-no recognition trial.

Bennedict (1997) reported that the BVMT-R may be clinically useful in identifying visual memory impairment associated with AD. In 1996, Benedict and colleagues compared scores on the BVMT-R and the Trail Making Test (TMT) among participants who were diagnosed with dementia and normal elderly controls. There were 133 total participants: dementia of Alzheimer’s type = 41, vascular or mixed dementia = 35, and controls = 57. The
groups were matched on age and education and there were large differences between the control and dementia groups on both tests. The scores on all of the BVMT-R measures distinguished between the two groups with the exception of Response Bias.

The BVMT-R is additionally useful because there are six alternative forms that can be used in serial evaluations to prevent prior exposure confounding results. According to the manual, the six forms are equivalent; however, subjectively some forms appear to be more difficult than others. Equivalency of the forms was assessed by testing 18 college students (mean age = 19.4) on all six forms with one-week intervals, and no significant difference was found between the performance on the difference forms. Use of a young sample may be problematic for generalization to older adults as neuropsychological memory test performance of the elderly is sensitive to stimulus complexity. Therefore even subtle differences in stimulus complexity of alternate forms may render them non-equivalent for the elderly even though the forms are equivalent for younger adults. Equivalency of the forms was also examined by grouping participants into six groups (each group was tested using one of the six forms) and comparing their performances. A significant difference was not found between performances on the different forms; however, the average age of participants was 39.25 and therefore the generalizability of these results to older adults is questionable.

The BVMT-R is useful for elderly adults because it is less complex than other visual memory assessments, thus is more sensitive to genuine memory impairment in this age group. However a limitation to this test is that the equivalency of alternate forms is based on data from young adults that may not be generalizable to older populations. Assessment of equivalency of the forms is needed for older adults in order to enhance the utility of the BVMT-R. The purpose of this study is compare Form 1, which is clinically most often used, and Form 4. Form 4 was
chosen based on a literature review that revealed one study examining the utility of the BVMT-R for individuals in their 80’s (Gale et. al, 2007). The researchers used Form 4 to create norming data for older adults and the results yielded data that seemed much lower than what would be expected given the normative data in the test manual. It was hypothesized that perhaps the norms created in Gale’s and colleagues study were lower because Form 4 is more difficult for older adults. This study, in combination with subjective review of the figures on the different BVMT-R, deemed the use of Form 4 most appropriate.

Methodology

Participants

Volunteers were all Caucasian, healthy, functionally independent persons solicited from churches and senior centers in Oregon. Individuals from all ethnic backgrounds were encouraged to participate; however, due to the minimal diverse population in Oregon, sampling techniques (primarily referrals & recruitment from senior centers), and requirement for English to be the native language, all participants were Caucasian. The sample included 96 participants ranging in age from 80 to 89, of whom 27 were males and 69 were females, 28% and 72% respectively. Mean level of education was 14.78 years with a range of 10-21. English was the primary language for all subjects. Participants completed a questionnaire and interview to screen for health problems and age-related diseases (see Appendix A for questionnaire) and were excluded if they had a history or evidence of a neurological or health problem, head trauma, past or present drug/alcohol abuse, or psychiatric disorder that could interfere with their performance. Additionally, exclusion criteria included scores greater than 8 on the Geriatric Depression Scale-Short Version (Sheikh & Yesavage, 1986), and scores less than 25 on the Mini-Mental State
Examination (MMSE). Two participants were excluded due to low scores on the MMSE, and four participants discontinued the study after the first session.

The remaining 90 subjects were divided into two age groups: 80-84 \( (N = 42) \) and 85-89 \( (N = 48) \). Multiple one-way analyses of variance were conducted to evaluate the relationship between the two age groups (80-84 and 85-89) and multiple descriptive variables including: years of education, WAIS Vocabulary and Block Design scaled scores, and MMSE total raw scores. None of the ANOVAs were significant; education: \( F, (1, 88) = .679, p = .412 \); Vocabulary: \( F, (1, 88) = 1.052, p = .308 \); Block Design: \( F, (1, 88) = .218, p = .597 \); MMSE: \( F, (1, 88) = 3.651, p = .059 \) (see Table 1 for group means and standard deviations for descriptive variables).

Table 1

<table>
<thead>
<tr>
<th>Descriptive Variables</th>
<th>Ages 80-84 ( (N = 42) )</th>
<th>Ages 85-89 ( (N = 48) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education Years</td>
<td>15.00 ± 2.34</td>
<td>14.58 ± 2.43</td>
</tr>
<tr>
<td>Vocabulary Scaled Score</td>
<td>14.12 ± 2.24</td>
<td>13.56 ± 2.82</td>
</tr>
<tr>
<td>Block Design Scaled Score</td>
<td>11.90 ± 3.64</td>
<td>11.50 ± 3.56</td>
</tr>
<tr>
<td>MMSE</td>
<td>29.29 ± 0.864</td>
<td>28.85 ± 1.22</td>
</tr>
</tbody>
</table>

Procedure

Before beginning data collection, the researcher acquired Institutional Review Board approval (File Number 073-09). All participants were informed of the study and their rights as participants and signed a consent form. The volunteers were interviewed and tested at their
homes. All participants were assessed for: (1) verbal and visual-spatial intelligence with the Vocabulary and Block Design subtests of the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III) (Wechsler, 1997); (2) mental status with the Mini Mental State Exam (MMSE); (3) depression with the Geriatric Depression Rating Scale-Short Edition (Sheikh & Yesavage, 1986); (4) verbal memory with the Rey Auditory Verbal Learning Test (RAVLT) (Rey, 1964); (5) visual-graphic memory with the BVMT-R (Bennedict, 1997); and (6) executive functions with Luria’s Frontal Lobe Tests.

Participants were examined during two testing sessions, one week apart. Participants were interviewed to complete the neurological and health screening questionnaire. For participants who passed exclusion criteria, the researcher administered the following tests in order: in the first session: AVLT Trials I-VI and B, BVMT-R Trials 1-3: Form 1 or 4 were given in counterbalanced order, Block Design, Geriatric Depression Scale, AVLT Trial VII and recognition, and BVMT-R delayed recall, recognition, and copy. This battery took approximately 45 minutes. During the second session, the following tests were administered in order: BVMT-R Trials 1-3: Form 1 or 4, Vocabulary, MMSE, Luria’s Tests, BVMT-R delayed recall, recognition, and copy. This battery took approximately 35 minutes to complete.

For participants who scored less than a 25 on the MMSE, a brief letter was sent to the participant and a family member (if a family member was available) indicating that the participant’s MMSE score was somewhat low and suggesting they schedule an appointment with their primary care physician for evaluation (see Appendix B for letter).
Results

A one-way multivariate analysis of variance (MANOVA) indicated that there were no significant differences between BVMT-R form order for Form 1 \( F(1, 89) = 1.68, p = .193 \) or Form 4 \( F(1, 89) = .538, p = .586 \), suggesting that the order in which Forms 1 and 4 were given did not have a significant effect on the results of this study. Furthermore, a significant correlation was observed between BVMT-R Total Recall and Delayed Recall raw scores \( r(88) = .867, p = .000 \), suggesting these variables should be compared using multivariate analyses.

Two age groups (80-84; 85-89) were created based on previous research that indicates there is a significant difference in visual-graphic memory test performance as individuals age, especially in their 9\textsuperscript{th} decade (WMS-III; Wechsler, 1997). A Repeated Measures MANOVA was conducted to examine the equivalency between Forms 1 and 4 of the BVMT-R for each age group.

There were no significant differences between Forms 1 and 4 for BVMT-R Total and Delayed Recall raw scores for the 80-84 age group (Wilks’s \( \Lambda = .952, F(2,40) = 1.01, p = .374 \)). There were significant differences between Form 1 and 4 raw scores for ages 85-89 (Wilks’s \( \Lambda = .842, F(2,46) = 4.32, p = .019 \)). BVMT-R Total Recall raw scores were higher for Form 1 \( F(1, 47) = 8.83, p = 0.005 \), and there was a trend for higher scores for Form 1Delayed Recall raw scores \( F(1, 47) = 3.94, p = 0.053 \) (see Table 2 for group means and standard deviations for BVMT-R scores within age groups). In summary, individuals in their early 80s obtained comparable scores on Forms 1 and 4 of the BVMT-R. For participants in their late 80s, learning, and likely delayed recall, is easier for Form 1 than Form 4.

Significant differences were not found between the two age groups on performance of Form 1 Total and Delayed Recall raw scores \( F(2, 88) = 1.837, p = 0.165 \). Significant differences
were found for Form 4 (Wilks’s $\Lambda = .959$, $F(2, 88) = 4.897$, $p = 0.010$). Raw scores for individuals in their late 80s were lower for Form 4 BVMT-R Total $F$, (1, 89) = 4.53, $p = 0.036$ and Delayed Recall $F$, (1, 89) = 9.61, $p = 0.003$ than for individuals in their early 80s (see Table 3 for group means and standard deviations for BVMT-R scores between age groups). These findings further highlight the difficulty of Form 4 for individuals in their late 80s.

Table 2

*BVMT-R Form Comparisons Within Age Groups 80-84 and 85-89*

<table>
<thead>
<tr>
<th>Ages</th>
<th>Form 1 Total R. M (SD)</th>
<th>Form 4 Total R. M (SD)</th>
<th>$F$</th>
<th>$p$</th>
<th>Form 1 Delayed R. M (SD)</th>
<th>Form 4 Delayed R. M (SD)</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-84</td>
<td>16.79 (6.24)</td>
<td>16.19 (7.07)</td>
<td>.41</td>
<td>.524</td>
<td>6.57 (2.72)</td>
<td>6.86 (2.94)</td>
<td>.61</td>
<td>.439</td>
</tr>
<tr>
<td>85-89</td>
<td>15.29 (6.96)</td>
<td>12.98 (7.20)</td>
<td>8.83</td>
<td>.005</td>
<td>5.50 (3.12)</td>
<td>4.83 (3.22)</td>
<td>3.94</td>
<td>.053</td>
</tr>
</tbody>
</table>

*Note.* $R =$ recall.

Table 3

*BVMT-R Form Comparisons Between Age Groups 80-84 and 85-89*

<table>
<thead>
<tr>
<th>BVMT-R Scores</th>
<th>Ages 80-84 ($N = 42$) M</th>
<th>SD</th>
<th>Ages 85-89 ($N = 48$) M</th>
<th>SD</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total R. Form 1</td>
<td>16.79</td>
<td>6.24</td>
<td>15.29</td>
<td>6.96</td>
<td>1.13</td>
<td>.289</td>
</tr>
<tr>
<td>Delayed R. Form 1</td>
<td>6.57</td>
<td>2.72</td>
<td>5.50</td>
<td>3.12</td>
<td>2.97</td>
<td>.088</td>
</tr>
<tr>
<td>Total R. Form 4</td>
<td>16.19</td>
<td>7.07</td>
<td>12.98</td>
<td>7.20</td>
<td>4.53</td>
<td>.036</td>
</tr>
<tr>
<td>Delayed R. Form 4</td>
<td>6.86</td>
<td>2.94</td>
<td>4.83</td>
<td>3.22</td>
<td>9.61</td>
<td>.003</td>
</tr>
</tbody>
</table>

*Note.* $R =$ recall.
Discussion

The purpose of this study was to enhance the utility of the BVMT-R by assessing the equivalency of Form 1 and Form 4 for individuals aged 80-89. This is important because serial memory testing in older adults is often used to aid in diagnostic decisions. Such memory evaluations are frequently the only way to distinguish normal memory declines associated with aging from abnormal memory decline indicative of dementia, especially in the early stages (Albert et al., 2001). Reliably making this distinction is clinically important to identify patients that need treatment, and help patients and families understand and cope if a neurological disease is diagnosed. The BVMT-R is particularly useful for elderly adults because it is less complex than other visual memory tests and thus is more sensitive for genuine memory impairment in this age group. The BVMT-R also has alternate forms which reduces the likelihood of practice effects during serial neuropsychological testing. However, a limitation of the BVMT-R is that the norms only extend to age 79. Given this age restriction, form equivalency for older adults has not been previously assessed.

The results of the current study demonstrate the importance of visual memory test data that are specific for individuals in their 80s. The BVMT-R test manual (Bennedict, 1997) indicates that all alternate forms are equivalent; however, based on the results of this study, it is clear that the sample’s scores used to assess equivalency in the test manual cannot be generalized to adults in their late 80s. Bennedict et al. (1996) assessed equivalency by conducting a “between subjects” design using the results from the 600 participants to create norming data for the revised version. The average age of the 600 participants was 39.25, more than ten years before normal age-related memory declines typically begin. The researchers also assessed 18 college students in a “within subjects” design and found no significant differences between forms. Given that test
performance of the elderly is sensitive to stimulus complexity, use of a young norming sample may be problematic for generalization. Even subtle differences in stimulus complexity of alternate forms may render them non-equivalent for the elderly even though the forms are equivalent for younger adults.

The results of the current study indicate that Form 1 and Form 4 of the BVMT-R are equivalent for individuals in their early 80s. However, for patients in their late 80s, learning across trials is significantly more difficult on Form 1 than Form 4. There is also a trend for Form 4 to be more difficult than Form 1 with delayed recall. Furthermore, individuals in both age groups (80-84 and 85-89) performed similarly on Total and Delayed Recall for Form 1, but the younger age group performed significantly better on both Total and Delayed Recall for Form 4 than their older counterparts. This finding further highlights the increased complexity of Form 4 relative to Form 1 for adults in their late 80s. No significant differences were found between the two age groups regarding education, verbal and visual-spatial intelligence, and cognitive mental status, suggesting that lower performances found on Form 4 are likely due to age-related declines. This finding is in concert with other research suggesting that normal, age-related visuospatial memory declines are marked throughout the 9th decade (WMS-III; Wechsler, 1997).

To the knowledge of this researcher, there have been no other studies examining the equivalency of BVMT-R forms with older adults. However, Gale, Baxter, Connor, Herring, and Comer (2007) assessed 57 older adults using Form 4 of the BVMT-R to obtain norming data. The scores obtained from participants in this study using Form 4 are lower than what would be expected given those published in the BVMT-R test manual (norms are a conglomerate of all six forms) for the same age group, 70-79. For example, the average Total Recall score for participants aged 70-79 in Gale’s study was 16.05 whereas the average score at the 50th
percentile in the test manual is 20. Similarly, the participants in Gale’s study averaged a raw score of 6.75 for Delayed Recall while the 50th percentile in the test manual is 8. These differences in normative scores for the same age group raise the possibility that the subjects in Gale’s study and the normative sample are different in some important ways. The average education for participants in Gale’s study was 15.48 years while the average education for subjects in the normative sample was 13.46 years. Based on this information, one would expect that participants in Gale’s study might perform better on the BVMT-R due to the higher education level; however, this was not the case suggesting that there is likely some other difference between the two samples. Likewise, the subjects in the current study had an average education of 14.79, somewhat higher than that of the BVMT-R normative sample. However, participants in the current study performed similarly to those in Gale’s study: Gale = Total Recall (14.6), Delayed Recall (6.4); Current study = Total Recall (14.58), Delayed Recall (5.85). The average Vocabulary scaled score (WAIS-III) was also comparable between Gale’s participants (13.4) and those in the current study (14.79.) Thus, differences in participant education does not appear to account for the differences in performance between Gale’s study, norms in BVMT-R manual, and the present study.

As noted above, serial assessments are often valuable when evaluating older adults to monitor the patient’s course and clarify diagnosis. The BVMT-R is useful because the six alternate forms available decrease the likelihood of practice effects. However, based on the results of this study, examiners must use caution when using alternate forms with patients in their late 80s. Given this study’s findings, for adults aged 85-89, a lower performance on Form 4 than Form 1 may not be indicative of decreased memory abilities, but rather reflects the increased complexity of Form 4. The other four BVMT-R forms (2, 3, 5 and 6) were not analyzed and
future research studies should compare the equivalency of these forms for older adults given the frequency of serial testing that occurs with this population. To the knowledge of this researcher, there are no studies that have utilized these forms with older adults (other than the BVMT-R normative sample) and therefore it is unclear if similar differences found in this study would arise. Subjectively, Forms 2, 3, 5 and 6 appear to contain figures that are less easily verbally mediated and thus more difficult to encode compare to Form 1.

An important consideration of the findings of this study is related to the high cognitive functioning of the study participants. The average education for the sample was 14.78, and WAIS III Vocabulary Scaled Score average was 13.82. These variables indicate that in addition to subjects being healthy, they were also higher functioning than the average population. This may be why no significant differences were found between Forms 1 and 4 for adults in their early 80s. It is possible that higher functioning subjects aged 80-84 were able to obtain similar raw scores on Form 1 and 4 due to overall above average cognitive ability. Another possibility is that by the late 80’s, age is a more powerful influence than above average cognitive ability and consequently, age effects result in lower performance on the more difficult Form 4. Given these theoretical explanations of the results, future studies should utilize a large sample that better depicts the average aging population (i.e. average education and IQ). Additionally, the sample should consist of diverse ethnicities, as a significant limitation to this study was the all Caucasian sample. Finally, it may be beneficial to examine the equivalency of all six BVMT-R forms to ensure meaningful results for older adults, particularly those in their late 80’s.
APPENDIX A

Neurological and Health Screening Questionnaire

1. Demographics

ID Number:_____________ Date of Questionnaire: _____________
Age: ______ Gender:   M     F   Marital Status: __________ Education: _________
Current or retired from occupation: ____________________

2. Is the volunteer a native English speaker?  YES  NO
   (The criteria are exclusionary as the tests given are designed, standardized, and valid
   measures only for English native speakers.)

3. Screening Questions:
   Do any of the following apply to the volunteer, circle either “Yes” or “No.” Obtain
   details of any yes answers.

Psychiatric History
Any psychiatric hospitalizations: YES  NO
Has the subject received outpatient psychotherapy: YES  NO
Has the subject taken psychotropic medications: YES  NO
Has the subject experienced substance abuse or dependency: YES  NO

Neurological/Medical
Has the subject experienced neurological or other medical problems: YES  NO
Hospitalizations: YES  NO
Stroke: YES  NO
Head Trauma/Concussion YES  NO
Respiratory Problems: YES  NO
Gastrointestinal Problems: YES  NO
Vascular Problems: YES  NO
Endocrine Problems: YES  NO
Liver Problems YES  NO
Kidney Problems YES  NO
Diabetes: YES  NO
Cardiac Problems: YES  NO
Hypoglycemia: YES  NO
Anoxia/Hypoxia (insufficient or no oxygen supply to the brain): YES  NO
Toxic Exposure: YES  NO
Hypertension: YES  NO
Surgery: YES  NO
Injuries: YES  NO
Post-Traumatic Amnesia: YES  NO
Seizure Disorder:  YES  NO
Multiple Sclerosis:  YES  NO
List Medications

4.  Current Medical Diagnoses
(Indicate date of onset and treatment)

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
APPENDIX B

Letter to Participants with Low MMSE Score

DATE_______

Dear Participant and/or Family Members,

Your test score on a test used to measure general cognitive functioning was somewhat lower than what is typically expected for individuals your age. To make sure there are no medical problems that need attention, it is my suggestion you schedule an appointment to follow up with your doctor.

MMSE Score__________

Sincerely,

Jessica Powell, M.S.
Pacific University
Doctoral Candidate


Geriatric Cognitive Disorders, 19, 383-389.


