The Relationship between Verbal “Intelligence,” Age, and Verbal Memory in Healthy Individuals in Their Eighties

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The Relationship between Verbal “Intelligence,” Age, and Verbal Memory in Healthy Individuals in Their Eighties

Abstract
Verbal intelligence has been shown to affect performance on verbal memory tests for healthy young adults. However, it is not clear that the association between verbal intelligence and memory is the same for healthy older adults because, while performance on verbal intelligence measures remains relatively stable in older age, there is significant normal age-related memory decline. In fact, the magnitude of age-related decline in verbal memory performance is so substantial that there may be a significant difference between the memory performance of individuals in their early (i.e. 80 to 84) versus late (i.e. 85 to 89) eighties. This raises the possibility of an interactive effect between verbal intelligence and age on verbal memory for individuals in their 9th decade. The purpose of this study was to examine the effect of verbal intelligence and age on verbal memory test performance in the elderly. One hundred thirty-nine healthy participants aged 80-89 were divided into four groups based on Wechsler Adult Intelligence Scale – III (WAIS-III) Vocabulary scaled score: average/below average (< 11) and above average (> 12); and age: early 80's (80 to 84) and late 80's (85 to 89). The groups were compared on Rey Auditory Verbal Learning Test (RAVLT) total and delayed recall scores. Results from two-way ANOVA indicated a significant interaction effect between age and Vocabulary score for the RAVLT total score. ANOVA pairwise comparisons revealed a between groups difference that is inconsistent with the established presence of age-related memory decline that yields the current data invalid and ungeneralizable: for individuals in the average and below intelligence group, the younger age group performed worse than the older age group. Two-way ANOVA results indicated no interaction or main effects for age or Vocabulary score on RAVLT delay score. Other significant and marginal findings are discussed which argue for further research on the use of different norms for people aged 80-84 and 85-89, though no finding on the applicability of the IQ – memory relationship can be discussed due to selection bias.

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THE RELATIONSHIP BETWEEN VERBAL “INTELLIGENCE,” AGE, AND VERBAL MEMORY IN HEALTHY INDIVIDUALS IN THEIR EIGHTIES

A DISSERTATION
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Abstract

Verbal intelligence has been shown to affect performance on verbal memory tests for healthy young adults. However, it is not clear that the association between verbal intelligence and memory is the same for healthy older adults because, while performance on verbal intelligence measures remains relatively stable in older age, there is significant normal age-related memory decline. In fact, the magnitude of age-related decline in verbal memory performance is so substantial that there may be a significant difference between the memory performance of individuals in their early (i.e. 80 to 84) versus late (i.e. 85 to 89) eighties. This raises the possibility of an interactive effect between verbal intelligence and age on verbal memory for individuals in their 9th decade. The purpose of this study was to examine the effect of verbal intelligence and age on verbal memory test performance in the elderly.

One hundred thirty-nine healthy participants aged 80-89 were divided into four groups based on Wechsler Adult Intelligence Scale – III (WAIS-III) Vocabulary scaled score: average/below average (< 11) and above average (≥ 12); and age: early 80’s (80 to 84) and late 80’s (85 to 89). The groups were compared on Rey Auditory Verbal Learning Test (RAVLT) total and delayed recall scores. Results from two-way ANOVA indicated a significant interaction effect between age and Vocabulary score for the RAVLT total score. ANOVA pairwise comparisons revealed a between groups difference that is inconsistent with the established presence of age-related memory decline that yields the current data invalid and ungeneralizable: for individuals in the average and below intelligence group, the younger age group performed worse than the older age group. Two-way ANOVA results indicated no interaction or main effects for age or Vocabulary score on RAVLT delay score. Other significant and marginal findings are discussed which argue for further research on the use of
different norms for people aged 80-84 and 85-89, though no finding on the applicability of the IQ – memory relationship can be discussed due to selection bias.

Key Words: Rey Auditory-Verbal Learning Test; Verbal Memory; Verbal Intelligence; Geriatrics; Assessment
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Introduction

As individuals age, they experience normal declines in cognitive functioning (Howieson, Holm, Kaye, Oken, & Howieson, 1993; Lezak, Howieson, & Loring, 2004; Salthouse & Ferrer-Caja, 2003; Van Hooren et al., 2007). However, not all cognitive abilities decline to the same degree, with some showing substantial decrease and others showing little. For instance, substantial decline in memory functioning begins between ages 50 and 60 and accelerates as people enter their 80’s (Albert, Duffy, & Naeser, 1987; Hertzog & Schaie, 1988; Hochanadal & Kaplan, 1984; Rabbitt, 1990), while performance on verbal intelligence tests remains stable until approximately age 90 (Schaie, 1996; Singer, Verhaegen, Ghisletta, Lindenberger, & Baltes, 2003). Normal age-related memory decline is important in clinical neuropsychology because memory impairment is an early symptom of many neuropathological conditions common in old age (Hyman & Gomez-Isla, 1998). In particular, memory deficits are among the first detectable symptoms of many neurodegenerative conditions. Consequently, neuropsychological assessment is often part of the evaluation to initially diagnose these diseases. It is essential that clinicians are able to reliably distinguish normal age-related memory decline from pathological memory change in order to accurately diagnose neurodegenerative conditions of old age. Establishing what constitutes normal memory performance in the elderly is the first step to reliably distinguishing normal age-related change from pathological memory change.

Various types of normative information are helpful in establishing normal memory performance for the elderly. Using age-based norms are a minimum requirement when evaluating an elderly individual’s memory test performance. Many individuals referred for neuropsychological evaluation are in their 80’s. Given the rapid decline of memory in this
cohort, it is important to determine if there is a substantial decline in memory functioning for healthy individuals in their late eighties (85 to 89 years) versus early (80 to 84 years) eighties.

In addition, research has shown the significant influence of intelligence on neuropsychological test performance in general (Bell & Roper, 1998; Dodrill, 1999; Tremont, Hoffman, Scott, & Adams, 1998), and memory in particular (Hawkins & Tulsky, 2001; Rapport et al., 1995), for younger adults. While this raises the possibility that intelligence has a significant influence on memory test performance in the elderly as well, the association is less clear. Although performance on verbal intelligence measures declines only slightly with age (Schaie, 1996; Singer et al., 2003), verbal memory test performance declines substantially starting as early as age 39 (Economou, 2009; Ebert & Anderson, 2009; Mitrushina, Boone, Razani, & D’Elia, 2005; Van der Elst, Van Boxtel, Van Breukelen, & Jolles, 2005; Van der Linden, Philipott, & Heinen, 1997). The different developmental trajectories of verbal “intelligence” and verbal memory suggest the possibility that the verbal intelligence – verbal memory associations that are true for younger adults may not be so for older adults. Thus, clarifying the influence of verbal intelligence on verbal memory test performance for individuals in their 80s will also aid in reliably distinguishing normal age-related change from pathological memory change.

The purpose of the current study was to examine the relationship between verbal intelligence as measured by the Vocabulary subtest of Wechsler Adult Intelligence Scale, 3rd Edition, (Wechsler, 1997a), age, and verbal memory as measured by the Rey Auditory Verbal Learning Test (RAVLT; Rey, 1958) Total and Delay trial scores in a population aged 80 to 89 years. To provide context for the themes and research being discussed, the
following pages will review literature on several important related topics. First, a
neuropsychological model of memory will be presented. Second, the effect of age on the
different components of memory will be discussed, utilizing experimental and then clinical
research studies. Third, literature that examines the impact of intelligence on
neuropsychological test performance will be introduced, with particular attention to the effect
of intelligence on memory. Fourth, limitations that prevent generalizing the results of much
of the current literature to populations in their eighties will be discussed. Lastly, the clinical
importance of determining the relationship between verbal memory, age, and verbal
intelligence will be presented.
A Neuropsychological Model of Memory

Memory was once thought to be a unitary ability (Heilman & Valenstein, 2003), but the study of memory has evolved to the current view of memory as a multi-faceted construct. Memory is often differentiated between short-term and long-term functions. Short-term memory, also called complex attention and/or working memory, refers to information that is held in active consciousness or awareness for a period of time while it is processed. Long-term memory refers to storage of information for later retrieval and use (Matlin, 2005).

**Short-term memory.** Short-term memory is an active cognitive process in which information is held in conscious awareness for a period of time so that an individual may use it to accomplish the cognitive task at hand. Short-term memory cannot hold information indefinitely. If rehearsal or use of the information is prevented an individual will forget the information after a brief delay, usually 30 to 60 seconds (Atkinson & Shiffrin, 1968; Peterson & Peterson, 1959).

Baddely (1986) proposed that within short-term memory there are four distinct processes involved in transferring information to and retrieving information from long-term memory: 1) the phonological loop, 2) the visuospatial sketchpad, 3) the episodic buffer, and 4) the central executive. The phonological loop holds a limited number of sounds for a short period of time. It allows an individual to take in and hold verbal information and is mediated by word length and word complexity. Information may then be transferred from the phonological loop to long-term verbal memory. Similar to the phonological loop, the visuospatial sketchpad can hold only a limited amount of information. The sketchpad processes visual and spatial information, as well as visual information encoded from verbal
stimuli (Baddely, 1999). This latter type of memory often occurs when a person visualizes a scene while being told a verbal narrative. Information then may be transferred from the visuospatial sketchpad to visual long-term memory.

The episodic buffer serves as an intermediate process where information from the phonological loop, the visuospatial sketchpad, and long-term memory are combined. According to Baddely (2000), the episodic buffer is active and allows us to interpret our experiences, solve new problems, or plan future activities. Just as the other components of working memory have finite capacity for the amount of information that can be processed, the episodic buffer also has limited processing capacity.

The final (and arguably most important) component of short-term memory is the central executive. Instead of integrating information from the other parts of working memory as the episodic buffer does, the central executive coordinates information and determines which processes of the system are necessary to complete a given task. The central executive is limited in the number of tasks it can complete at any given time, and it cannot work effectively on two tasks simultaneously. Together, these four aspects of short-term memory allow us to attend to and utilize information in our environment for a brief duration of time.

**Long-term memory.** Long-term memory, sometimes called delayed memory, is the process by which information and experiences gathered over a lifetime are stored. Several cognitive models have examined and identified distinct types of long-term memory. These types include episodic memory, semantic memory, and procedural memory (Hoerl, 2001; Tulving, 1999). Episodic memory involves memories of events (or *episodes*) that have happened in a person’s lifetime. It allows individuals to subjectively re-experience previous episodes of time or events that occurred in their life. Semantic memory involves generalized
knowledge unrelated to memory of a specific event. It includes concept-based information, factual information, and general knowledge about the world. Procedural memory refers to knowledge of how to perform a sequenced task, such as how to complete a complex arithmetic problem or ride a bicycle.

Three cognitive processes that are important to long-term memory are encoding, consolidation, and retrieval. Encoding affects long-term memory and refers to the initial acquisition of information (Buckner, 2000). Consolidation is the process by which information is transformed into memory and may also be referred to as storage. Retrieval refers to locating and accessing stored information (Neath & Suprenant, 2005).

Memory and Aging

It is common knowledge that as people age cognitive abilities decline (Howieson et al., 1993; Lezak et al., 2004). Memory in particular is an important cognitive function that shows normal age-related decline as early as age 50 to 60 (Albert et al., 1987; Davis et al., 2003; Hertzog & Schaie, 1988; Hochandal & Kaplan, 1984). As discussed above, memory is a multi-faceted and complex ability, comprised of many components. These components are affected differently by declines associated with aging; some are impacted significantly while others evidence only mild decline. The following section will review experimental research studies on the impact of age on the different components of memory, as well as visual-graphic and auditory-verbal memory ability. Last, research related to age-related declines on clinical memory tests and other measures of cognitive ability will be discussed.

Short-term Memory. Multiple research studies have examined the impact of age on short-term memory. Bopp and Verhaegen (2005) conducted a meta-analysis of 123 such studies. Results indicated age differences are present in all stages of memory, including
short-term memory. Their findings indicated differences in immediate recall ability for younger and older adults, noting that on tasks of short-term memory span older adults lose a constant linear proportion of items when compared with younger adults. For example, on a simple immediate recall (e.g., listening to and immediately recall of a numeric string), older adults were able to recall about 90% as much as young adults. When the complexity of the task increased (e.g., recalling the numeric string in reverse order), older adults lost approximately 75% of the information that younger adults were able to retain. The results of Bopp and Verhaegen’s (2005) meta-analytic study indicated the presence of age-related decline on short-term memory performance that is more pronounced with increased task complexity.

**Long-term Memory.** Davis and colleagues (2003) research showed age-related decline in long-term memory in a normal population. Their sample consisted of four age-stratified groups: 30 to 45, 46 to 60, 61 to 75, and 76 to 90. A verbal memory task was administered and recall was assessed at 20 minutes and one day after presentation. At both recall conditions participants in the two eldest age groups had significantly lower levels of recall than did the two younger groups. There was also another significant decrease in recall ability at the one day condition when compared to the 20 minute condition. This suggests that declines in long-term memory are evident in the early 60’s and that further decline occurs with longer latency between presentation and recall of information.

Further research indicates that age-related decline in long-term memory is more prominent when task complexity increases. Stephens and Kaufman (2009) researched the impact of task complexity on long-term recall in a relatively small sample of 24 people split evenly into two age groups: 18 to 26 and 44 to 79. They administered digit symbol tasks in a
simple (i.e., symbols arranged in an ordered numerical sequence) and complex (i.e., symbols arranged randomly) paradigms. After 25 minutes, recall of the order of the symbols was prompted. While participants in the younger group did not show a difference in performance across the two conditions, the older group performed worse in the complex condition. This finding suggests that age-related decline is increasingly evident on more complex or cognitively demanding tasks.

**Episodic, Semantic, and Procedural Memory.** As discussed earlier, episodic memory, semantic memory, and procedural memory are all forms of long-term memory (Hoerl, 2001; Tulving, 1999). These different types of memory are also sensitive to normal age-related decline, but to different degrees. For example, Mitchell (1989) assessed episodic and procedural memory in a group of 96 adults, stratified into two age groups (young: ages 18 to 34, and old: ages 57 to 83). The researchers presented a series of pictures to the participants, asking them to say the first word that came to mind for each image. Episodic memory was assessed via recognition recall of the pictures. For procedural memory, the original pictures and a new set of images were presented several times with the same instructions (each time with the original pictures and a new set). The length of time (i.e., response latency) it took for participants to respond with a word to the original pictures versus new pictures was the measure of procedural memory. The results revealed that the older group performed significantly worse than the younger group on recognition. However, there was no significant difference in the response latency of the two groups for their response to the original pictures, indicating no age-related decline in procedural memory as defined in this study. The authors concluded episodic memory is impacted by age while procedural memory is not.
Spaniol, David, and Voss (2006) researched the differential impact of age on semantic and episodic memory in a group of 48 participants split evenly into two groups: (young: 18 to 22 years, and old: 66 to 84 years). Episodic memory was assessed via recognition of previously presented printed words. Semantic memory, or general world knowledge, was assessed by having participants view words and state whether the word was a “living” or “non-living” entity. Results indicated that the older individuals were significantly less accurate in both the episodic and semantic memory conditions, with a greater degree of decline in the episodic task. Other researchers have found congruent findings. Piolino, Desgranges, Benali, and Eustache (2002) studied age-related differences in semantic and episodic autobiographical memory in a sample of 52 subjects, aged 40 to 79, divided into four age groups. Participants completed two autobiographical questionnaires, one involving the recall of semantic events (recall of general information) and the other episodic events (recall of specific events that occurred in their life). Results revealed episodic recall deteriorated more with age than semantic recall.

This body of research indicates that age has a differential impact on episodic, semantic, and procedural long-term memory. Episodic memory is most affected by age-related decline, semantic memory is affected to a lesser degree, and procedural memory is the least affected (Mitchell, 1989; Piolino et al., 2002; Spaniol et al., 2006).

**Encoding.** Encoding ability has been shown to decline significantly with age (Troyer, Häflinger, Cadieux, & Craik, 2006). To assess the impact of age on intentional encoding, Troyer and colleagues (2006) compared performance on intentional learning of 32 randomly selected surnames for 40 normal participants divided into young (mean age = 21.3) and old (mean age = 72.2) age groups. Participants viewed surnames at a rate of one every
five seconds and were instructed at the time they were presented to remember designated names. After a 20 second distractor task, free and recognition recall of the surnames was assessed. Younger participants performed significantly better for both recall and recognition of the names compared to the older group.

To assess encoding ability as it related to task complexity and age Lindenberger, Marsiske, and Baltes (2000) examined age-related differences in the ability to encode information while engaging in a motor task. Forty-five middle-aged (40 to 50), and 48 older (60 to 70) adults were presented an auditory 16-word list while walking, sitting, or standing. Afterward, participants had to recall the list in forward serial order. Results revealed the older age group performed significantly worse on immediate recall, indicating age-related decline in encoding. This finding was evident only for the motorically more complex walking condition and not the sitting or standing conditions. Older individuals also showed a slower pace of walking while engaging in the task. This research suggests that the more complex the demands during encoding, the greater the decrease in efficiency of encoding with age.

**Consolidation.** Research regarding the impact of age on consolidation (or storage) indicates that normal age-related decline is dependent on the length of time between encoding and retrieval. Park, Smith, Morrell, Puglisi, and Dudley (1990) examined how time affected retrieval of information in young and old participants. Ninety-six younger adults (mean age = 18.64) and 73 older adults (mean age = 70.79) viewed a series of line drawings and then completed recognition tests three minutes, 48 hours, one week, two weeks, and four weeks later. No age-related differences were found for the three-minute and 48-hour recognition tasks, but the older group remembered significantly less at all weekly intervals.
This indicates an age-related decline in efficiency of consolidation as time increases.

However, it is important to note that clinical memory tests use delays that are 20 to 30 minutes in length, and the norms for these measures show age-related decline in performance for immediate recall, delayed recall, and recognition memory (Lezak et al., 2004, passim). One possible reason for this difference is the relatively easy test paradigm (recognition of pictured objects) used by Park and colleagues compared to the more complex paradigms of clinical memory tests that require unprompted recall of more complex information.

**Retrieval.** There are different ways in which memory retrieval is assessed clinically. Free recall refers to a person’s ability to repeat or reproduce previously presented information upon request. Cued recall involves the presentation of hints to aid in recall of information. Recognition refers to a person’s ability to identify target stimuli and foils, usually one item at a time. Research suggests there are differences in the degree of normal age-related decline for free recall, cued recall, and recognition.

A study by Sauzeon, N'Kaoua, Lespinet, Guillem, and Claverie (2000) found age-related differences in free and cued recall performance. A series of memory and recall tasks were administered to an age-stratified sample (young = 20 to 39 years, middle-old = 50 to 69 years, and old = 70 to 89 years). Results revealed that both the middle-old and old group had significantly lower performance than the young group on free recall tasks, though no significant differences was noted between the middle-old and old groups. While there was a negative relationship between age and cued recall the differences between age groups were not significant. These results suggest that age-related decline in free recall of memory is present as early as age 50. Additionally, there is a trend towards cued recall decline with age.

Kemps and Newson (2006) assessed the impact of age on visual and verbal memory
tasks. In a sample of 96 participants aged 18 to 93 years who were administered recall and recognition measures, the authors found significant age-related declines in both free recall and recognition performance. However, a steeper decline was present in recall tasks, with recall showing a more precipitous decline after the age of 85.

These findings indicate that memory retrieval is impacted by normal age-related declines. However, the manner in which memory retrieval is assessed may yield different results. The literature discussed indicates that free recall is impacted most by age, while cued recall and recognition are less affected.

**Auditory-Verbal and Visual-Graphic Memory.** Research is variable on age-related memory decline in auditory-verbal and visual-graphic domains. While there is consensus that both domains decline with age (Lezak et al., 2004; Park et al., 2002), some literature suggests there is a different trajectory of decline with visual-graphic memory being affected more by age than auditory-verbal memory (Hale et al., 2011). However, a large body of work has found that both forms of memory decline at the same rate (Kemps & Newson, 2006; Park et al., 2002; Salthouse, 1995).

A recent study by Hale et al. (2011) examined the rate of age-related decline for both visual-graphic and “verbal” memory. Participants were 388 adults, ranging in age from 20 to 89 who were administered simple and complex working memory tasks of both visual-verbal (i.e., “verbal memory”) and visual-graphic (i.e., “spatial memory”) material. Simple tasks included short visual-verbal and visual-graphic tests in which participants were instructed to read or view items on a screen then recall them immediately, either verbally for visual-verbal information or by drawing for visual-graphic information. Complex tasks involved presentation of a variant of a simple task, followed by a more complex visual-verbal or
visual-graphic task that required participants to view items on a screen then quickly make a decision about the item, prior to recalling the initial simple task. Results indicated significantly greater age-related short-term memory decline on visual-graphic tasks than visual-verbal tasks. Of note, in this study the visual-graphic stimuli presented were novel, non-familiar designs and therefore verbal mediation could not be utilized as a memory technique.

In contrast, research by Kemps and Newson (2006) examined the impact of age on “verbal” and “visuo-spatial” memory in participants who were administered recall and recognition measures. “Verbal” memory was assessed by asking the participants to learn the names of four people presented in photographs over a series of trials. They were asked to recall the names immediately and after a delay. Visuo-spatial memory was assessed by showing the participants four simple black and white line drawings and asking them to draw the designs immediately after all had been presented. Visuo-spatial recognition was assessed by asking the participants to identify previously presented photographs of doors when they were presented alongside distractors. Both verbal and visuo-spatial memory test performance declined with age and there was no significant difference in their rate of decline. A caveat to this study is that, similar to Hale and colleague’s research (2011), verbal memory was assessed with presentation of visual stimuli coupled with a verbal learning component. Therefore, visual-graphic memory could have been used in mediating “verbal” memory.

Further evidence of commensurate age-related memory decline in “verbal” and visual-graphic memory domains was found by Park and colleagues (2002) who administered a series of memory tests to a group of 345 people, ages 20 to 92. Short-term memory for verbal information was assessed with forward and backward recall of digit strings presented
auditory, while short-term “visuospatial” memory was assessed with a spatial span task. Long-term verbal memory was assessed with free and cued recall of 32 words which were presented visually. Long-term visual-graphic memory was assessed by presenting novel line drawings and asking the participants to recall them immediately and after a delay. Both “verbal” and “visuospatial” short-term and long-term memory performance showed age-related decline compared to the younger participants and there was no difference in the degree of age-related decline for verbal versus visuospatial tasks. As with the other studies discussed, the long-term measure of “verbal” memory involved a visual component which may have allowed for visual-graphic mediation of the information.

Cumulatively, these findings indicate normal age-related decline in both auditory-verbal and visual-graphic memory domains. The majority of this research suggests that the two domains share a common trajectory of decline. Yet the contradictory findings also indicate the difficulty of differentiating auditory-verbal and visual-graphic memory. It is possible that the measures used to assess these abilities are not of equal difficulty and differences in age-related decline for these two types of memory likely depend on how each is assessed. Also, the studies discussed reported measuring verbal memory, though the test stimuli involved a visual-graphic component (i.e., reading, photographs; Hale et al., 2011; Kemps & Newson, 2006; Park et al., 2002). These tests are then not true measures of verbal memory since recall of recognition of the stimuli could be mediated by visual-graphic memory.

To summarize, experimental studies suggest that in older populations memory declines occur in multiple memory domains. Review of the literature indicated normal age-related declines in the areas of short-term and long-term memory, encoding, consolidation,
retrieval, and both visual-graphic and auditory-verbal memory (Bopp & Verhaegen, 2005; Davis et al., 2003; Hale et al., 2011; Kemps & Newson, 2006; Sauzeon et al., 2000; Troyer et al., 2006). Within the domain of long-term memory, episodic memory is most affected by age-related decline, semantic memory is affected to a lesser degree, and procedural memory is the least affected (Mitchell et al., 1989; Piolino et al., 2002; Spaniol et al., 2006). Retrieval abilities also showed differential age-related decline, with free recall impacted most by age, while cued recall and recognition are less affected (Kemps & Newson, 2006; Sauzeon et al., 2000). Additionally, the effect of increased task complexity was shown to result in greater age-related declines in the areas of short-term memory (Bopp & Verhaegen, 2005), long-term memory (Stephens & Kaufman, 2009), and encoding (Lindenberger et al., 2000).

**Age and Clinical Verbal Memory Tests.** Although there is some variability in the findings regarding the effect of age on different aspects of memory when experimental tests are used, age-related declines are consistently found on clinical memory tests. The influence of age has been shown on multiple measures of verbal memory, including verbal list learning and story memory tasks which measure multiple memory components. Research by Ebert & Anderson (2009) involving the administration of the California Verbal Learning Test (CVLT; Delis, Kaplan, Kramer, & Ober, 1987)) to 86 participants aged 18 to 90, revealed significant decline for those aged 65 or older on learning ability, short-term and long-term free recall, short-term and long-term cued recall, and recognition. Another study by Van der Linden and colleagues (1997) also examined the impact of age on the CVLT. Data from 72 healthy participants, aged 20 to 80, indicated that aging affects multiple trials of the CVLT starting at the ages of 60 to 69 and became more prominent in those aged 70 years or more. The Logical Memory subtest of the Wechsler Memory Scale series (Wechsler, 1945; 1987;
Economou (2009) examined the impact of age on Logical Memory in a group of 322 participants, aged 47 to 88 years. They found that age had a significant impact on learning, and short-term and long-term recall of information.

The Rey Auditory Verbal Learning Test (RAVLT; Rey, 1958) is a widely used measure of word-list learning on which normal age-related decline has been shown to have a significant impact. The influence of age on RAVLT performance is suggested to be more pronounced than the effect of other significant demographic variables, such as education or gender (Mitrushina et al., 2005; Strauss, Sherman, & Spreen, 2006; Van der Elst et al., 2005). Mitrushina et al. (2005) performed a meta-analysis on the influence of demographic variables on RAVLT performance, including data from 8 studies (1,910 participants) collected between the years 1988 to 2003. The cumulative age range of these studies ranged from 20 to 79. The results revealed that age had a consistent linear relationship with lower performance on all trials of the RAVLT. Van der Elst and colleagues (2005) found similar results in a study where they administered the RAVLT to a large group of 1855 healthy participants, aged 24 to 81 years old. They found that RAVLT performance consistently decreased with age, starting as early as age 39.

Research on the impact of age on clinical verbal memory test performance shows consistent age-related declines in all areas of memory performance (Ebert & Anderson, 2009; Mitrushina et al., 2005; Van der Linden et al., 1997). However, less research has focused on differences in memory performance within older age groups. An area that needs further study is whether or not there are significant age changes within the eighties; i.e., are there significant changes in memory ability between people aged 80 to 84 and 85 to 89. This area of research is especially important for understanding cognitive abilities in older populations,
and the current study focuses on these age groups and verbal memory as measured by the RAVLT.

**Aging and Other Cognitive Abilities.** While the research discussed thus far has focused specifically on age-related memory decline, it is well-established that other areas of cognitive functioning also decline with advancing adult age, even among healthy individuals (Howieson et al., 1993; Lezak et al., 2004; Salthouse & Ferrer-Caja, 2004; Van Hooren et al., 2007). Van Hooren and colleagues (2007) administered a battery of processing speed and executive functioning tests to 578 healthy participants, aged 64 to 81 years old. Even within this restricted age range, there was a significant age-related decline in performance on all tasks. Salthouse and Ferrer-Caja (2004) conducted research on the impact of age on multiple cognitive abilities, administering a large battery that included measures of visual-spatial, executive functioning, and processing speed abilities. Their sample consisted of 204 healthy participants, stratified into three age groups: 20 to 39, 40 to 59, and 60 to 91 years. Age-related decline was noted in performance on all tasks. Correlations between age and composite scores for each cognitive domain assessed was -.73 for processing speed, -.50 for reasoning, and -.43 for visual-spatial skills, indicating that age has the greatest impact on processing speed, lesser impact on reasoning skills, and the least impact on visual-spatial abilities.

In contrast to normal age-related declines that occur with verbal memory and other areas of cognitive ability, research indicates minimal changes on measures of verbal intelligence over the lifespan. Most studies on the impact of age on verbal intelligence indicate either stability or slight decline until much older ages (90 plus years of age) (Schaie, 1996; Singer et al., 2003). Singer and colleagues (2003) completed a six-year longitudinal
study involving 132 participants (mean age at the time of first assessment was 78). These researchers found that although the cognitive abilities of perceptual speed, memory, and fluency declined steadily with age, verbal intelligence remained stable until approximately age 90. After age 90 there was evidence of significant decline.

Extant literature on the topic of normal age-related cognitive decline indicates consistent decline in many areas with verbal intelligence remaining stable until very old age (i.e. 90 plus years). The stability of performance on verbal intelligence tests into old age is clinically useful. Often performance on measures of verbal intelligence is used to estimate premorbid cognitive ability and help establish an expected level of current performance on neuropsychological tests. However, the use of intelligence measures as predictors of premorbid ability is an area of professional discussion. The next section reviews research that indicates the nature of the relationship between intelligence and neuropsychological test performance may vary as a function of intelligence level.

**Intelligence and Neuropsychological Test Performance**

The relationship between intelligence level and neuropsychological ability is an area of historical debate. The literature indicates that while there is a positive correlation between IQ and neuropsychological performance, the strength of the correlation is stronger for people with average and below average levels of IQ than it is for those with an IQ in the above average range (Bell & Roper, 1998; Dodrill, 1997; 1999; Tremont et al., 1998).

In 1997 former APA president Carl Dodrill addressed this issue. He stated that it is a myth in the field of neuropsychology that “above average performances on neuropsychological tests are expected when intellectual abilities are above average” (p. 9).
He presented supporting data from 181 normal subjects (mean age = 28.36, SD = 10.92) who were administered the Wechsler Adult Intelligence Scale – Revised (WAIS-R; Wechsler, 1981) and the Halstead-Reitan Neuropsychological Test Battery (HRNB; Halstead, 1947). Results revealed that while there was a strong correlation between IQ scores and neuropsychological test scores up through IQ levels of 90 or 95, this relationship was not sustained for higher IQ levels. When IQ scores were 100 or higher there was little consistent improvement in neuropsychological test scores.

Dodrill (1997) discussed three explanations for his research results. First, performance on measures of intelligence is normally distributed. In contrast, performance on neuropsychological tests designed to differentiate people with normal versus impaired cognitive functioning is not normally distributed, as they only differentiate normal from abnormal performance. Neuropsychological tests are not designed to be as sensitive to differences in normal performance and therefore will be unable to do so as well as tests of intelligence. Second, for people who have well above average performance on intelligence tests, clinicians should not expect their performance to be equally high on other measures of neuropsychological ability due to statistical regression towards the mean. Third and last, Dodrill stated that it does not make sense that higher intelligence would result in commensurate levels of performance on all neuropsychological tests. For example, tests of grip strength and finger tapping are more motoric and performance should not be expected to increase commensurate with intelligence. Dodrill concluded that when an individual has above average IQ clinicians should not expect above average performance on all neuropsychological tests. Further, he noted that it is inappropriate for clinicians to conclude cognitive decline has occurred when a person’s IQ is estimated to have been above average.
premorbidly and they are currently performing in the average range on neuropsychological measures (Dodrill, 1997).

Bell & Roper (1998) challenged Dodrill’s (1997) “myth” and discussed several research studies that found above average performance on neuropsychological tests for people with above average IQ. For example, using the same measures as Dodrill, Reitan (1985) found a consistent relationship between WAIS IQ and HRNB Impairment Indices for groups with and without brain injury. Reitan separated participants with above average IQ into four stratified groups and found significantly better performance on the HRNB as IQ increased. Reitan concluded that clinicians should adjust their expectations of performance in relation to IQ performance (1985). Other researchers found a similar relationship between IQ and neuropsychological test performance in psychiatric populations (Warner, Ernst, Townes, Peel, and Preston, 1987). Bell and Roper also discussed data from Wiens, Tindall, and Crossen (1994), who presented data from a list learning task, the California Verbal Learning Test (CVLT; Delis et al., 1987). In an age and IQ stratified sample, they found that for men aged 30 to 39 with average intelligence (IQ score = 100 to 109), a raw score of 49 over five learning trials reflected an average level of performance. However, within the same age range for a male with an above average level of intelligence (IQ score >130), the same raw score fell in the impaired range.

Bell and Roper (1998) concluded that for people with above average intelligence, there is indeed a relationship between IQ and neuropsychological test performance. In response to Dodrill’s (1997) claim, they stated “we believe it would be more accurate to state that people who are above average in intelligence are likely to perform within the above-average range on some, not necessarily all, neuropsychological tests” (p. 242). Additionally
they noted that for patients with above average intelligence, a few average scores should not automatically be considered indicative of brain injury.

Tremont and colleagues (1998) also responded to Dodrill (1997), focusing on methodological errors in his research. They noted that his sample was primarily young, healthy, and White. This limits the generalizability of his results, as most people who present for neuropsychological assessment are likely to have psychiatric, neurological, and/or medical complaints that impact test performance. Additionally, they criticized Dodrill’s use of 13 overlapping FSIQ ranges to examine the relationship between IQ and neuropsychological test performance, as this created an exaggerated homogeneity of variance and increased regression to the mean, potentially distorting between-groups differences.

Tremont et al. (1998) presented findings to contest the validity of Dodrill’s findings from a study using a clinical sample of 157 participants, aged 16 to 74, who were administered the Wechsler Adult Intelligence Scale - Revised (WAIS-R; Wechsler, 1981), Wechsler Memory Scale (WMS; 1945), and the Halstead-Reitan Neuropsychological Test Battery (HRB; Halstead, 1947). Participants were stratified into three IQ levels. They found that performance on the majority of neuropsychological tests was significantly better for those in the above average IQ group versus the average group, which in turn had significantly better performance than the low average group. For the few neuropsychological measures (other than motor tests) that were not significantly different between the three groups, the above average group performed significantly better than the average and below average group combined. Additionally, IQ scores significantly contributed to the variance accounted for in neuropsychological test scores, even after controlling for age and education.
Tremont et al. (1998) re-analyzed Dodrill’s (1997) data by dividing Dodrill’s subjects into three separate IQ groups and comparing their neuropsychological test performance. Dodrill’s data revealed the same pattern of results as Tremont and colleague’s sample; participants in the higher IQ group had significantly better performance on neuropsychological tests than those in the average and low average groups, and those in the average IQ group had significantly better neuropsychological test scores than those in the low average IQ group. They suggested that the high number of IQ groups in Dodrill’s original study may have concealed this finding. Additionally, the magnitude of the differences were greater in Dodrill’s sample than in Tremont and colleague’s data, a finding attributed to the young age and lack of neurological or psychiatric complaints in Dodrill’s sample. Tremont and colleagues concluded that their findings support the view that individuals with above average IQ perform better than individuals with average IQ. Tremont et al. (1998) concurred with Reitan’s (1985) suggestion that clinicians consider a person’s IQ level and adjust their expectation for neuropsychological test performance accordingly.

In light of the literature and research findings presented by Bell and Roper (1998) and Tremont et al. (1998), Dodrill (1999) responded to his critics. Dodrill reworded his original “myth”: “Just as below average performances on neuropsychological tests are found when intelligence is below average, to that same degree above average performances on neuropsychological tests are expected when intellectual abilities are above average” (p. 568; Dodrill, 1999). As such, Dodrill’s final position on the relationship between intelligence and neuropsychological test performance is that intelligence is less correlated with neuropsychological performance at the above average range than when intellectual ability is below average.
The Impact of Intelligence on Memory Performance

Other research has focused specifically on the relationship between IQ and memory performance. Similar to the debate discussed above regarding the relationship between IQ and neuropsychological performance, there are differing opinions on the IQ – memory relationship.

Williams (1997) studied the relationship between intelligence and memory test performance noting the assumption in the field that among normal subjects IQ and memory scores should be highly correlated (Oscar, Clancy, & Weber, 1993). Williams compared IQ scores with index scores from the WMS-R (Wechsler, 1987) and the Memory Assessment Scales (MAS; Williams, 1992) for the MAS normative population ranging in age from 16 to 74 years. He found that 25% had a discrepancy of 18 points or greater between IQ and memory test scores. Williams also conducted a factor analysis which revealed that the correlations between WMS-R summary scores and IQ range from .4 to .7. Although this range of correlation represents a moderate to strong statistical relationship (Mertler & Vannatta, 2005), Williams noted that prediction of one score from the other would still have a considerable amount of error. Based on his findings of the frequency of IQ – memory score discrepancy, Williams concluded it is normal for people to have discrepancies between IQ and memory test performance. In regards to the degree of error associated with predicting memory based on IQ, he cautioned that inferences made based on IQ scores and memory test scores differences should only be made when performance is impaired on memory tests and there is also a large discrepancy between IQ and other neuropsychological scores.

Rapport et al., (1997) further explored the IQ – memory relationship. They administered the WMS-R (Wechsler, 1987), CVLT (Delis et al., 1987), and WAIS-R
(Wechsler, 1981) to 64 normal subjects aged 18 to 56 years. Subjects were stratified into three different IQ groups: low-average, average, and high-average. Results revealed that the low-average IQ group performed more poorly on the WMS-R General Memory (GMI) and Delayed Recall indices as well as Total Words and Discriminability scores of the CVLT compared to those in the average and high-average IQ groups. Multiple regression analysis indicated Verbal IQ accounted for 42% of the variance in the WMS-R GMI and Delayed Recall index and 14-20% of the variance in CVLT performance. They concluded these results support the notion of a strong relationship between intelligence and memory performance. Given the amount of variance in memory test scores that was accounted for by intelligence test performance, they also recommend that IQ be considered when interpreting results of memory tests.

In recent years there has been an increase in the co-norming of intelligence and memory measures. Hawkins and Tulsky (2001) analyzed co-normed data for the WAIS-III (Wechsler 1997a) and WMS-III (Wechsler, 1997b) normative sample consisting of 1250 subjects, ages 16 to 89 years. They examined the frequency, magnitude, and direction of score discrepancy between WAIS-III Full Scale IQ (FSIQ) and WMS-III General Memory Index (GMI). Results revealed the magnitude as well as the direction of IQ - memory score discrepancy varied depending on IQ level. For people with average intelligence there was an almost even split between superiority of GMI scores over FSIQ scores and vice versa. For subjects with FSIQ scores less than 80, FSIQ exceeded GMI in 16.1% of cases. Nonetheless, memory scores for this group were below average, just not as far below average as their IQ scores (The Psychological Corporation, 1997). FSIQ surpassed GMI in 86.6% of subjects with FSIQ of 120 or greater (Hawkins & Tulsky, 2001). Despite this, the memory
performance on this group was still well above average, just not as far above average as their IQ (The Psychological Corporation, 1997). These results indicate that the relationship between IQ and memory measures is different depending on a person’s level of intelligence. In this research the authors did not analyze the effect of age on IQ – memory associations, therefore it remains unclear if the relationship between IQ and memory also varies as a result of age.

To summarize, some studies indicate that people with above average intelligence perform better on verbal memory tests than those with average or below intelligence (Hawkins & Tulsky, 2001; Rapport et al., 1997). The studies that obtained this finding compared groups stratified on intelligence level and often utilized discrete memory test scores. Research examining IQ - memory score discrepancies qualifies this finding and indicates that fairly substantial discrepancies occur in a significant minority of normal individuals (Williams, 1997) and that the direction and magnitude of the discrepancy is related to the individual’s intelligence level (Hawkins & Tulsky, 2001). Despite this, individuals with above average intelligence have above average memory test performance and those with below average intelligence have below average memory test performance, with memory scores being closer to the mean than respective IQ scores. It is important to note that these discrepancy studies all used memory index scores and not scores on discrete memory tests, such as were used in the studies that found memory test differences based on IQ level. The use of index vs. discrete memory scores may have some influence on the measured relationship between intelligence and memory. Additionally, none of these studies examined the relationship between more discrete measures of verbal intelligence and verbal memory where associations may be stronger.
Limitations in Generalization for Older Populations

The research discussed in the previous section suggests, with some qualification, that above and below average IQ is associated with above and below average performance on memory tests respectively. The literature on aging and memory reviewed in the second section of this paper indicates there is normal age-related memory decline in older individuals. In contrast, performance on measures of verbal intelligence, such as vocabulary, remains stable well into the 80’s. Due to these different developmental trajectories in memory and “intellectual” ability, the intelligence-memory associations demonstrated for younger adults may not apply to older adults and therefore need to be analyzed separately for this age group. Existing studies did not consider the IQ - memory association separately for younger and older populations. The majority of research on the IQ – memory association has involved populations that are 74 years of age and younger with no age stratification of samples. For example, in the previous section three studies were discussed, only one of which utilized a sample of people up to 89 years of age (Hawkins & Tulsky, 2001), and this research did not focus on age differences.

Age-related inter-individual variation is another factor limiting generalization of the research on IQ and neuropsychological test performance in younger populations to older populations. Older subjects, as a group, have a greater range of normal performance on psychometric tests than younger subjects (Horn & Hofer, 1992; Morse, 1993). Horn and Hofer (1992) analyzed variability in Wechsler Adult Intelligence Scale scores (WAIS; Wechsler, 1955) for subjects of different age cohorts. Inter-individual variation increased with age on verbal subtests in sample groups up to 75 years of age, but not for performance on measures of working memory or abstract reasoning. The increased variability in scores
for older individuals means that the relationship between IQ and memory maybe less consistent, and therefore not as strong. Such individual differences among the old raises questions about whether the IQ – memory association demonstrated for younger populations can be appropriately applied to older groups. Further research needs to be conducted that examines the relationship between IQ and memory specifically in older populations.

The Importance of Understanding the Relationship between Verbal Intelligence and Memory for Older Individuals

People are living longer than ever before, resulting in an increased need to understand cognitive functioning in older age. A recent 2011 Congressional Research Service report indicated that lifespan expectancy has been increasing steadily (Shrestha & Heisler, 2011). As a result, the percentage of the population aged 65 and older has been increasing as a percentage of the total United States population. In 1950 only 8.1% of the population was aged 65 or older, in 2009 12.8% of the population was 65 or older, and it is estimated that this percentage will increase to 20.2% by the year 2050. These numbers suggest that studying the impact of age on cognitive ability is more important than ever, due to the increasing number of individuals living into old age.

Memory problems are the primary reason people seek neuropsychological evaluation (Green, 2000). Abnormal memory decline is an important manifestation of many neuropathological conditions, some of which have high morbidity in older age. In particular, dementia is a syndrome that is characterized by multiple cognitive impairments; memory impairment usually is a prominent symptom of dementia and is required for diagnosis using some diagnostic criteria (APA, 2000). One study that examined Indiana Medicaid
beneficiaries found that, for individuals 40 years or older, the diagnostic prevalence of
dementia varies from 7.7% to 15.3%, whereas diagnostic prevalence estimates for individuals
60 years or older varies from 14.5% to 26.6% (Bharmal et al., 2007). Due to these high
numbers it is imperative that clinicians be well informed and prepared to identify the early
stages of memory change in older populations.

There are various types of neuropathological conditions that can cause dementia and
many occur more commonly in old age. Some types of dementia show progressive cognitive
decline (e.g., Alzheimer’s dementia, Parkinson’s dementia; Green, 2000), while others have a
more variable course (e.g. vascular dementia; Jiwa, Garrard, Hainsworth, 2010). Since
memory is often a symptom (Hyman & Gomez-Isla, 1998), and sometimes the earliest
symptom, of these dementias, it is essential to be able to reliably distinguish normal age-
related memory decline from pathological memory change in order to accurately diagnose
neurodegenerative and other neuropathological conditions of old age. Understanding the
relationship between intelligence and memory in older populations will aid in distinguishing
normal age-related from pathological memory decline.

Despite the well established presence of normal age-related memory decline, to date
there is no research on the relationship between verbal intelligence and verbal memory for
healthy people in their eighties and little research regarding how memory performance
changes during the eighties specifically. Understanding the influence of age and verbal
intelligence on verbal memory for individuals in their 80’s can help distinguish normal age-
related memory change from pathological memory decline and aid in diagnosis of
neuropathological conditions in this age group. Since memory decline accelerates in the
ninth decade it is also important to consider if there is a significant difference in memory
performance for individuals in their early 80’s versus their late 80’s. If such a difference exists, age appropriate norms for patients in their early versus late 80’s will be central to distinguishing age-related from pathological memory change.
Method

Participants

Volunteers ages 80 to 89 were recruited from independent living communities, churches, and senior centers in the Portland, Oregon metropolitan area and southern Washington. Volunteers completed a questionnaire and interview to screen for medical, psychological and substance use problems (see Appendix A) and were excluded if they had a history of a neurological or health problems that might impair cognitive functioning, past or present drug/alcohol abuse, or psychiatric disorder that could interfere with performance. Additional exclusion criteria included a score greater than 8 on the Geriatric Depression Scale-Short Version (GDS; Sheikh & Yesavage, 1986) and a score less than 25 on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975). Note that a MMSE score of 23 or less is indicative of mild to moderate cognitive impairment (Folstein, et al., 1975).

Three volunteers were excluded due to low scores on the MMSE. One hundred forty-three individuals that meet inclusion and exclusion criteria agreed to participate in the research. Of these, four participants chose to discontinue participation after the first session. The final sample included 139 healthy, functionally independent Caucasian participants. Forty-three were males and 96 were females, 31% and 69% respectively. Mean level of education was 14.67 years, with a range of 10-21 years. English was the primary language for all subjects.

The sample was divided into four groups based on WAIS-III Vocabulary scaled scores and age. For Vocabulary, participants with scaled scores ≤ 11 were classified as average/below and those with scores ≥ 12 as above average. For age, participants were
assigned to early 80’s (80 to 84 years) and late 80’s (85 to 89 years) groups. Please see Table 1 for group means and standard deviations. There were no significant differences between groups for education, MMSE, or GDS.

Measures

Verbal Ability (i.e. Verbal “Intelligence”). The Wechsler Adult Intelligence Scale – Third Edition (WAIS-III; Wechsler, 1997a) is a widely used measure of general intelligence and cognitive ability. The Vocabulary subtest is a measure of word knowledge during which the individual is asked to provide meanings for 33 words of increasing difficulty; responses for each item are scored 0, 1 or 2, depending on accuracy and conceptual understanding of the word. Vocabulary is a component of the Verbal Comprehension Index (VCI), a composite measure of verbal intelligence and correlates .86 to .92 with VCI depending on age; it has a high association with g (The Psychological Corporation, 2002). Singularly, Vocabulary scores have been used as a proxy for premorbid intelligence when there are no academic records or previous testing data (Lezak, 1995). The Vocabulary scaled score was used as a measure of “verbal intelligence” in this study.

Verbal Learning and Memory. The Rey Auditory-Verbal Learning Test (RAVLT) was first developed by Swiss psychologist, Edouard Claparede, in the early 1900’s. The original version was a one-trial word list memory test (Strauss, Sherman, & Spreen, 2006). Later, Clapadere’s doctoral student, Andre Rey, modified the task to include five recall trials followed by a recognition trial (Rey, 1958). The RAVLT has been used extensively to evaluate memory functioning in normal, medical, and psychiatric conditions. Standard administration of the RAVLT includes five successive presentations and recalls of a target list of 15 words (the total recalled over five trials is termed the Total score), a single
presentation and recall of an interference list, post-interference recall of the target list, and 30-minute delayed recall (Trial 7) of the target list followed immediately by a recognition trial for the target list words (Lezak, 1995). For this study, RAVLT Total score was used as a measure of verbal learning and the number of words recalled on the Delay trial was used as a measure of long-term memory.

**Procedure**

Before beginning data collection, Pacific University Institutional Review Board approval was acquired (File Number 073-09). All participants were informed of the study and their rights as participants and signed a consent form. Participants were interviewed and tested in their homes. Participants first were interviewed to complete the neurological and health screening questionnaire and those who met inclusion criteria were administered a neuropsychological battery. All participants were assessed for: (1) verbal and visual-spatial ability using the Vocabulary and Block Design subtests of the WAIS-III (Wechsler, 1997a); (2) mental status using the MMSE (Folstein & Folstein, 1975); (3) depression using the GDS Short Edition (Sheikh & Yesavage, 1986); (4) verbal memory using the RAVLT (Rey, 1958); (5) visual-graphic memory using the Brief Visual Memory Test-Revised (BVMT-R; Benedict, 1997); and (6) motor executive functions using Luria’s Frontal Lobe Tests. Vocabulary, RAVLT, GDS, and MMSE are analyzed in the current study.

Participants were examined over two testing sessions, one week apart. The first 45-minute session included, in order: health questionnaire; RAVLT Trials 1-5 and Trial B; BVMT-R Trials 1-3 (either Form 1 or 4, counterbalanced across groups); WAIS-III Block Design; Geriatric Depression Scale; RAVLT Trial 7 and Recognition; and BVMT-R Delayed Recall, Recognition, and Copy. The second 35-minute session included, in order:
administration of the BVMT-R Trials 1-3 (either Form 1 or 4, whichever had not been administered during the first session); WAIS-III Vocabulary; MMSE; Luria’s Tests; and BVMT-R Delayed Recall, Recognition, and Copy.

For the volunteers who scored less than 25 on the MMSE, a brief letter was sent to the participant and, with their permission, to a family member with whom they resided, 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).
Table 1
Combined Vocabulary and Age Group Means and Standard Deviations for Descriptive Variables

<table>
<thead>
<tr>
<th>Descriptive Variables</th>
<th>Vocabulary Average/Below Average</th>
<th>Vocabulary Above Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early 80's (N = 24)</td>
<td>Late 80's (N = 19)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Age</td>
<td>82.21</td>
<td>1.35</td>
</tr>
<tr>
<td>Vocabulary Scaled Score</td>
<td>10.17</td>
<td>0.82</td>
</tr>
<tr>
<td>Education Years</td>
<td>13.50</td>
<td>1.91</td>
</tr>
<tr>
<td>MMSE</td>
<td>29.25</td>
<td>0.95</td>
</tr>
<tr>
<td>GDS</td>
<td>1.25</td>
<td>1.68</td>
</tr>
</tbody>
</table>
Results

A two-way analysis of variance (ANOVA) was conducted to evaluate the effects of age and Vocabulary performance on RAVLT Total score. There was a significant interaction between age and Vocabulary on RAVLT Total score ($F (1, 463) = 5.11, p = .025$). The means and standard deviations for RAVLT Total score as a function of the two factors are presented in Table 2. Please see Graph 1 for depiction of the interaction effect. Follow-up ANOVA pairwise comparisons revealed the following significant differences: 1) individuals in the early 80’s – Vocabulary average/below average group scored significantly lower than the individuals in their early 80’s – Vocabulary above average group ($p = .000$), 2) individuals in the early 80’s – Vocabulary average / below average group scored significantly lower than the late 80’s – Vocabulary average/below average group ($p = .033$), 3) individuals in the early 80’s – Vocabulary above average group scored significantly higher than the late 80’s – Vocabulary average/below average group ($p = .020$), and 4) individuals in their early 80’s – Vocabulary above average group scored significantly higher than those in the late 80’s – Vocabulary above average group ($p = .015$). Though not reaching the required .05 level of significance, a marginal finding of individuals in the early 80’s – Vocabulary average/below average group scoring lower than those in the late 80’s – Vocabulary above average group was found ($p = .066$). The remaining pairwise comparison between the late 80’s – Vocabulary average/below average and Late 80’s – Vocabulary above average groups was not significant ($p = .699$). Pairwise comparison results are displayed in Table 3.

A two-way ANOVA was conducted to evaluate the effects of age and Vocabulary performance on RAVLT Delay score. The interaction between factors was not significant ($F (1, 11.87) = 1.24, p = .267$), see Table 4 for the means and standard deviations of the combined
groups. One-way ANOVA’s indicated no significant main effect for Vocabulary performance ($F(1, 13.46) = 1.41, p = .237$), and a marginal, yet non-significant, effect for age ($F(1, 28.56) = 2.99, p = .086$) with the younger group performing better than older group. See Table 5 for means and standard deviations of non-significant main effects for RAVLT Delay.
### Table 2

**Means and Standard Deviations for Combined Age and Vocabulary Groups on RAVLT Total**

<table>
<thead>
<tr>
<th>Groups</th>
<th>RAVLT Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
</tr>
<tr>
<td>Early 80's - Vocabulary average / below average</td>
<td>29.67</td>
</tr>
<tr>
<td>Early 80's - Vocabulary above average</td>
<td>36.96</td>
</tr>
<tr>
<td>Late 80's - Vocabulary average / below average</td>
<td>33.16</td>
</tr>
<tr>
<td>Late 80's - Vocabulary above average</td>
<td>32.50</td>
</tr>
</tbody>
</table>

### Table 3

**Analysis of Variance Pairwise Comparisons for RAVLT Total Score**

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Difference</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early 80's - Vocabulary average/below average</td>
<td>-7.29</td>
<td>.000</td>
</tr>
<tr>
<td>Late 80's - Vocabulary average/below average</td>
<td>-3.49</td>
<td>.033</td>
</tr>
<tr>
<td>Late 80's - Vocabulary above average</td>
<td>-2.83</td>
<td>.066</td>
</tr>
<tr>
<td>Early 80's - Vocabulary above average</td>
<td>3.80</td>
<td>.020</td>
</tr>
<tr>
<td>Late 80's - Vocabulary average/below average</td>
<td>4.46</td>
<td>.015</td>
</tr>
<tr>
<td>Late 80's - Vocabulary above average</td>
<td>0.66</td>
<td>.699</td>
</tr>
</tbody>
</table>
Table 4

*Means and Standard Deviations for Combined Age and Vocabulary Groups on RAVLT Delay*

<table>
<thead>
<tr>
<th>Groups</th>
<th>RAVLT Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
</tr>
<tr>
<td>Early 80's - Vocabulary average / below average</td>
<td>5.51</td>
</tr>
<tr>
<td>Early 80's - Vocabulary above average</td>
<td>6.98</td>
</tr>
<tr>
<td>Late 80's - Vocabulary average / below average</td>
<td>5.32</td>
</tr>
<tr>
<td>Late 80's - Vocabulary above average</td>
<td>5.36</td>
</tr>
</tbody>
</table>

Table 5

*Means and Standard Deviations for RAVLT Delay Non-significant Main Effects*

<table>
<thead>
<tr>
<th>Groups</th>
<th>RAVLT Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Early 80's</td>
<td>78</td>
</tr>
<tr>
<td>Late 80's</td>
<td>61</td>
</tr>
<tr>
<td>Vocabulary Average/Below Average</td>
<td>43</td>
</tr>
<tr>
<td>Vocabulary Above Average</td>
<td>96</td>
</tr>
</tbody>
</table>
Graph 1

Two-way ANOVA Interaction Effect between Combined Age and Vocabulary Groups on RAVLT Total
Discussion

The purpose of the current study was to examine the relationship between verbal intelligence and verbal memory in a healthy population aged 80 to 89 years. This research is critical given that discrepancies between intelligence level and performance on neuropsychological measures are sometimes used as a basis for making inferences regarding changes in cognitive functioning (Dodrill, 1999; Bell & Roper, 1997; Tremont et al., 1998). With older adults, such inferences are often used to differentiate between normal age-related memory decline and deficits due to a neuropathological process. Research on the relationship between intelligence and memory has focused primarily on younger populations (i.e., 74 years of age or below). Due to different trajectories of age-related cognitive decline there is question as to whether the same IQ – memory relationship that is found for young adults is also demonstrated for older adults. Memory abilities evidence normal age-related decline beginning at age 50 or 60 (Albert et al., 1987; Hertzog & Schaie, 1988; Hochandal & Kaplan, 1984; Rabbitt, 1990), while performance on verbal intelligence measures remains stable until approximately age 90 (Schaie, 1996; Singer et al., 2003). Furthermore, given the rapidity of cognitive decline in the ninth decade, it is possible that adults within the 80 to 89 age range experience a decline in memory so swift that normal performance for people aged 85 to 89 is significantly lower than those aged 80 to 84. If so, separate norms for the early and late 80’s would be necessary. Understanding the influence of age and verbal intelligence on verbal memory for individuals in their 80’s will assist clinicians in identifying patients with normal declines versus those that may need treatment secondary to a neurodegenerative disease. The current study explored this relationship between IQ and memory in an older population; verbal
memory was assessed using the RAVLT Total (i.e., learning ability) and Delay (i.e., long-term memory) scores and verbal intelligence was assessed using Vocabulary scores.

There was an unexpected and anomalous finding in this data that must be considered prior to discussion of other significant results. For the average / below average Vocabulary participants, the older 80’s group’s score on the learning trial was significantly higher than the younger 80’s group. This finding is contrary to a large body of literature indicating younger individuals perform better than older individuals on memory measures in general (Ebert & Anderson, 2009; Economou, 2009; Van der Linden et al., 1997), and on RAVLT Total score in particular (Mitrushina et al., 2005; Van der Linden et al., 2005). This extensive literature indicates that the early 80’s group was expected to perform better than (or at least equal to) the late 80’s group, but not worse. This anomalous finding is likely due to a selection bias for the sample participants in the average / below Vocabulary group. It appears the subjects in this study were different from each other in some way other than the independent variables of age and intelligence level and that this influenced performance on the RAVLT Total score.

However, the data gathered in this study does not identify what the selection bias may be, as there was not a significant difference between groups regarding years of education, reported levels of depression (as measured by the GDS), or general cognitive ability (as measured by the MMSE). Furthermore, all participants were screened for medical, neurological, psychiatric, and substance abuse, so it is unlikely that these factors accounted for the anomalous finding.

The unidentified factor could have affected the data in several ways. It is possible that the mean score obtained by the early 80’s low Vocabulary group is lower than it would be (i.e., lower than would be obtained without the influence of selection bias). It is also possible that the mean score obtained by the late 80’s low Vocabulary group is higher than would be. Or, both
possibilities may be true. The actual impact of this unidentified factor is unknown. Nevertheless, the superior performance exhibited by older subjects is contrary to a large body of extant research, thus raising questions about its validity. Consequently, the results for the learning trial for the Vocabulary average / below groups will not be discussed or interpreted further with the exception of the comparison between the early 80’s above Vocabulary group and the late 80’s average / below Vocabulary group. The other significant results obtained from the learning trial that did not include the average/ below Vocabulary group will be discussed with the caveat that they must be interpreted and/or generalized with caution.

The between groups difference for the early 80’s above average intelligence and late 80’s average / below Vocabulary group on the learning trial was interpreted for a specific reason: If the obtained and “true” mean score (i.e., the one that would be obtained without selection bias) is the same for the late 80’s lower intelligence group, then the results of the analysis are accurate. If the true mean is lower than the obtained mean, then the magnitude of the difference between the two group’s means is actually larger and so is the level of statistical significance. That is, the significance of the difference between the two groups is at least as great as this analysis indicates and may be greater. The significant difference between these groups demonstrated that the younger participants with higher IQ performed better than the older participants with lower IQ.

Previous research indicates that younger people are expected to perform better on clinical memory tests in general (Ebert & Anderson, 2009; Economou, 2009) and the RAVLT in particular (Mitrushina et al., 2005; Strauss et al., 2006; Van der Elst et al., 2005). Previous research also indicates that people with higher intelligence levels are expected to perform better on memory tests (Hawkins & Tulsky, 2001; Rapport et al., 1997). Therefore it is expected that a combination of younger age (early 80’s) and higher intelligence would result in the highest
memory score performance. No other studies referenced in this work have specifically discussed the combined impact of young age and high IQ. Therefore, this study is the first to demonstrate that this combination of age and IQ resulted in the highest memory test performance for individuals in their early 80’s.

With regard to the remaining pairwise comparisons on the learning trial, there are other findings that warrant discussion. Within the above average vocabulary group, individuals in their early 80’s performed better than those in their late 80’s. This finding suggests that, for those with above average intelligence, individuals in their late 80’s have a significantly lower level of performance on a verbal learning measure than younger individuals. However, this statistically significant difference has limited clinical utility. The difference in mean scores for these groups was 4.46 raw points and both groups had a standard deviation of approximately 10 points. This large variability limits the clinical usefulness of the score difference. For example, an individual in the early 80’s high intelligence group could obtain a score that is within the average range for early 80’s, yet still falls below the mean score for the late 80’s high intelligence group. Therefore, the extent of the overlap in the distributions for the early and late 80’s groups indicates that there is a minimal difference in terms of practical or clinical significance between the two groups.

Turning to long-term memory, there was no significant interaction effect. Importantly, the anomalous pattern that was present for the low intelligence groups on the learning trial was not found on the Delay trial. Therefore, consistent with the literature on normal age-related decline, younger participants of both intelligence levels had higher scores than the older participants. There were no main effects for Vocabulary groups on long-term memory performance. Therefore, intelligence level does not have a significant impact on long-term
memory performance for individuals in their 80’s. Though not significant, there was a marginal finding for age, with individuals in the early 80’s group tending to perform better than the late 80’s group ($p = .086$). This trend in performance is consistent with the literature on normal age-related long-term verbal memory decline (Davis et al., 2003; Ebert & Anderson, 2009; Mitrushina et al., 2005; Stephens & Kaufman, 2009; Van der Elst et al., 2005; Van der Linden et al., 1997). It is possible that a lack of significant findings in this trending area is due to the small sample size. Power analysis indicated that a total sample size of 210 participants would be necessary for statistically significant findings (Erdfelder, Lang, & Buchner, 2009). Therefore, the true impact of age on long-term memory may have gone undetected in this study because of the sample size.

The findings in this study are severely limited by the anomalous pattern of verbal learning performance among the lower intelligence group. The presence of an unidentified selection bias affected the learning trial scores for the young 80’s low intelligence and / or the late 80’s low intelligence group, resulting in a pattern of performance between the groups that is inconsistent with the well-established relationship of normal age-related memory decline. Due to this irregularity, a large portion of data was disregarded and it was not possible to address the question of the IQ – memory relationship in the verbal learning measure because data was only valid for the above average intelligence groups. Therefore, the presence and nature of the IQ – memory relationship, and whether it varies according to age, remains unknown for verbal learning.

Some findings suggest that there are age-related differences in memory performance for early and late 80’s. On the long-term memory trial there was a trend for younger individuals to perform better than older individuals, regardless of intelligence level. This pattern was also
present on the learning trial, though it was only demonstrated for the above average intelligence group because data from the average group was disregarded. Due to the present selection bias, direct generalization of data from this study is strongly cautioned against. However, the observed age-related decline for individuals in their 80’s warrants further research.

There are other limitations to the present study that restrict its generalizability to other populations. First, the entire sample identified as Caucasian and it is unclear how well these results will apply to patients from non-dominant cultures. Second, the participants overall had a relatively high level of educational attainment (mean = 14.67, sd = 2.68) and high Vocabulary scores (mean scaled score = 13.01, sd = 2.59). There were more than twice as many participants with above average Vocabulary scores (N = 96) than average and below scores (N = 43). This sample may best be characterized as “super normals” and thus the results are most representative for individuals in their 80’s with above average cognitive ability.

Further research needs to be done to examine the relationship between verbal intelligence, age, and memory in people ages 80 to 89. First, replication of the current study should be done so as to achieve a sample that produces results that are consistent with the established findings on age-related decline thus alleviating concern about selection bias and invalidity of findings. This would allow analysis of the association of verbal intelligence, age, and memory in this age group. Second, this replication should be done with a larger sample, as this may yield significant findings in the trending areas. Third, any replication should also aim to better depict the average aging population so that the results are more generalizable. Such a study would include a sample with a mean education level that is closer to the population average and would include participants who represent a diversity of cultural backgrounds. Last, there was some evidence to suggest age-related decline in both verbal learning and long-term
memory. Further research of age-related differences in performance should be conducted so that the norms may be most accurate for people in their ninth decade.
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

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.  (541) 905-4763
Meagan Etchells, M.S.  (503) 869-6598
Pacific University
Doctoral Candidates
REFERENCES


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