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# A COMPARISON OF THE REY AUDITORY-VERBAL LEARNING TEST AND THE WECHSLER SCALES

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# A COMPARISON OF THE REY AUDITORY-VERBAL LEARNING TEST AND THE WECHSLER SCALES

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AND THE WECHSLER SCALES

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# ABSTRACT

The present study was designed to determine the correlation between a commonly used cognitive ability test (i.e., Wechsler) and a verbal memory test (i.e., Rey Auditory-Verbal Learning Test) by analyzing archival data from a clinical sample of adults. Many researchers have continued to establish the relationship between cognitive ability, or IQ, and learning and memory skills; however, there is little research regarding when differences between IQ and memory scores are statistically significant. Results of this study indicated 17 of 20 IQ index/memory correlations were statistically significant and a series of simple regressions generated standardized residuals. These residuals generated confidence bands that can permit practitioners to interpret when differences between IQ and memory scores are uncommon and, therefore, meaningful. Implications and suggestions for future research are provided.

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# CHAPTER ONE: INTRODUCTION

The obvious purpose of schools is to teach children a wide range of basic skills and applied academic skills and to prepare them for employment and post-secondary training. Education is a fundamental right for all individuals and is provided to ensure all students are provided the basic academic skills required to meaningfully navigate the demands of adulthood. Specifically, the right to education for all students was recognized internationally in Article 26 of The Universal Declaration on Human Rights (United Nations, 1948). Some students, however, as a result of physical, mental, or social-emotional disabilities, require accommodations and/or modifications within the school environment to ensure they are able to access the general curriculum. In the United States, these individuals have the right to a free appropriate public education (FAPE) according to the Individuals with Disabilities Education Act (Public Law No. 94-142).

Students are expected to learn and remember the material in the curriculum through classroom instruction. When they struggle to meet this expectation as a result of a disability, such as developmental delays, learning disabilities, hearing and/or vision impairments, or attention problems, they often fall behind in school (Cortiella & Horowitz, 2014). In these instances, special education services may be necessary to provide students effective access to the curriculum materials and/or to provide them an appropriate learning environment. Adults with disabilities who transition out of the public school system and still require supports must rely on family members and community services such as vocational rehabilitation and adult education programs (Cameto, Levine, & Wagner, 2004; Stanberry, 2016).

Though memory deficits may be a function of an individual's overall cognitive processing ability, additional influences may impact memory functioning including brain injury, drug use, and Alzheimer's disease. Head trauma, when it is severe enough to result in loss of consciousness, cognitive dysfunction, or neurological deficits are referred to as a brain injury (Lucas, 1998). Common causes of brain injury include motor vehicle accidents, falls, and gunshots. Other brain injuries include those which may occur over time or without traumatic incident, including stroke, multiple concussions, electric shock, and oxygen deprivation or intoxication. These injuries may impair a variety of cognitive functions which relate to the ability to encode, retain, and decode information (American Psychiatric Association, 2013; Lucas, 1998) and the ability to utilize planning and memory strategies to retain information (Rassovsky et. al. 2006).

The impact of impaired memory functioning includes problems learning and retaining new information, which can be reflected in standardized achievement tests such as those administered to determine progress over time and those required to judge the school's performance under the No Child Left Behind Act of 2001 and its most recent legislative update, the Every Student Succeeds Act of 2015. Similarly, impaired memory can affect standards-based classroom tests in school-age children and daily living skills and vocational skills performance for adults (Fleck, 2015; Klingberg, 2012).

**Cognitive Assessment**

Cognitive assessments, including IQ tests, are a common evaluation measure in most assessments. These tests are formal assessments designed to gather information regarding an individual’s cognitive abilities for comparison to a normed sample of the population. These consist of measures of verbal ability, visual-spatial skill, processing speed, fluid reasoning, and memory (Wechsler, 2008). Verbal ability includes the ability to understand and produce verbal language including understanding the meaning of vocabulary words and the ability to grasp complex verbal concepts. Visual-spatial/perceptual reasoning skills include the nonverbal ability to physically and mentally manipulate visual information, including building objects to match a visual stimulus and solving visual puzzles. Processing speed is generally measured with a physical task such as decision-making speed and accuracy. Fluid reasoning skills, the skills necessary to apply past learning to new and novel situations (Cattell, 1987), are assessed through tasks requiring learning and applying rules and identifying and using patterns to draw conclusions. Deductive and inductive reasoning, mental flexibility, and executive mental processing fall under the fluid reasoning umbrella.

Memory, both short-term and long-term, is measured by most measures of intelligence. For example, long-term memory is needed to remember vocabulary and sound-symbol combinations. Short-term memory is needed to pay attention and retain information long enough to manipulate it and place it into long-term storage. Other aspects of memory assessment include prospective and retrospective memory, visual memory for the short and long-term, verbal memory for the short and long-term, episodic memory, and recognition memory (Butters, Soety, & Gliskey, 1998; Sattler, 2008).

**Memory Assessment**

Memory specific assessments, such as the Wide Range Assessment of Memory and Learning (WRAML2; Sheslow & Adams, 2003), Wechsler Memory Scales (WMS-

IV; 2009), and the Test of Memory and Learning (TOMAL-2; Reynolds & Voress, 2008), can be used to evaluate memory functions such as short- and long-term memory, verbal and nonverbal memory, attention, learning, and recall. There are shorter memory tests, including the Rey Auditory-Verbal Learning Test (RAVLT; Schmidt, 1996) and the Rey Complex Figure Test (RCFT; Meyers & Meyers, 1995).

Often, tests of memory are used in conjunction with cognitive assessment measures; however, it can be argued that cognitive assessments are measuring memory functioning already. Naturally, cognitive assessments and tests of memory are correlated (Morales et al., 2017; Murayama et al., 2012; Schuchardt, Gebhardt, & Mäehler, 2010). It is important, therefore, to gain a better understanding of the similarities and differences among cognitive assessments and tests of memory. It would be particularly helpful to know when the difference between an individual’s ability to retain information and their cognitive ability is considered statistically uncommon. Specifically, it would be helpful to know when a difference between a memory test and a cognitive assessment becomes statistically uncommon and, therefore, meaningful. Put another way, distinguishing between deficits in general cognitive ability and memory functions can help make appropriate diagnostic distinctions and interventions. For example, a generalized cognitive impairment that is common in a closed head injury or age related cognitive decline could be distinguished from age inappropriate memory decline or a memory impairment associated with some other disease or condition (Ratliff & Saxton, 1998).

**Purpose of the Study**

The present study was conducted to compare the Rey Auditory-Verbal Learning Test (RAVLT) (Schmidt, 1996), a commonly used measure of verbal memory, to the

Wechsler Adult Intelligence Scale—Fourth Edition (WAIS-IV) (Wechsler, 2008), a commonly used measure of intelligence. Much research has been conducted regarding the use of the RAVLT in assessing memory in adults (Geffen et al., 1990; Munson, 1987; Savage & Gouvier, 1992; Wiens et al., 1988; and Uchiyama et al., 1995 as cited in Schmidt, 1996); however, research regarding the determination and interpretation of significant difference between cognitive functioning and memory skills is limited. The present study investigated how and when to determine and interpret differences between scores on the WAIS-IV and scores on the RAVLT.

## Significance of the Study

Though there is considerable research regarding the relationship between memory skills and cognitive functioning across age levels, little research has been conducted regarding when differences between cognitive ability and verbal memory are considered statistically meaningful. The present study makes significant contribution to the literature because to date there are no studies that have established the meaningfulness between of significant differences between cognitive performance and ability on memory-specific assessments. Specifically, the present study was designed to determine when differences between cognitive ability as measured by the WAIS-IV and verbal memory as measured by the RAVLT are considered statistically uncommon. Understanding this distinction could help discern generalized cognitive dysfunction from a specific memory disorder.

## Terms and Definitions

- Cognitive assessment: a set of norm-referenced tests administered to gather information regarding information processing skills including verbal knowledge, visual-spatial manipulation, short-term/working memory, long-term memory, processing speed, and problem-solving skill among other cognitive abilities

- Wechsler Adult Intelligence Scale (Fourth Edition): an individually administered, norm-referenced measure of cognitive abilities including a verbal, visual-perceptual, memory, and processing speed indices which combine to generate a full-scale intelligence quotient
- Full Scale Intelligence Quotient (FSIQ) Score: this is the cognitive composite score generated by the 10 core subtests of the WAIS-IV. It provides a summarized cognitive ability score
- Verbal Comprehension Index (VCI): this is a measure of verbal reasoning and comprehension composed of the following core subtests: Similarities, Vocabulary, and Comprehension
- Perceptual Reasoning Index (PRI): this index is a measure of fluid reasoning composed of the following core subtests: Block Design, Picture Concepts, Matrix Reasoning
- Working Memory Index (WMI): this index measures short-term, working memory and is composed of the following core subtests: Digit Span, Letter-Number Sequencing
- Processing Speed Index (PSI): this final WAIS-IV index measures speed in decision making and visual scanning and is composed of the following core subtests: Coding, Symbol Search

- Index Scores: Index scores are generated by using the tables of the WAIS-IV and are based on the sum of scores generated by the subtests within each respective index
- Rey Auditory-Verbal Learning Test (RAVLT): this instrument is a measure of memory for verbally presented information; administration includes 9 sections including 5 learning trials, 1 intervening trial, an immediate recall test, delayed recall test, and recognition test
- RAVLT stimulus list (List A): this is a list of 15 nouns presented verbally by an examiner to be learned/recalled by the examinee
- Distractor list (List B): the distractor list is a list of 15 additional nouns unrelated to List A used as an intervening memory task immediately following the learning trials of the RAVLT
- Initial recall (Trial 1): trial 1 requires the examinee to recall as many of the 15 nouns just presented
- Trials 2 through 5: these trials consist of the examiner repeating the same 15 nouns to the examinee as in the initial recall and asking the examinee to recall as many of the nouns as possible for each trial
- Intervening/Distractor list: immediately following the teaching trials, the examinee is verbally presented with an unrelated list of 15 nouns and asked to restate all stimulus items they can recall from this second list
- Intermediate memory: here the participant is asked to recall the initial stimulus list directly following the intervening/distractor trial without additional teaching

- Delayed recall: after 20-minute delay, the examinee is asked to recall all stimulus words they can recall from the initial stimulus list without additional teaching
- Recognition trial: here the examinee is presented with a brief passage including all 15 initial stimulus list words as well as some from the distractor list. The participant is asked to read through the passage and indicate those words belonging to the initial list
- T-Scores: these scores are obtained by the RAVLT using the available norms. T-scores have a mean of 50 and a standard deviation of 10. This score is used to determine the participant's performance in relation to norm-referenced expectations based on age and sex

# CHAPTER TWO: REVIEW OF LITERATURE

## Intelligence Testing/Cognitive Assessment

The history of using cognitive assessments in the United States to determine impact on an individual's general ability and life function began with Henry Goddard and his efforts to bring Alfred Binet's intelligence testing to the United States (Zenderland, 1998). Goddard took Binet's intellectual testing mainstream by applying it in employment and educational settings and later generating a series of socio-economic implications, including his thoughts on the origins of the "feebleminded" and the study of eugenics. According to Sattler (2008), Goddard re-published the Binet-Simon Scales in 1910 with an updated standardization to include 2,000 U.S. children. In 1916, Lewis Terman and Hubert Childs collaborated to update the Binet-Simon Scale with the assessment of school children in mind. In 1919, the Army Alpha and Army Beta were published with the goal of assessing potential military personnel to determine which duties they were mentally fit to handle during World War I. The Army Alpha was a verbal assessment while the Army Beta was a fully nonverbal assessment administered using pictures, gestures, and pantomime (Army Alpha and Army Beta, n.d.). These assessments ultimately influenced the development of the first Wechsler cognitive assessment published in 1939 (i.e., the Wechsler-Bellevue Intelligence Scale, Form I). Performance on the Wechsler scales, then and now, is viewed as a representation of one's mental ability across domains (Sattler, 2008).

Many theories of intelligence have represented the function of assessments over the past 80 years or so. For example, Thorndike's 1927 multifactor theory of intelligence in which cognitive skills were broken into social, concrete, and abstract intelligence by means of theory rather than research. Gardner's multiple intelligence theory of intelligence considered factors such as musical skill, bodily skill, social ability, and spiritual awareness (Sattler, 2008). Modern views of intelligence continue to include the concept of an overarching general intelligence factor (*g*) composed of multiple cognitive skills – the traditional IQ score can be viewed as a measure of *g* (Sattler, 2008).

**Wechsler Adult Intelligence Scale – Fourth Edition**

The Wechsler scales continue to be a well-known cognitive assessment series and includes measures for early developmental cognition with the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IV; Wechsler, 2012), childhood intelligence using the Wechsler Intelligence Scale for Children (WISC-V; Wechsler, 2014), and adult intelligence using the Wechsler Adult Intelligence Scale (WAIS-IV; Wechsler, 2008). The WAIS-IV includes four core indices measuring verbal comprehension (VCI), perceptual reasoning (PRI), working memory (WMI), and processing speed (PSI); together these comprise the full-scale intelligence quotient (FSIQ). A General Ability Index (GAI) score is also available for consideration when a large discrepancy is present between core cognitive processes of visual and verbal perception and the processing abilities of attention and processing speed.

Change in performance on cognitive measures with advanced age is not unexpected and are likely related to "age-related declines in processing speed, executive functioning, sensory acuity, psychomotor ability, working memory, attention, memory, and a host of other variables" (Kaufman & Lichtenberger as cited in Wechsler, 2008, p. 4). According to Wechsler, verbal cognitive ability tends to show a gradual increase from age 16 to age 50 with slight decrease noted after age 55 with overall verbal ability being preserved over time. Perceptual abilities such as visual processing and reasoning, however, show continual decline with greatest loss of functioning beginning at age 50 to 60 (Wechsler, 2008). Tasks involving working memory show slight decline beginning after age 45; however, Wechsler (2008) notes that many working memory assessments are verbal in nature which may relate to their lower degree of decline in comparison to visual/perceptual processing. During development of the WAIS-IV, considerations were made to account for the perceptual and processing differences of older adults as well as other individuals which may experience similarly diminished processing abilities including problem solving, processing speed, auditory and visual acuity, and motor ability. These considerations include providing explicit directions for tasks to demonstrate the problem-solving process, giving additional points for quick performance to eliminate some overlap of processing speed influence on other tasks not specifically related to speed, avoiding the use of "phonetically similar numbers and letters" on verbally administered subtests (p.19), enlarged pictures and other visual stimuli, and including perceptual reasoning tasks which do not require motor manipulation to demonstrate knowledge (Wechsler, 2008).

Ensuring the WAIS-IV was adequately representative of the U.S. population in its update, outdated items or situations were given contemporary replacements and a sample modeled after the 2005 U.S. census was gathered to collect normative data between March 2007 and April 2008 (Wechsler, 2008). A stratified sample of 2,200 individuals age 16 through 90 generate the normative information for the WAIS-IV. Examinees were divided into 13 age groups. Groups age 16 through 69:11 included 200 examinees: Those age 70 through 90:11 included groups of 100. An equal distribution of male and female participants was included in age 16 through 64:11 groups while age groups 65 through 90:11 included disproportionately more female participants to mimic U.S. census data. In addition, race/ethnicity was made proportionate to the U.S. census within each age group – an overwhelming majority of the census population and subsequently the WAIS-IV sample were white individuals. Proportionate geographic representation of the Northeast, Midwest, South, and West regions were considered as well as educational level (Wechsler, 2008).

It is also necessary to consider the reliability of any assessment measure to ensure it generates consistent results and accurately measures its intended content. Test-retest reliability generated strong ($r > 0.8$) reliability coefficients across all core subtests including Block Design (.87), Similarities (.87), Digit Span (.93), Matrix Reasoning (.90), Vocabulary (.94), Arithmetic (.88), Symbol Search (.81), Visual Puzzles (.89), Information (.93), and Coding (.86). Even stronger reliability was indicated for the four indices and full-scale score: Verbal Comprehension Index (.96), Perceptual Reasoning Index (.95), Working Memory Index (.94), Processing Speed Index (.90), Full Scale Intelligence Quotient (.98). These composite score reliability coefficients are equal to or greater than those of the WAIS-III (Wechsler, 2008). Of the protocols used for the norming sample, all were scored twice by separate scorers and demonstrated very strong inter-rater reliability scores. For the four subtests requiring more in-depth judgement, Similarities, Vocabulary, Information, and Comprehension, 60 randomly selected cases were scored by two graduate-level clinical psychology students separately to determine inter-rater reliability: These students had no prior experience with the WAIS-IV scoring rules. For these subtests, inter-scorer reliability exceeded 0.9 for each: Similarities (.93), Vocabulary (.95), Information (.97), Comprehension (.91). This demonstrates the ability of the WAIS-IV to be used reliably without the requirement of extended practice with WAIS-IV scoring practices (Wechsler, 2008).

Validity of the WAIS-IV as a measure of intelligence is addressed through theories of convergent and discriminant validity, demonstrating high and low correlation respectively (Wechsler, 2008). Through correlational data obtained of the norming sample, performance on each of the indices as well as the subtests comprising these is able to be compared. The general theory of convergent and divergent validity proposes subtests of a specific construct likely correlate most highly (convergent validity) with other measures of the same construct and to a lesser degree (discriminant validity) with measured of different constructs. For example, when considering Verbal Comprehension subtests with relation to Processing Speed subtests, it is expected that Similarities, Vocabulary, and Information should correlate to a higher degree with themselves than with Symbol Search and/or Coding. Formal evaluations of this theory on subtests of the WAIS-IV demonstrated this pattern of correlations. Specifically, Verbal Comprehension subtests correlated highly with each other and moderately with Perceptual Reasoning subtests, Perceptual Reasoning subtests correlated highly with each other (and nearly as high with Verbal Comprehension subtests, Working Memory subtests correlate most highly with each other and moderately with Verbal Comprehension subtests, Processing

Speed subtests correlate most highly with each other and show some moderate correlations to other subtests (Wechsler, 2008).

**Memory Assessment**

The limits of an individual's memory span were explored in the 1956 research of George Miller which focused on the continuing reoccurrence of the number seven in natural phenomenon. Ultimately, Miller concluded that while the limits of individual memory spans are finite, the limits are not absolute (Miller, 1956). Formal assessments of memory continue to be used in psychological evaluations including the Wechsler Memory Scales (WMS-IV, 2009), Tests of Memory and Learning (TOMAL-2; Reynolds & Voress, 2008), Wide Range Assessment of Memory and Learning (WRAML2; Sheslow & Adams, 2003), Rey Auditory-Verbal Learning Test (RAVLT; Schmidt, 1996), and Rey Complex Figure Test (RCFT; Meyers & Meyers, 1996).

The WMS-IV is an individually-administered measure of memory for individuals age 16 through 90. The WMS-IV allows for a flexible assessment approach by including six possible batteries for evaluation: standard, older adult/abbreviated, logical memory/visual reproduction, logical memory/designs, visual reproduction/logos, and logos/names. The WMS-IV Standard Battery includes Logical Memory I and II, Verbal Paired Associates I and II, Designs I and II, Visual Reproduction I and II, Spatial Addition, and Symbol Span. The WMS-IV subtests generate five index scores for Auditory Memory (AMI), Visual Memory (VMI), Visual Working Memory (VWMI), Immediate Memory (IMI), and Delayed Memory (DMI). The AMI measures an individual's ability to attend to orally presented information, verbally repeat the information, and recall this after 20 to 30 minutes. The VMI measures memory for visual details and spatial location. The VWMI measures the ability to demonstrate short-term retention and manipulation of locations and details. The IMI and DMI are comprised of information gathered from other subtests and give information regarding the ability to immediately recall/restate information (IMI) then recall the same information after a 20- to 30-minute delay (DMI). The WMI-IV index scores do not generate an overall memory score (Wechsler, 2009).

The TOMAL-2 (2008) is a measure of specific memory functions for individuals age 5 to 59 which measures Verbal Memory, Delayed Recall, Learning, Free Recall, Attention and Concentration, Nonverbal Memory, Composite Memory, Sequential Memory, and Associate Recall ability. Reliability values of composites and subtests is high across the measure, and test-retest reliability coefficients all exceed .70 (Reynolds & Voress, 2008). The TOMAL-2 is able to be used with individuals believed to have learning disabilities, traumatic brain injury, neurological diseases, emotional disturbance, and attention deficits (Reynolds & Voress, 2008).

The WRAML2 (2003) is an individually administered memory assessment which has an expansive age administration range from 5 to 90 years. The WRAML2 core battery includes a General Memory Index (GMI) as well as three skill-specific indices: Verbal Memory Index, Visual Memory Index, Attention and Concentration Index. In addition to this core battery, additional working memory, delayed memory, and recognition indices are available. The WRAML2 may be used in the assessment of impact on memory in students with learning disabilities and attention deficits as well in individuals following head injury (Sheslow & Adams, 2003).

The Rey Complex Figure Test (RCFT) is a neuropsychological test that measures visuospatial construction and visual recall, recognition memory, processing speed, and appropriate response distinction (Meyers & Meyers, 1995). This assessment consists of a timed initial copy trial, an immediate recall drawing trial, a delayed recall drawing trial, and an item recognition form. For the initial copy trial, the participant is presented with the complex figure (a geometric design) and asked to recreate the figure on a separate blank sheet without tracing or erasing any marks made. Time to completion is recorded for norm-referenced comparison. The immediate recall drawing trial is initiated 3-minutes after completion of the initial copy trial without presentation of the complex figure stimulus. The delayed recall drawing is initiated 30-minutes after completion of the initial copy trial, again, without presentation of the complex figure stimulus. After completion of the delayed recall drawing, the participant is asked to identify the 18 pieces of the complex figure from a set of accurate and distractor items (Meyers & Meyers, 1995).

**Rey Auditory-Verbal Learning Test (RAVLT)**

The RAVLT Handbook was published in 1996 by Schmidt in an effort to compile the research conducted using this verbal memory assessment (Schmidt, 1996). The RAVLT was originally developed by André Rey in 1941. It is a verbal list-learning test consisting of 15 unrelated words. It includes a measure of immediate memory, intermediate memory, delayed recall, and recognition, as well as a measure of proactive interference. A number of studies have been conducted regarding the RAVLT including language variations in French, English, Hebrew, German, Italian, and Dutch. Combined research regarding the reliability and validity of multiple test versions has been conducted and compiled into metanorms for use by practitioners in neuropsychology assessments, rehabilitation assessments, and general psychological evaluations (Schmidt, 1996). Metanorms, in the case of the RAVLT, were generated by combining the data of all studies cited in the RAVLT manual (Schmidt, 1996). The RAVLT is relatively quick and easy to administer, and the directions of the assessment are easily understood by most examinees. Similarly, the RAVLT does not require multiple moving pieces or special set-up to be administered (Schmidt, 1996).

Norms for this assessment include individuals age 7 through 89 and are comprised of data gathered through multiple research studies. Norming information for children, age 7 to 12, was only obtained by one study conducted by Forrester and Geffen in 1991. The same is true for children age 13 with only Munson's 1987 data. With regards to adult performance, 14 studies are considered within the meta-norming data. Each study focused on different subject groups including individuals with high cognitive performance, college students, young adults of average intelligence, and individuals in correctional settings (Schmidt, 1996). Elderly individuals of average cognitive performance, high performing ability, and lower functioning were measured through five studies with the largest norming sample coming from the Mayo Older Americans Normative Studies (MOANS) normative data reported in 1992 (Schmidt, 1996). Considerations for effects of age, educational level, intelligence, gender, and presence of a clinical diagnosis are included in the Handbook. Overall, RAVLT performance was seen to improve with age in children and decrease with age in adults, small to moderate positive correlations have been noted between educational level and performance, gender studies have indicated female participants tend to perform as well as or better than their male counterparts on the RAVLT, and individuals with injury of the left hemisphere or frontal lobe show diminished ability with memory tasks in relation to neurotypical participants (Schmidt, 1996).

Correlation between RAVLT performance and early versions of the WAIS were also completed by researchers and is reviewed in the RAVLT Handbook (1996). The first of these was completed by Query and Berger (1980; as cited in Schmidt, 1996). In this study, significant correlation (r = .61) between RAVLT recognition memory and WAIS FSIQ were identified. Learning, however, was not correlated with FSIQ scores. In 1983, Query and Megran identified additional correlations among WAIS FSIQ, learning, and recognition memory (as cited in Schmidt, 1996). Studies including the WAIS-R FSIQ in 1986-1990 show similar variation, sometimes demonstrating mild correlations and other times showing no significant relationship among FSIQ, learning, and recognition memory.

**Current Research in Memory and Cognition**

Many cognitive assessments include measures of memory functioning. For example, the WAIS-IV assesses working memory via the Digit Span, Arithmetic, and Letter-Number Sequencing subtests (Wechsler, 2008). Memory performance is shown to be correlated with overall cognitive functioning in a number of studies, including the 2012 study conducted by Murayama and colleagues. with elderly individuals in Japan. In this study, researchers sought to compare memory and intelligence, using the Wechsler Memory Scale Revised (WMS-R) and the Wechsler Adult Intelligence Scale, Third Edition (WAIS-III), as they relate to educational attainment. Though educational level demonstrated a small correlation with working memory ability, cognition and memory were highly correlated. Specifically, Verbal IQ was found to be highly correlated with memory performance and did not indicate the same level of cognitive decline associated with older individuals and those with Alzheimer's (Murayama et al., 2012).

Correlations in cognition and memory are additionally noted by recent research by Morales and colleagues (2017). In this study, individuals with mild or moderate intellectual disabilities were presented with a memorable event then asked to recall certain aspects of the experience after one hour and again after one week. Those with a moderate intellectual disability, defined as an IQ between 35 and 55, recalled fewer details about individuals they had interacted with than those with mild intellectual disability, defined as an IQ between 55 and 70 (Morales et al., 2017). The ability to describe details of the person they had interacted with during the stimulus activity was significantly correlated with the participant's total IQ, but showed even greater correlation with verbal IQ specifically (Morales et al., 2017).

Similarly, Schuchardt, Gebhardt, and Mäehler (2010) sought to distinguish if the level of cognitive impairment showed concomitant levels of weakness in working memory functioning. Levels of cognitive impairment were labeled as borderline intellectual disability (BID; IQ 70 to 84) or mild intellectual disability (MID; IQ 50 to 69). Working memory tasks involved visual, verbal, and executive memory processing. As expected, the ability to perform working memory tasks was much more developed in children with average cognitive ability, was more difficult for those with borderline intellectual disability, and showed more significant impairment for those with mild intellectual disability (Schuchardt, Gebhardt, & Mäehler, 2010).

With specific regard to cognitive performance in patients with epilepsy, Baxendale, McGrath, and Thompson (2014) spotlighted the discrepancy in FSIQ and General Ability Index (GAI) scores on the WAIS-IV. While the FSIQ score contains verbal, perceptual, memory, and processing speed domains, the GAI eliminates the influence of slow processing and working memory deficits on the core cognitive areas of visual and verbal processing. In this research, 100 adults who were referred for neuropsychological evaluations were administered the 10 core subtests of the WAIS-IV comprising the FSIQ. For each participant, FSIQ and GAI scores were calculated to determine if a discrepancy was present between the two in patients with continuing seizure activity while on medication. While 11% of the measured sample demonstrated a clinically significant difference in their FSIQ and GAI scores, 44% demonstrated at least a statistically significant difference in their performance scores (Baxendale et al., 2014). This research sought to consider the impact of certain antiepileptic drugs on cognitive processes, but additionally noted the impacts of epileptic activity on memory and processing speed in adults.

More recent studies with the WAIS-IV and the working memory index from the Wechsler Memory Scale—Third Edition revealed strong correlations between their respective working memory indices (above .60). Even stronger correlations were found between the WAIS-IV Full Scale score and the WMS-III Working Memory Index ($r$ = .69). Additionally, the WAIS-IV Verbal Comprehension index was more highly correlated with the WMS-III Auditory Memory index than with the Visual Memory index (Wechsler, 2008). Other researchers, however, found an association between working memory and nonverbal reasoning. Specifically, Voelke, Troche, Rammsayer, Wanger, and Roebers (2013), sought to understand the association between IQ and the ability to discriminate between various sensory experiences. They believed that working memory to be a mediating factor in this association and could help explain the connection between sensory discrimination and cognitive ability. They concluded that there is “a significant amount of overlap” between working memory and fluid reasoning (p. 533) and that working memory accounted for a greater degree of variance in fluid reasoning than sensory processing (2013).

Still, other researchers have found that level of IQ tended to influence the degree of association between IQ and memory. Foley, Garcia, Saw, and Golden (2009) researched the relationships between cognitive ability level, memory/learning skills, academic achievement, and flexible problem-solving skills in students. They found that for those with above average range IQ scores demonstrated a higher correlation between IQ and verbal memory than those with lower levels of cognitive functioning. For children with below average range IQ, their cognitive ability was associated with flexible problem solving and both verbal and visual memory.

Lastly, regarding traumatic brain injury, a comprehensive study by Johnstone, Leach, Hickey, Frank and Rupright (1995) found that TBI patients with frontal lobe injury demonstrated greater deficits in memory for stories on the WMS-R, the intervening memory task from the RAVLT, and a measure of cognitive flexibility than those with no history of brain injury. However, patients with non-frontal lobe TBI demonstrated significantly more impairment on measures of immediate verbal memory, memory for stories, and on all aspects of the RAVLT compared to patients with a non-frontal lobe brain injury.

## Summary

Cognitive and memory tests are often used in conjunction with adults suspected of having learning, neurocognitive, and attention problems. The research reviewed for the current study demonstrated a rather strong relationship between overall cognitive functioning and memory abilities, which seems to question whether cognitive functioning and memory functioning are separate constructs. To date, there have been no studies that specifically sought to determine when an IQ/memory discrepancy is meaningful from a statistical standpoint. The strong correlation between IQ and memory indicates that these constructs (or more accurately, scores on these scales) fluctuate in a predictable way. It is when the IQ and memory scores are statistically different that is the focus of this study.

# CHAPTER THREE: METHODS

## Participants

The cognitive ability and memory data from 42 adult clients were collected by the faculty mentor from archives from a psychological clinic on the Murray State University campus that provides low-cost assessment and consultation services to members of the public. Community members are provided a range of psychological services through this clinic, including testing for learning disabilities, ADHD, and mood disorders. All data were treated in accordance with the approved IRB protocol. These 42 folders represented 100% of the files from fiscal year 2016 that met the research parameters—this is, they had a complete WAIS-IV test and a complete RAVLT. The mean age for the 42 subjects was 27.0 years (*SD* = 10.7 years). Coincidentally, the number of males and females was identical (males, n = 21; females, n = 21). Of the participants and overwhelming majority were Caucasian (n = 38) and few were African American (n = 4).

## Instrumentation

Wechsler Adult Intelligence Scale—Fourth Edition (WAIS-IV; Wechsler, 2008). The WAIS-IV is an individually-administered test of intelligence designed for ages 16 years to 89 years. It consists of 10 subtests that are combined to generate a Full-Scale IQ (FSIQ). Different non-overlapping combinations of subtests generate the Verbal Comprehension Index (VCI), the Perceptual Reasoning Index (PRI), the Working

Memory Index (WMI), and the Processing Speed Index (PSI). The VCI measures verbal reasoning, word knowledge, and fund of general information. The PRI measures fluid reasoning, conceptual thinking, and visual-spatial problem solving. The WMI measures short-term auditory memory, verbal attention, and verbal multitasking. Lastly, the PSI measures eye-hand coordination, decision speed, and visual scanning speed. The WAIS-IV has been thoroughly researched and has strong validity and reliability (Wechsler 2008).

Rey Auditory-Verbal Learning Test (RAVLT; Schmidt, 1996). The RAVLT is an individually administered test of verbal memory and verbal learning. It generates standardized z-scores for five different scales—Immediate Memory, Total Memory, Intermediate Memory, Delayed Memory, and Recognition Memory. The Recognition memory index was not used for this study. The norms for the RAVLT are provided in the manual (Schmidt, 1996). Although the RAVLT provides a number of different norm tables, only the metanorms for the age of the client were used for this study. The RAVLT, like the WAIS-IV described above, has been thoroughly researched and is considered valid and reliable (Schmidt, 1996).

**Procedures**

In accordance with the IRB approved research protocol, the faculty mentor physically pulled the folders from archives (described above) and entered the variables of interest on an Excel spread sheet. The specific variables were sex, age, the standard scores for the FSIQ, VCI, PRI, WMI, and PSI from the WAIS-IV and the standard scores for the Immediate Memory, Total Memory, Intermediate Memory, and Delayed Memory scales from the RAVLT. Once entered, the documents were replaced, and the folders were filed in a locked file cabinet in the faculty mentor's office. The data were uploaded to SPSS for further analysis.

**Hypotheses**

It was hypothesized, based on previous research with the WAIS-IV and the WMS-IV that the VCI and WMI scales would correlate higher with the different scales from the RAVLT than the PRI and PSI scales. It was also hypothesized, based on these correlations, that a confidence band could be obtained allowing one to judge, statistically, when differences between the IQ indices and the RAVLT scales were meaningful and therefore should be interpreted as separate constructs.

**Analyses**

First, the RAVLT scores were converted from a z-score to a standard score with a mean of 100 and a standard deviation of 15 (identical to the WAIS-IV) to more easily and reliably compare scores from the two tests. Second, descriptive data were obtained, including the average age, proportion of males/females, average WAIS-IV scores, and average RAVLT scores and are provided in Table 1. Third, the correlations between the WAIS-IV and RAVLT variables were conducted using Pearson correlations. Lastly, a series of simple regressions were computed using the individual WAIS-IV indices as the independent variable and the RAVLT scales as the dependent variable. The "Enter" method was employed, and the standardized residuals were saved in order to obtain the standard deviation of the residuals. A simple regression is a statistical method of predicting a score on one dependent variable (i.e., the predicted or outcome variable) from the score on an independent variable (i.e., the predictor variable; Field, 2013). Lastly, the standard deviation of the standardized residuals is an index of the imprecision of the model. Because scores on the dependent variable cluster predictably around the line of best fit (which is based on the independent variable), this scatter has a standard deviation (Field, 2013) and is normally distributed. The more closely the two variables are correlated, the smaller the standard deviation of the residuals. It is this standard deviation of the residuals that can be used to generate a confidence band—a method of determining when the predicted score is statistically different from expectations. For example, if the standard deviation of the standardized residuals is 10 points, and the score on the independent variable is 100, then one could say that there is a 68% chance that the score on the dependent variable will fall between a score of 90 and 110.

# CHAPTER FOUR: RESULTS AND DISCUSSION

## Results

A review of the skewness and kurtosis indices revealed that both data sets (i.e., the Wechsler scales and the RAVLT) were normally distributed, thus allowing for parametric statistical tests. Tables 1 and 2 show the means and standard deviations for both instruments as well as the number of cases within each category. As a group, the mean Wechsler scale scores were within the average to low average range. Specifically, the mean Full Scale, Verbal Comprehension, and Perceptual Reasoning scores were at the lower limits of the average range while the Working Memory and Processing Speed indices were in the low average range. Compared to the normative sample described in the WAIS-IV manual, the standard deviations for the sample were quite similar (between 14 and 16 points). Similarly, for the RAVLT, mean scores for the sample ranged from the low average range in Immediate Memory and Total memory to the lower limits of the average range in Intermediate Memory and Delayed Memory. Here, the standard deviations were higher than those found on the WAIS-IV (between 14.2 and 19.9).

Table 3 summarizes the Pearson correlations between the WAIS-IV and RAVLT. Sixteen of the 20 WAIS-IV/RAVLT index pairings were statistically significant—the strongest correlation was found between the Processing Speed Index from the WAIS-IV and the Total Memory Index from the RAVLT ($r = .582$). The weakest correlation was found between the Perceptual Reasoning Index from the WAIS-IV and the Immediate Memory Index from the RAVLT (r = .206). These correlations were similar to those obtained from the WAIS-III and WMS-III study (Murayama, 2012) and the WAIS and RAVLT (Query & Berger, 1980).

Lastly, a series of simple regressions were computed using the WAIS-IV index as the predictor variable and the individual RAVLT indices as the predicted variable (Table 4). When using the FSIQ as the predictor variable and the RAVLT Immediate Memory score as the predicted variable, the resulting R value was .457 and the resulting R square was .209. The R square is the square root of the R value and provides an estimate of the overlap or shared variance between the two variables. For the FSIQ/Immediate Memory pairing, this means that the FSIQ and the RAVLT Immediate Memory share about 20% variance. The resulting standard deviation of the residuals of 12.4. This means that for any given Full-Scale IQ score, the Immediate Memory score will fall within 12.4 points of that score 68% of the time. Using the FSIQ as the predictor score and the remaining RAVLT indices as the predicted variable, the standard deviation of the residuals was 15.4 for the Total Memory score, 12.6 points for the Intermediate Memory score, and 13.2 points for the Delayed Memory.

For the remaining WAIS-IV indices, the standard deviation of the residuals was quite similar. Specifically, when using the Verbal Comprehension index to predict the four scales from the RAVLT, the resulting standard deviations ranged from a low of 12 points for the Immediate Memory scale to a high of 19 points for the Intermediate Memory scale. For the Perceptual Reasoning index, the RAVLT standard deviations ranged from a low of 13.7 for the Immediate Memory scale to a high of 17.9 on the

Intermediate scale. When using the WMI index to predict the RAVLT scales, the standard deviations ranged a low of 12.3 to a high of 19.3. Lastly, when predicting the RAVLT scales from the PSI index, the resulting standard deviations ranged from a low of 12.6 for the Immediate Memory to a high of 17.8 on the Intermediate Memory scale. Across all five WAIS-IV indices, the strongest correlations (and therefore the lowest standard deviations) were found on the Immediate Memory scale, followed by the Total Memory scale. The Delayed Memory and Intermediate scales consistently had the weakest correlations (and therefore the highest standard deviations).

**Discussion**

As expected, given previous research (Foley, Garcia, Saw, & Golden, 2009; Morales, 2017; Query & Berger, 1980; Schuchardt, Gebhardt, & Mäehler, 2010; Voelke et al., 2013) there were significant correlations between the WAIS-IV intelligence test and the RAVLT verbal memory test. What is different about this study, however, is the series of standard deviations that were generated based upon the regression analyses. These standard deviations permit examiners to reliably predict when discrepancies between IQ scores from the WAIS-IV and verbal memory scores from the RAVLT are statistically uncommon. To date, no research has been found that compared these two instruments to generate a confidence band of sorts (using the standard deviation of the residuals). The associations between the FSIQ, VCI, and WMI indices and the RAVLT scales were not surprising—these three WAIS-IV scales are verbally loaded. Conversely, the associations between the PRI and the PSI indices were surprising, since these scales are purported to be measuring more nonverbal abilities (Wechsler, 2008). However, this finding too was consistent with previous research (Voelke et al, 2013). In many ways, these strong associations between all aspects of the WAIS-IV and all most aspects of the RAVLT suggest that both tests share considerable variance—on other words, the two tests overlap considerably and seem to be measuring similar constructs.

In terms of the hypotheses, the first hypothesis was not wholly supported; in fact, most aspects of the WAIS-IV were associated with the different RAVLT indices. This is surprising since half of the WAIS-IV is considered to be measuring verbal information processing (verbal perception, encoding, retention, and decoding) and half is considered to be measuring the visual, spatial, and perceptual aspects of cognitive functioning. The second hypothesis, on the other hand, was supported. Based upon the correlations and regression analyses, an easily interpreted and meaningful confidence band was generated, allowing practitioners to better understand when and how to interpret differences between general intellectual functioning and verbal memory.

# CHAPTER FIVE: IMPLICATIONS, LIMITATIONS, and FUTURE RESEARCH

## Implications

Normally, in neuropsychological testing, cognitive ability tests and memory tests are interpreted separately. The results of this study, however, suggest that, at least for the WAIS-IV and RAVLT, cognitive functioning and verbal memory are measuring similar constructs. This is important because it cannot be argued that the RAVLT is providing any additional information regarding how a client's memory deficits may be hindering their day to day functioning above and beyond their deficits in general intellectual functioning.  Conversely, when considering the standard deviations of the residuals (indicated in Table 4), examiners will be able to consider the RAVLT when scores on this instrument fall beyond or outside of the confidence band. This confidence band is the standard deviation of the residuals and stems directly from the regression equations.

In practice, then, when evaluating clients and the examiner has administered the WAIS-IV and the RAVLT, the examiner should first convert the RAVLT scores from a z-score to a standard score with a mean of 100 and a standard deviation of 15. Then, examiners should specifically consider the one of the four memory scores when it falls outside of the confidence band. For example, the confidence band (aka standard deviation of the residuals) for Immediate Memory is 12 points when comparing it to the VCI. If the client's VCI score is 85, then scores that fall below 73 are lower should be considered an unexpected weakness and those falling 97 or higher should be considered an unexpected strength. If the Immediate Memory score is within plus or minus 12 points of the VCI score (in this instance, 73 to 97 for a VCI score of 85), then the Immediate Memory score should not be considered unusual or unexpected. Put another way, 68% of the time a RAVLT Immediate Memory score will fall within 12 points of the VCI score. Similarly, a RAVLT Intermediate scale score will fall within 19 points of the VCI score 68% of the time.

In practice, the most efficient way to use the data obtained for this study would be to generate a simplified discrepancy table (see Table 5) that permits easily comparison between the FSIQ, VCI, and WMI indices and the RAVLT. By rounding the standard deviations to the nearest whole number, an examiner could simply refer to the table in order to determine when an unexpected discrepancy between any specific WAIS-IV/RAVLT pairing is unexpected. Then the WAIS-IV/RAVLT discrepancy meets the criteria, then the RAVLT index should be interpreted. If not, then the examiner should interpret the RAVLT scale score by indicating that it is consistent with or commensurate with expectations given the client’s score on the WAIS-IV. It is important to note too that comparisons between the PRI and PSI and the RAVLT scales were not provided since, in practice, the relationship between verbal memory and nonverbal reasoning (PRI) and between verbal memory and processing speed (PSI) are of no real interpretive interest since they are perceived to be measuring different constructs and different areas of the brain.

## Limitations

Like all studies, this study has limitations that hinder its applicability and generalizability to a broader population. First, the sample size, while substantial, was still too small to consider a broader application. Second, the participants were primarily Caucasian, which would limit the study's generalizability to a more diverse population of consumers. Third, the participants represented a diverse sample of clinically-referred young adults—the participants were referred for testing for learning disabilities, ADHD, or a mood disorder and had a mean age of 27. As such, the findings lack external validity with adults with a brain injury or those with dementia, Alzheimer's disease, or other age-related disorders.

## Future Research

Future researchers interested in extending this research should consider obtaining a larger, older, and more racially diverse sample. Similarly, if researchers want to use a younger sample, they should consider focusing on clients referred for more unidimensional conditions, such as traumatic brain injuries, learning disabilities, ADHD, or mood disorders (in isolation). Researchers should consider extending this research to other measures of intellectual ability (the WJ-IV COG) and other measure of verbal memory and visual memory (the WMS-IV, the RCF). It would also help to extend this research to children using the WISC-V or KABC-2 as the intelligence measure and the WRAML, TOMAL, or Children's Memory Scale as the memory measure.

Table 1.

*Descriptive statistics for the WAIS-IV and RAVLT*

| WAIS-IV | Mean | *SD* | Category |
|---|---|---|---|
| Full Scale IQ | 88.2 | 14.8 | Low Average |
| Verbal Comprehension | 90.3 | 15.2 | Average |
| Perceptual Reasoning | 92.4 | 16.4 | Average |
| Working Memory | 86.7 | 14.2 | Low Average |
| Processing Speed | 89.2 | 15.5 | Low Average |
| RAVLT | | | |
| Immediate Memory | 86.3 | 14.0 | Low Average |
| Total Memory | 85.6 | 18.2 | Low Average |
| Intermediate Memory | 90.9 | 19.9 | Average |
| Delayed Memory | 92.6 | 19.0 | Average |

Note. Scores 90 to 110 are generally considered "average"
*N* = 42.

Table 2.

Distribution of WAIS-IV Full Scale Scores

| Category | Score Range | *N* |
|---|---|---|
| Extremely Low | <70 | 4 |
| Borderline | 70 – 79 | 9 |
| Low Average | 80 – 89 | 8 |
| Average | 90 – 109 | 19 |
| High Average | 110 – 119 | 2 |
| Superior | 120 – 129 | 0 |
| Very Superior | 130+ | 0 |

*N* = 42.

Table 3.

*Pearson Correlation Matrix Between the WAIS-IV and RAVLT*

| | RAVLT Scales | | | |
|---|---|---|---|---|
| | Immediate | Total | Intermediate | Delayed |
| WAIS-IV Index | | | | |
| Full Scale IQ | .457/.002* | .567/.001* | .436/.004* | .470/.002* |
| Verbal Comprehension | .500/.001* | .449/.003* | .302/.052 | .335/.030* |
| Perceptual Reasoning | .206/.190 | .442/.003* | .432/.004* | .454/.003* |
| Working Memory | .479/.001* | .451/.003* | .238/.129 | .248/.113 |
| Processing Speed | .431/.004* | .582/.001* | .445/.003* | .477/.001* |

*N* = 42.
*= statistically significant at the .05 level or greater

Table 4.

*Summary of shared variance and Residual standard deviation of the residuals between the WAIS and Rey Scales*

| WAIS-IV Index | RAVLT Scale | *R* | $R^2$ | *Resid. SD* |
|---|---|---|---|---|
| FSIQ | Immediate Memory | .457 | .209 | 12.4 |
| | Total Memory | .567 | .322 | 15.0 |
| | Intermediate Memory | .436 | .190 | 17.9 |
| | Delayed Memory | .470 | .221 | 16.8 |
| VCI | Immediate Memory | .500 | .250 | 12.0 |
| | Total Memory | .449 | .202 | 16.2 |
| | Intermediate Memory | .302 | .091 | 19.0 |
| | Delayed Memory | .335 | .112 | 17.9 |
| PRI | Immediate Memory | .206 | .043 | 13.7 |
| | Total Memory | .442 | .195 | 16.3 |
| | Intermediate Memory | .432 | .187 | 17.9 |
| | Delayed Memory | .454 | .206 | 16.9 |
| WMI | Immediate Memory | .479 | .230 | 12.3 |
| | Total Memory | .451 | .203 | 16.2 |
| | Intermediate Memory | .238 | .057 | 19.3 |
| | Delayed Memory | .248 | .062 | 18.4 |
| PSI | Immediate Memory | .431 | .186 | 12.6 |
| | Total Memory | .582 | .339 | 14.8 |
| | Intermediate Memory | .445 | .198 | 17.8 |
| | Delayed Memory | .477 | .228 | 16.7 |

*N* = 42

Table 5.

Simplified Interpretation Matrix for Interpreting Differences Between the WAIS-IV and RAVLT

| WAIS-IV Scale | RAVLT Scale | +/- Difference needed to Interpret |
|---|---|---|
| FSIQ, VCI, WMI | Immediate Memory | 12 pts |
| FSIQ, VCI, WMI | Total Memory | 16 pts |
| FSIQ, VCI, WMI | Intermediate Memory | 19 pts |
| FSIQ, VCI, WMI | Delayed Memory | 18 pts |

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